COMPREHENSION DURING INTERPRETING: WHAT DO INTERPRETERS KNOW THAT BILINGUALS DON'T?

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A fundamental question for professionals involved in the selection, training, evaluation and hiring of simultaneous interpreters is that of what interpreters know that bilinguals do not. Do simultaneous interpreters know different strategies for allocating attentional and memory resources? For making sentence processing more efficient? For bringing prior knowledge to bear on comprehension? Answers to these questions are important in that they can provide the principles on which to base assessment of proficiency and aptitude, planning of training, and on-going improvement of professional performance.

Although simultaneous interpreting has received increasing attention as an object of study (Mackintosh, 1985; Henry & Henry, 1987; Gile, 1988), unfortunately little of it has been in the form of reliable experimental research (Gile, 1988). Consequently, precious little is known about the differences between experienced and novice interpreters' performance, and nothing at all is known about any possible differences in the way they go about carrying out the task (Dillinger, 1989). Two sets of opinions, however, have emerged on this issue.

In most studies, it is assumed and/or asserted (without evidence) that the skills of interpreters are not characteristic of bilinguals in general (e.g., Gerver, 1976: 167), and hence that the models developed of skilled interpreting do not apply to novice interpreters (e.g., Moser, 1978: 361). On this view, then, there are important but still unidentified differences in the ways that novice and experienced interpreters perform the task. An important implication of this view is that experience and training are of great importance because they lead to qualitative differences in how the task is carried out.

More specifically, Nida (1969, cited in Gerver, 1976: 198) predicts that "experienced simultaneous translators may often short circuit the deeper [semantic] level of analysis". Although there is no evidence either for or against Nida's hypothesis, nor is it clear just what he meant, experienced interpreters have been found to add more information and delete less (Barik, 1969), process larger chunks of the input, and give less literal translations (McDonald & Carpenter, 1981), as well as being less sensitive to whether translation is from or into the dominant language (Lawson, 1967; Barik, 1969).

The second position holds that translation ability in general (e.g., Harris & Sherwood, 1978) and interpreting skill in particular (e.g., Longley, 1978: 47) are natural consequences of bilingualism. On this view, then, there are few or no differences in the ways that novice and experienced interpreters (as distinct groups) perform the task: there are only individual and quantitative differences in text processing skill. This implies that experience and training have little effect on how the task is carried out. There is apparently no experimental evidence available either for or against this second position.

The research reported here was carried out in an attempt to address, in a systematic fashion, the question of whether there are qualitative differences in processing between novice and experienced interpreters, and thus to provide strong evidence in favor of one or the other position as well as an empirical base for characterizing the nature of interpreting skill. Rather than attempting to study interpreting in all its complexity, however, this research focussed only on the interpreters' comprehension processes to permit more detailed consideration of them. Translation and production processes were left for further research.

To address the issue of possible differences in comprehension processing, bilinguals with no interpreting experience were contrasted with experienced conference interpreters with respect to the degree to which their interpreting performance reflected different degrees of comprehension of the source text. The general question about this half of interpreting skill was broken down into more specific questions about the different kinds of syntactic and semantic processing going on in comprehension during interpreting.

Method

Subjects. The experienced interpreters (no.= 8) were professional conference interpreters from the Montreal area with an average of 3830 hours[1] of active interpreting experience. The group was predominantly female (75%), and the average age was estimated at 45 years.

The inexperienced interpreters (no. = 8) were bilingual graduate students attending one of the two English-language universities in Montreal (McGill or Concordia). These subjects had never attempted simultaneous interpreting before. Males were more numerous in this sample (69%), and the average age was 29 years.

Other than self-evaluation, no assessment of subjects' bilingualism was attempted, since in several studies self-rating proved most highly predictive of performance, especially among highly educated subjects (see Albert & Obler, 1978: 45). All subjects were quite obviously very proficient in both languages (i.e., balanced bilinguals), and all subjects used both languages on a day-to-day basis (overall, English 53% and French 47% of the time), so there is reason to believe that subjects' self-evaluations of dominance reflected only small differences in their functional language skills, especially with respect to comprehension. Of the experienced interpreters, 25% of the subjects gave English as their better language, 50% gave French, and 25% said they were equally fluent in both. The responses were the same for the language they preferred to translate into. Of the inexperienced subjects, 69% of them gave French as their better language, 6% gave English, and 25% reported that they were equally fluent in both.

Some authors (e.g., Gile, 1990, p. 7) consider a "major methodological problem" with experimental research that the data acquired are not "representative" because the samples are small and non-random, which "severely limits the validity of statistical tests performed on them". This is quite correct, but only when inappropriate use is made of the statistical analysis techniques. Samples are in fact usually small, but there are a variety of statistical techniques that were developed or adapted for the analysis of small samples (such as the repeated-measures ANOVA or profile analysis used here). The sample used here is not non-random — that would imply some systematic selection of subjects — but no sampling method using human subjects is truly random. Sampling from human subjects is always biased by their willingness to cooperate and by their spatial distribution, hence convenience for the experimenter. Thus, it is not realistic to expect perfectly random sampling for any experiment. The consequences of this deviation from randomness are well-known and many statistical techniques are insensitive to all but very gross deviations. The worst scenario in any case is that one would not be able to generalize beyond the subjects used — but even then the information is still perfectly valid for those subjects. Gile's preoccupations are well placed, even if exaggerated: the inappropriate use of statistics is not only uninformative, but can yield misleading results.

Materials. Two 580-word texts in English (see Appendix A), a narrative and a procedure, were used as stimuli.

To assess the processes dealing with high-level semantic ("frame") information which is often associated with text type, it was very important to isolate frame-level properties as the only important difference between texts. This was to permit the interpretation that text differences were due primarily to differences in these frame properties. To assure the reliability of this contrast, a multidimensional profile of some thirty lexical, syntactic, and semantic properties was constructed and the two texts were equated along each dimension (see Dillinger, 1989, Ch. 4). This strategy yields a finer-grained, much more reliable comparison across texts than the similar-length-and-content comparison usually found in comprehension and interpreting studies using more than one text.

In an attempt to neutralize the effects of prior knowledge on comprehension, texts on a topic unfamiliar to the subjects (positron emission tomography) were used. Rate of presentation was controlled at 145 words per minute, for all subjects (see Gerver, 1976 for the effects of rate of presentation on interpreting accuracy).

It should be made perfectly clear that the texts were **not** "artificially composed with the aim of obtaining certain linguistic characteristics" (Gile,

1 Given that under normal conditions professional interpreters work 20 minutes on, 20 minutes off during a six-hour working day, that is 3 hours of interpreting per day, and that a reasonably active interpreter might work some 150 days per year, the subjects who participated here therefore had an average of 8.5 years' interpreting experience.

1990: 6). The texts were written with the express intention of making them "communicative", natural texts; they were written to be read to an audience. The linguistic characteristics of the texts were measured afterwards. Even so, some might consider them "artificial", but it is not clear what that might mean or how it might affect interpreters' performance. It might mean that the prose is turgid or stilted; but that is merely a question of taste. It might also mean that they're not the sorts of texts that one would find as "conference speeches given to delegates," but one could conceive of a science education conference from which these texts could have been excerpted. In any case, what sort of conference with what sort of delegates would have to be involved for one to speak of a "natural" text and more valid interpreting data? It might also mean that the texts are "artificial" because they were not excerpted from actual conference proceedings. One might ask, however, why this would make a difference. No one knows what the differences are (if there are any) between the texts used here and the sorts of texts found in actual conference situations. The hypothesis that the texts are different and the processes involved in comprehending and interpreting them are qualitatively different because one text was presented to an audience and the other was not is not only unsupported by any evidence, but also seems entirely implausible. In sum, there seem to be no objective criteria to judge the "artificiality" or "naturalness" of the texts used, and more importantly, there is no evidence that the "artificiality" of the texts makes any difference in how interpreters interpret.

Tasks. Subjects were instructed to interpret, and afterwards to recall, each experimental text. They were explicitly instructed not to worry about remembering the text but to concentrate on interpreting it. Both texts were presented in English; interpreting was from English into French. Presentation of each text lasted approximately four minutes. A short practice text on a related topic was also presented to all subjects for warm-up.

Procedure. Subjects were seated individually in a small, quiet room which was very similar in appearance to an interpreter's booth, equipped with a Fostex X-15 series II four-track cassette tape recorder and full-sized enclosed headphones with an unobtrusive Radio Shack 33-1063 miniature lapel microphone clipped to the headphone wire. After a short introduction presented on tape, subjects interpreted a two-minute warm-up text, then the first experimental text. After the first experimental text, they were asked to provide a recall of it, and took a short break while the experimenter readied the equipment for the second text. Finally, they interpreted the second experimental text and provided a recall. All instructions and stimuli were presented binaurally from the left channel (channel 1) of the stimulus tape. Subjects' interpreting performance, as well as their recalls, were recorded on the right channel (channel 2). After the task was completed subjects were given a short debriefing session to get information on their training, experience and reactions to the experiment.

Deviations from standard interpreting practice. Much ink is wasted in the literature on interpreting to decry experimental research as irrelevant and uninteresting. Most of the experimental research admittedly does not address the questions that interpreters and interpreter-trainers would like answered. Some of it is even flawed methodologically. This, however, is to be expected in a field with no experimental tradition and little theoretical development, and does not justify the view implying that it should not be undertaken. The current situation, in which practitioners and experimenters have become polarized around pseudo-issues such as the "validity" or "representativity" of experimental data, has had the single effect of stunting the growth of research on interpreting. Everyone, practitioners and experimenters alike, loses when research on interpreting is not done: practitioners lose the opportunity to acquire reliable information about how to identify and develop interpreting skills, and experimenters lose the opportunity to investigate one of the most complex linguistic processes known. It is not enough to encourage interpreters to do research, because they commit basic errors of experimental design and statistical analysis, not having in-depth training in them. Nor is it sufficient to encourage experimenters to study interpreting, because they commit basic errors of interpreting practice, not having the necessary experience with the task. The only rational solution, of course, is to do cooperative research, since neither has the necessary experience with the others' expertise.

Out of respect for practitioners' concerns about how well laboratory data corresponds to real-world interpreting, the following task analysis is offered in an attempt to show that the data obtained here are to no small extent "valid" and "representative". The experimental task used in a laboratory setting for this study seemed to deviate from standard interpreting practice in several ways:

1) The task was decontextualized. That is, the text interpreted was not presented in the context of a particular audience, on a particular social occasion such as a conference of specialists. These communicative parameters were left undefined, and constitute the major difference between laboratory and natural conditions. The extent to which this may affect actual interpreting performance has not been studied in any detail, although its importance has been repeatedly emphasized by Seleskovitch (1984) and colleagues. It is important to bear in mind, however, that their theorizing is based almost entirely on the interpretation of spontaneous speech, in particular dialogue. In a conversational situation, context is obviously much more important than in interpreting a prepared text, so that their theorizing may be less relevant for the present interpreting task.

2) It was not possible to see the speaker. This is a particular instance of the difference pointed out in (1), and subject to the same caveats. Note that all of the examples used by Seleskovitch & Lederer (1984) to emphasize the importance of contextual variables are cases in which either deictic reference to the immediate physical situation or speaker/addressee identity are important, and that neither of these is important in the presentation of a prepared text. Thus, the kind of text chosen and type of social situation (lecture) that was presupposed here both acted to reduce the importance of contextual variables, thus making this laboratory task much more similar to one kind of natural setting than would initially seem to be the case. Moreover, Anderson (1979) found no differences in accuracy between interpreting with or without a view on the proceedings.

3) The interpreters were not allowed to prepare for the task, nor were they allowed to choose the topic. Interpreters sometimes specialize in, or develop a preference for, given topics, and in most cases are given the opportunity to do some preparation before interpreting about a given topic. This difference refers to the role of prior knowledge in interpreting performance, a clearly important, although entirely uninvestigated, factor. This does not, however, make the experimental task very different from normal practice, for the following reasons.

On the one hand, interpreters rarely have technical knowledge of topics they are called upon to interpret; at best they have some general awareness of the area under discussion, at least in Canada where the market does not make great demands on technical specialization. On the other hand, it is unlikely that in a few days' time an interpreter untrained in physics, math or chemistry (i.e., the majority) will be able to understand very much of any technical topic. Moreover, preparation time is used (according to experienced subjects) to become familiar with the vocabulary of the area, rather than attempting to understand theory. This emphasis on the lexical characteristics of a given type of technical text is also reflected in the widespread use of terminology databases and specialized dictionaries. The difference, then, between preparing and not preparing for an interpreting session seems to be one of increasing the subjective frequency of rare words — presumably with a consequent facilitation of access to them, rather than increasing prior knowledge *per se*.

4) There was no audience. One subject reported that an important difference of the laboratory setting was the absence of an audience. She found the tension and pressure to perform an important stimulus that was missing in the laboratory. The consequences for processing are unknown, but one might expect little more than a slight (if any; see Anderson, 1979) decrement in overall performance because of this difference, rather than a major qualitative difference in how the task is carried out.

5) Subjects were not paid. The consequences of this difference are, unfortunately, quite unpredictable, but again might entail a slight decrement in performance. However, it is unlikely that subjects will be able to perform such an enormously complex task in more than one way.

In sum, the main deviations from standard interpreting practice bear on context and prior preparation. The setting and type of text used here (pre-prepared material read in a lecture or radio broadcast setting) reduced the importance of contextual variables. Preparation would have emphasized correct terminology, rather than increasing prior theoretical knowledge. Since the translations produced were analyzed for content, correct or incorrect terminology (cycloscope for cyclotron, for example) made little difference in coding. Thus, the differences between the experimental task and normal practice have been minimized as much as was possible.

Data manipulation. The steps described above yielded 16 interpreting protocols for each text. All of the protocols were transcribed including false starts, hesitations, etc. and were divided into syntactic units to facilitate subsequent analyses. French-language protocols were transcribed by a French-native-language linguist. Only the analyses of these 32 protocols are reported here.

In all comprehension research some

assessment is made of the degree to which the response protocols — in this case, the subjects' translations — match or mismatch the input text (Ericsson & Simon, 1984); this is the fundamental step of generating data from the observations. One typical, but more detailed than usual, form of this analysis (recall/inference coding, see Bracewell, Frederiksen & Frederiksen, 1982) proceeds by categorizing the propositional information units of the original text as absent, recalled, inferred, or recalled with inference in the response protocol. This coding technique has proved to be very useful, and is in fact more detailed and reliable than many more widely used techniques (e.g., simple presence vs. absence of propositions judged without reference to explicit criteria). Since a proposition — the unit of meaning used in this analysis — represents preferentially the "structural meaning" of a sentence, it is made up of a head concept (or predicator), a list of concepts ("fillers"), and their relations ("slots") to the head concept. For example, the structural meaning of "John translated two baroque poems this month" would be represented with the following slot-filler pairs, which constitute two propositions:

HEAD:	translate
AGENT:	John
OBJECT:	(two) poems
TEMPORAL:	(this) month

HEAD:	(two) poems
ATTRIBUTE:	baroque

The slots (in capital letters) are basic semantic relations derived from the work of Fillmore (1968), Gruber (1976) and others, as defined in Frederiksen (1975). This sort of analysis is standard practice for representing sentence meanings in linguistics (where the slots are called "theta roles"), cognitive psychology and computer science. Of course, this notation is understood to represent only a part of the meaning of a given string of words, and it is this structural meaning and the relative synonymy of the words involved that are analyzed in the Bracewell et al. coding technique, as well as that used here.

The attempt in the present study to measure subtle processing differences using a small number of subjects made a more refined adaptation of this method necessary. Rather than matching entire propositions, here the units of comparison were the individual slot-filler pairs that constitute each proposition. That is, each slot-filler pair of each proposition in the input text received a score according to the degree of similarity between it and the segment of the subject's response being analyzed, using the following ordinal scale of similarity:

0 if the slot-filler pair was not present in the segment (*absent*); least similar.

1 if there was a change of meaning in either the slot or the filler (*semantic change*).

2 if there was a change in surface form of either the slot or the filler, without a change in meaning (*paraphrase*).

3 if the slot-filler pair appeared in the segment verbatim (*verbatim*); most similar.

For each proposition, the difference/similarity between the response protocol and the propositions of the input text was represented with three measures: (a) the proportion of the original proposition's slot-filler pairs reproduced with semantic changes, (b) the proportion paraphrased, and (c) the proportion reproduced verbatim.

The response type called verbatim merits some comment in dealing with translation protocols. Obviously, translations are never verbatim, but are meaning-preserving paraphrases in another language. However, in this study, verbatim was used to indicate that in translation the same sentence structure and direct translation-equivalent lexical items were used. Paraphrased responses were those in which there were other meaning-preserving surface changes (for example, use of passive voice instead of active). Perhaps more accurate names for these response types might be strictly meaning preserving and loosely meaning preserving; the relative proportions of each type, however, show that this is not an important difference in the present data.

One question that arises with respect to this coding method is that of its applicability across languages. The semantic relations in terms of which sentence meanings are described were proposed as language universals, and have been used in the analysis of a wide variety of languages. The applicability of such concepts as Agent, Affected Object, Instrument, Location, Time, etc. is hardly controversial; quite the contrary, it would be of great interest to discover a language to which they do not apply. This sort of semantic analysis, as does any other, has its limitations; it does not, for example, capture the connotations of different synonyms, of stylistic differences between roughly synonymous sentences, nor the presuppositions or entailments of different constructions. Such aspects of meaning have been systematically excluded so better to concentrate on the aspects of interest at the moment.

Design and analyses. For each of the experimental texts a database was constructed, using Microsoft® Excel, in which each record (row) corresponded to a text proposition, and each field (column) to information about the linguistic properties of the text. This made it simple to generate information about propositions with a given property (e.g., those found in matrix or non-matrix clauses, that were root or non-root propositions, those found in a segment with n clauses, etc.), as well as to classify propositions by these properties. Once the raw data matrices were appended to these databases as new fields, generating dependent measures by performing calculations on classes of propositions became simple with the database calculation functions built into Microsoft® Excel. The matrices of dependent variables generated by the methods described above were subjected to mixed between and within repeated-measures multivariate analyses of variance using the Multivariance VII statistical analysis package (Finn & Bock, 1985). The between-subjects factors were Experience and Text Order; the within-subjects factors tested were Clause Density, Clause Embedding, Proposition Density, Directness of Mapping, Frame/non-Frame propositions, Frame component, and Text Frame type. See Dillinger (1989, Chapter 4) for details of the within- and between-subjects statistical models used to analyze the data, as well as complete results of the analyses.

Results

The Effects of Experience on Interpreting. This section deals with the differences in interpreting performance associated with the subjects' experience with the task. Recall that the difference in experience between the two groups was intentionally large (3830 hours, or some 8.5 years), precisely so that the differences would show up unambiguously. The interest of identifying these differences is clear: they will indicate what skills the experienced interpreters have acquired over the years. It may be that with experience interpreters come to comprehend more efficiently (quantitative differences) or even in different ways (qualitative differences) than the inexperienced subjects. These differences, of course, are what interpreter training is all about.

Overall. Accuracy of interpreting overall was, as expected, better for the experienced interpreters than for the inexperienced subjects, and this difference was statistically significant (See Appendix B, Table 1 for a summary of the significant statistical tests). Quantitatively, experienced subjects interpreted accurately approximately 17% more of the text than the inexperienced subjects (M_{exp} = 57.6%, M_{inexp} = 41.0%). The difference, although rather smaller than expected, was not at all surprising.

The important, qualitative, questions now arise: what is this advantage due to? What do experienced interpreters know how to do differently or more efficiently than inexperienced bilinguals? Is the difference one of syntactic processing, i.e., having to do with the operations performed on a sequence of words to generate one or more sentences? Is the difference to be found in proposition generation, i.e., the operations that generate propositional meaning units from the grammatical information in clauses and sentences? Or perhaps the difference lies in the ways in which these propositions are linked together to form the more complex meaning structures characteristic of different kinds of texts, i.e., a difference in "frame" processing. Finally, the differences between experienced and inexperienced interpreters might lie in all of these processes, or even in none of them, which would lead to the conclusion that the differences are not to be found in comprehension but in the processes of translation or production. These are the questions dealt with here: rather than just investigate whether and to what extent there is a difference in overall accuracy, the differences in specific processes that underlie this difference — just how this difference is obtained — are studied.

Syntactic Processing. A given item of information might appear in a simple sentence or in a complex one, or in syntactically different places in the sentences; if this affects subjects' ability to interpret, we can conclude that this difference is an indication of the importance of syntactic processing in interpreting. Moreover, if the experienced subjects are more or less sensitive to this syntactic distinction, then we can conclude that their syntactic processing is different from that of the inexperienced subjects. Two such syntactic properties were investigated: clause density and clause embedding.

Clause density designates the total number of clauses per segment — roughly the proportion of subordinate clauses to main clauses —, and as such is a measure of the syntactic complexity of the segment. Each proposition was classified as to whether it was found in a segment with 1, 2, or 3 or 4 clauses (i.e., simple, somewhat complex, and more complex clauses).

Clause embedding designates the syntactic "prominence" of the clause: whether it was a main ("matrix") or subordinate ("non-matrix") clause. Each proposition was classified as to whether it was found in a matrix or a non-matrix clause.

Both of these measures are associated with the assumption that clause density and embedding lead to more "effort" in syntactic processing and consequently to a higher probability of errors in interpreting performance.

None of the tests of the joint effects of experience and either of these syntactic properties revealed any systematic differences (i.e., the interactions of experience with clause density and with clause embedding were not significant). The same was true even when the comparisons were made taking the different kinds of texts into account (i.e., there were no significant interactions of experience and text type with clause density or embedding — See Appendix B, Table 1). This strongly suggests that experienced and inexperienced interpreters are analyzing the grammatical properties of the texts in the same ways during interpreting. The differences between experienced and inexperienced interpreters apparently lie elsewhere.

Proposition Generation. A given item of information (proposition) might appear in a sentence that contains a lot of other information or might be less directly related to the grammatical characteristics of the sentence in question, thus making it more difficult to construct propositional information units from the grammatical information provided. If these affect the subjects' ability to interpret, we can conclude that this difference is an indication of the importance of proposition generation in interpreting. Again, if the experienced subjects are more or less sensitive to this distinction, then we can conclude that their processes of proposition generation are different from those of the inexperienced subjects. Two text properties were investigated that were indicative of this sort of processing: proposition density and directness of mapping.

Proposition density designates the total number of propositions per segment — roughly the number of propositional information units in the segment —, and as such is a measure of the complexity of comprehending each segment. Each text proposition was classified as to whether it was found in a segment with 1 to 3, 4, or 5 to 7 total propositions (i.e., low, medium and highly informative segments).

Directness of mapping designates the correspondence or non-correspondence between the syntactic "importance" the clause and the semantic "importance" of the information in the same clause: if a given unit of information was found in a main (matrix) clause and in a main ("root" or "unembedded") proposition, then the correspondence between clause and proposition was considered direct. The same was the case if both clause and proposition were subordinate ("embedded"). If one was embedded and the other not, then the correspondence was considered indirect.

Both of these measures are associated with the assumption that proposition density and more indirect mappings lead to more "effort" in semantic processing and therefore to a higher probability of errors in interpreting performance.

As was the case with syntactic processing, the tests of the joint effects of experience and proposition density revealed no systematic differences. However, the tests involving experience and directness of mapping showed clear differences, in particular of processing main clauses that corresponded to embedded and unembedded propositions. (See Appendix B, Table 1).

Figure 1 below shows that for both texts unembedded (root) propositions were processed better than embedded propositions, and that this difference was greater for the experienced interpreters. The figure is broken down by text to show that the same qualitative pattern of results was found for both experienced and inexperienced interpreters; the experienced interpreters apparently carried out the appropriate processes more efficiently, hence interpreted more accurately, leading to the quantitative difference shown in the graph. This pattern of results strongly suggests that experienced and inexperienced interpreters are analyzing the texts in the same ways during interpreting, although the experienced interpreters are more accurate in their analyses. This, then, is one difference in what experienced and inexperienced interpreters seem to be doing — a very specific one that deals with giving special treatment to constructing propositional information units from main (matrix) clauses. Note that there were no systematic differences having to do with other kinds of clauses, or with the amount of information per segment.

Frame Processing. A given item of information (proposition) might be more or less important to the kind of text in question or might belong to a part of the text (to an episode, or subprocedure, for example). If either of these properties affects subjects' ability to interpret, we can conclude that this difference is indicative of the importance of linking together propositional information units into what are called "frames",

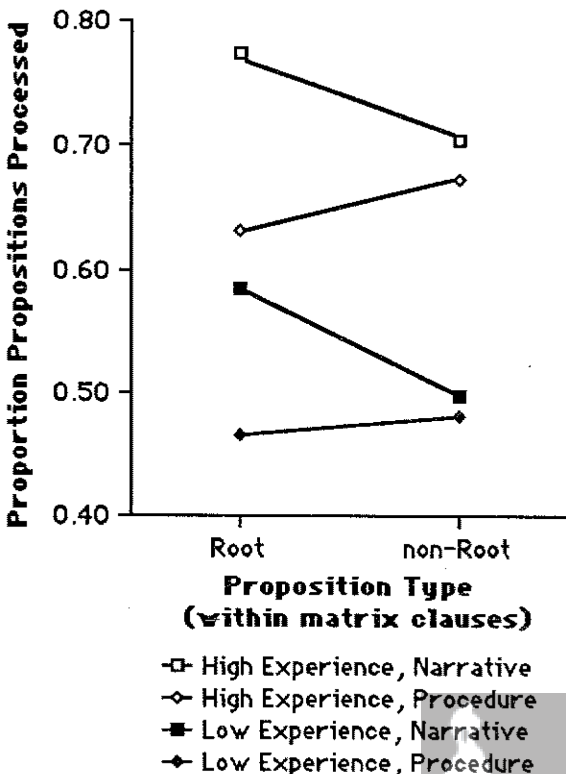

Figure 1. Joint effects of Experience, Text Type and Directness of mapping on interpreting performance.

"scripts" or "schemata" — the more complex information structures that characterize texts, rather than sentences. Again, if the experienced subjects are more or less sensitive to these distinctions, then we can conclude that their processes of frame processing are different from those of the inexperienced subjects. Two text properties were investigated that were indicative of this sort of processing: proposition type within the frame and frame component.

Proposition type refers to whether a given proposition belongs to the main frame structure ("frame" propositions) or not ("non-frame" propositions), and as such is an indicator of the relative "importance" of that proposition to the kind of text frame structure that needs to be built to understand the text.

Frame component refers to the part of the text frame that a given proposition belongs to. The narrative text contained three episodes, so the propositions in that text were classified as to whether they belonged to episode 1, episode 2, or episode 3. Likewise, the procedural text contained three subprocedures, and the propositions in that text were classified as to whether they belonged to subprocedure 1, subprocedure 2, or subprocedure 3.

These measures are associated with the hypothesis that similar parts of a frame are processed in similar ways: that frame propositions are more likely to be interpreted in the same way, and that the propositions belonging to episodes or subprocedures are more likely to be treated together and related.

The tests of the joint effects of experience and these frame-related factors revealed no systematic differences (See Appendix B, Table 1). This once again strongly suggests that experienced and inexperienced interpreters are structuring the propositions of the texts in the same ways during interpreting. The differences between experienced and inexperienced interpreters are apparently not to be found here.

The Effects of Text Structure on Interpreting. The results above dealt with the differences between experienced and inexperienced interpreters. This section deals with the similarities between them: in particular, what aspects of text structure influence interpreting performance, regardless of the subjects' experience? This is of importance because it characterizes the interpreting process in more detail, as well as providing a base for predicting interpreters' performance as a function of text characteristics, and for scaling the difficulty of texts used in training interpreters. A methodological note is in order at this point: the effects of text-structure variables were assessed "within subjects", that is, the statistical tests were carried out with each subject serving as his own "control". This is important because it makes the test much more sensitive than a "between subjects" assessment.

Text Type. Two text types were contrasted in the present study: narrative and procedural. The types were defined in terms of the different ways in which propositional information is structured in each text. If this difference affects subjects' ability to interpret, we can conclude that they are making use of this type of information about the high-level conceptual structure of the text, even in the very limited time they have available. Recall that the two texts were very carefully controlled to be very similar with respect to thirty or so other characteristics, so that text-induced differences can be unambiguously interpreted as being due to the different ways in which propositional information is organized in them. Effects of text type also serve as evidence that interpreters go beyond more or less literal sentence meanings to integrate them into a text structure as they go.

There was a very strong effect of text type on interpreting performance: subjects interpreted significantly more of the narrative text than of the procedure (See Appendix B, Table 2 for a summary of the significant statistical tests involving text type). That is, in spite of the fact that both texts had the same number of words, clauses, cohesive elements, and propositions, as well as similar distributions of the amounts and types of each of these, there was a systematic difference in how well interpreters performed with them. This difference can be attributed to the different ways in which propositional information was organized to form an informational structure, or frame, for the text.

Besides an overall effect of text type on interpreting performance, there were systematic joint effects of text type and each of the text-structure variables (again, see Appendix B, Table 2). In other words, syntactic processing and especially proposition generation varied systematically as a function of the different text types. This is quite a surprising result, since it suggests that similar syntactic and propositional units are dealt with differently when they are used to build information structures of different types, which is the opposite of what is often assumed to be the case. The effects of these syntactic and propositional characteristics of the texts will be examined next.

Syntactic Processing. The same syntactic variables as discussed above (clause density and clause embedding) were tested for their influence on interpreting performance. When assessed independently of text type, only one test proved significant: the difference between information found in segments with high and medium clause density. This is indicative of a weak overall effect of syntactic characteristics on interpreting performance, one that only begins to appear when there are at least three clauses per segment. Note that segments with more than three clauses are apparently not characteristic of spoken texts, only of complex texts written to be read. This suggests that the normal syntactic characteristics of spoken texts do not affect interpreting performance systematically.

When assessed with text type, the role of syntactic processing appeared in a different light. The joint effects of text type and clause density were weak, but this time affecting the simpler segments with 1 or 2 clauses each. On the other hand, the joint effect of text type and clause embedding was very strong. As shown in Figure 2 below, more of the propositions in subordinate (non-matrix) clauses were interpreted accurately, but more of the propositions in main (matrix) clauses were used as the basis for inferences, in particular for the Narrative text.

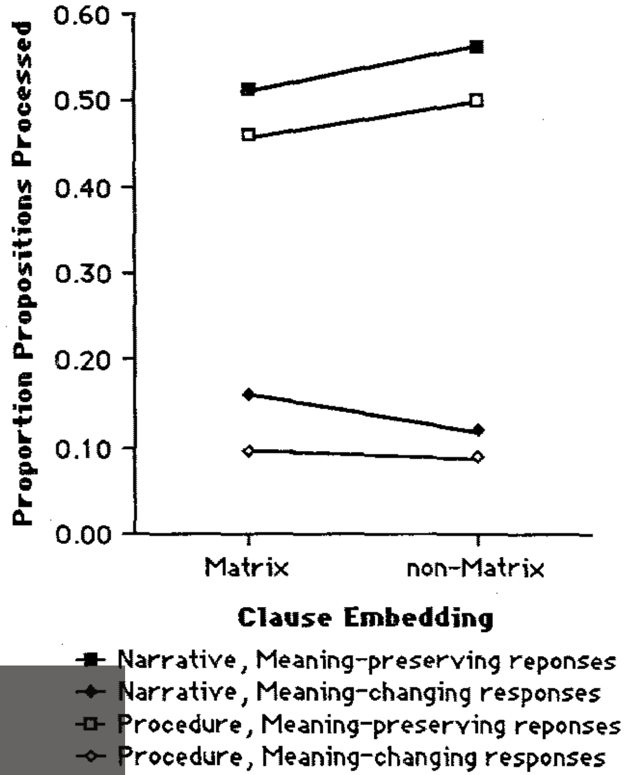

Figure 2. Joint effects of Clause embedding, Text Type and Response Type on interpreting performance.

In sum, there was little effect of syntactic complexity on interpreting, and more of an effect of embedding, in particular in the context of the different text types. This is most likely due to the fact that more of the information in the narrative appeared in matrix clauses, whereas more of the information in the procedure appeared in embedded clauses.

Proposition Generation. The same variables relating to proposition generation as discussed above (proposition density and directness of mapping) were tested for their influence on interpreting performance. Both when tested independently of and together with text type the effects of both variables were very strong and systematic. This is indicative of the central role that this stage of processing — the step of generating propositional information units from grammatical information — plays in interpreting.

Independently of text type, accuracy of interpreting decreases with increasing propositional density (see Figure 3); this reproduces Treisman's (1965) report of decreasing "efficiency" in translation with increasing information rate. The effects of directness of mapping were also very strong, both for matrix and embedded clauses: in general, the embedded propositions were interpreted less accurately than root (unembedded) propositions.

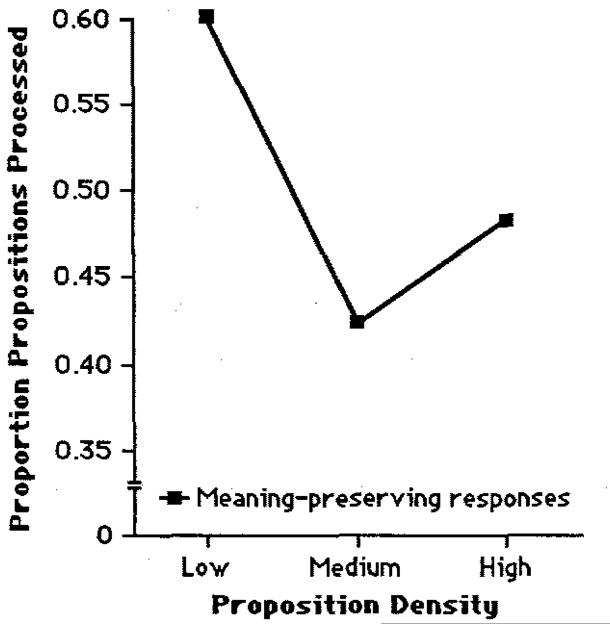

Figure 3. Effects of Proposition density on interpreting performance.

The joint effects of these variables with text type were also very strong. In Figure 4 below, it is clear that the propositions found high-density segments were more important for understanding the procedure than for the narrative.

The next Figure (5) shows that understanding the procedure entailed emphasizing the non-root propositions in matrix clauses and the root propositions in non-matrix clauses, whereas the opposite was the case for the narrative.

Frame Processing. The same variables relating to frame processing as discussed above (proposition type and frame component) were tested separately for each text-type for their influence on interpreting performance. The effects of the frame/non-frame distinction were strong for the narrative text, but not present for the procedure (with one exception). The effects of the differences between frame component were only present for the first two components, and were equally weak for both texts. The difference between frame and non-frame information (Figure 6) was very strong for the narrative, but not significant for the procedure. This suggests that interpreters (regardless of experience) were able to comprehend the event structure of the narrative, but were unresponsive to the hierarchical structure of procedure and subprocedure in the procedural text. This suggests that interpreters

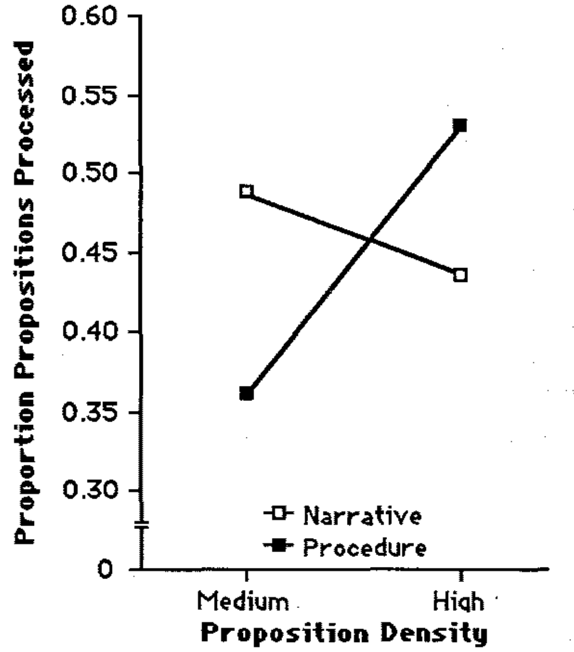

Figure 4. Joint effects of Proposition density and Text Type on interpreting performance.

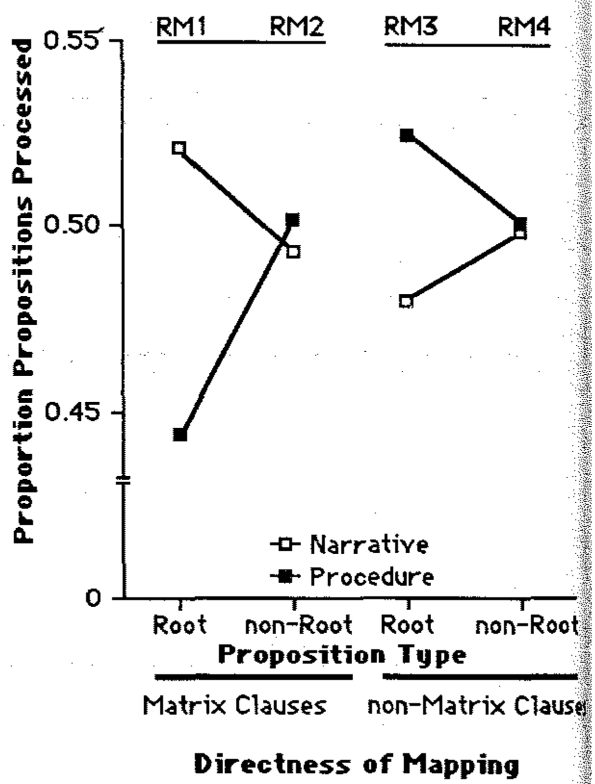

Figure 5. Joint effects of Directness of Mapping and Text Type on interpreting performance.

were treating the procedure as if it were a mere sequence of events — as a narrative.

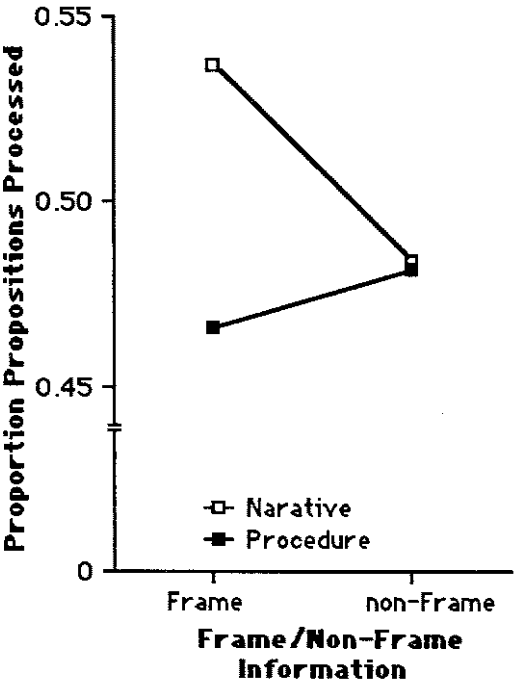

Figure 6. Effects of Frame information on interpreting performance, by Text Type.

The difference between the frame components (episodes for the narrative and subprocedures for the procedure) was present but weak for both texts and only referred to the difference between the first and second components (Figure 7). The general trend of decreasing performance from component to component as the text progressed may be due to fatigue or waning interest, but it is clear that an understanding of the gist of the text is much more dependent on the first component of the text. This suggests that interpreters were processing the frame component information for both texts in the same ways, and were more successful for the narrative apparently because it is a simpler or more common genre.

To summarize, in processing both texts interpreters, regardless of experience, were similar in that they were not sensitive to variations in syntactic complexity, but were very sensitive to how directly the text's syntactic properties (in particular clause embedding) reflected the importance of the information it contained. Processing the procedural text entailed much more attention to information in more complex and denser segments, as well as to embedded propositions. Understanding the narrative text entailed more attention to matrix clauses and root propositions in simple segments. These differences can account for the differences in subjects' performance: in processing the procedure, apparently more "effort" was expended with syntactic analysis and proposition generation, creating an extra processing load that was reflected in less accurate performance.

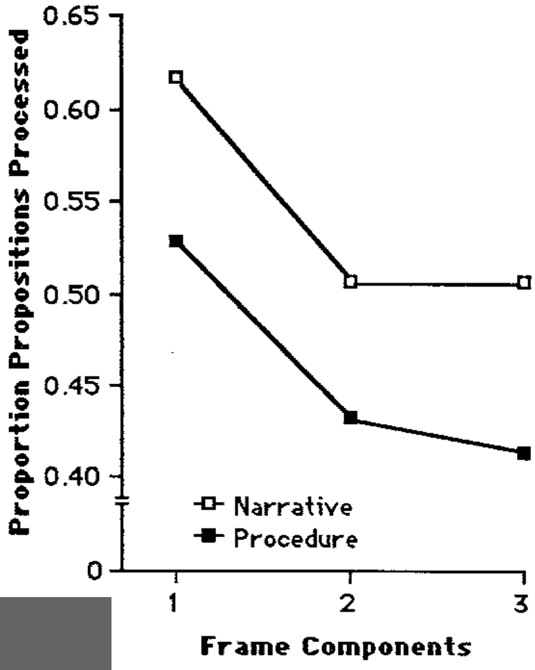

Figure 7. Effects of Frame component on interpreting performance, by Text Type.

Differences due to experience only arose with respect to the crucial step of proposition generation: Experienced interpreters seemed to perform this subprocess more efficiently, independently of any of the other variables investigated.

Discussion

The present study was concerned, in most general terms, with how simultaneous interpreting is carried out, in particular with the similarities and differences between experienced and inexperienced interpreters' comprehension processes during interpreting. This general question about the nature of interpreting expertise was broken down into more specific questions about the extent and relative importance of syntactic processing, proposition generation and frame-structure processing — component processes of comprehension in general.

Experience had a weak quantitative effect on interpreting overall, reflecting the fact that the experienced interpreters performed 16.6% more accurately than the inexperienced bilinguals across the board. There were few qualitative differences as were indicated by interactions of experience with text-structure variables, and the order of presentation of the texts had no important effects at all. The only exception to this pattern was a weak interaction of experience with directness of mapping: experienced interpreters were apparently more selective in their processing of non-root propositions in the matrix clauses of the procedural text. This suggests that the experienced subjects may have learned to be more selective in the surface information they will process semantically, as a function of the text frame structure that is to be built with it. That is, the subprocess of proposition generation may be more closely tailored to the needs of subsequent frame processing for the experienced interpreters.

The pattern of results found here is consistent with the view that experienced interpreters have not acquired any special set of abilities, rather that normal comprehension processes are more flexible than previously believed. This is supported in particular by the presence of main effects of experience and text-structure variables in the absence of systematic interactions between them. Experienced subjects apparently performed the same sorts of processing in the same ways, but with a slight quantitative advantage.

Figure 8 provides a summary of the results, depicting performance by experience group as a function of the text-structure variables assessed. The parallelism of the two sets of lines reflects the absence of major group differences; the deviations from parallelism indicate the small, unsystematic differences in processing that were found. Note that experience-related differences only began to appear for the processing of the procedural frame information, and the only statistically significant interaction of experience was with the directness of mapping variables (RtMtx). Two kinds of responses are shown as well: meaning-preserving responses (accurate translations), and meaning-changing responses (modifications to the meaning of the original text) to show that the relation of both response-types to the different text-structure variables and to experience are similar.

These results, then, constitute support for the view that translation ability and interpreting skill are natural consequences of bilingualism (see Harris & Sherwood, 1978 and Longley, 1978), and, as a result, that the differences between experienced and inexperienced interpreters will be mainly quantitative. It is very important to note, however, that the results discussed here refer to the simultaneous interpreting of prepared texts in a conference setting, and may not be generalizable to interpreting more spontaneous dialogue or debates. Conversational text is different from the materials used here in that it is generally less explicit and less predictable, so its processing makes greater demands on prior knowledge and inference generation. Moreover, Frederiksen (1989) argues that the processing of different text types is independent of general comprehension skill (as reflected here in the quantitative differences in understanding the two texts), so that it is possible that an

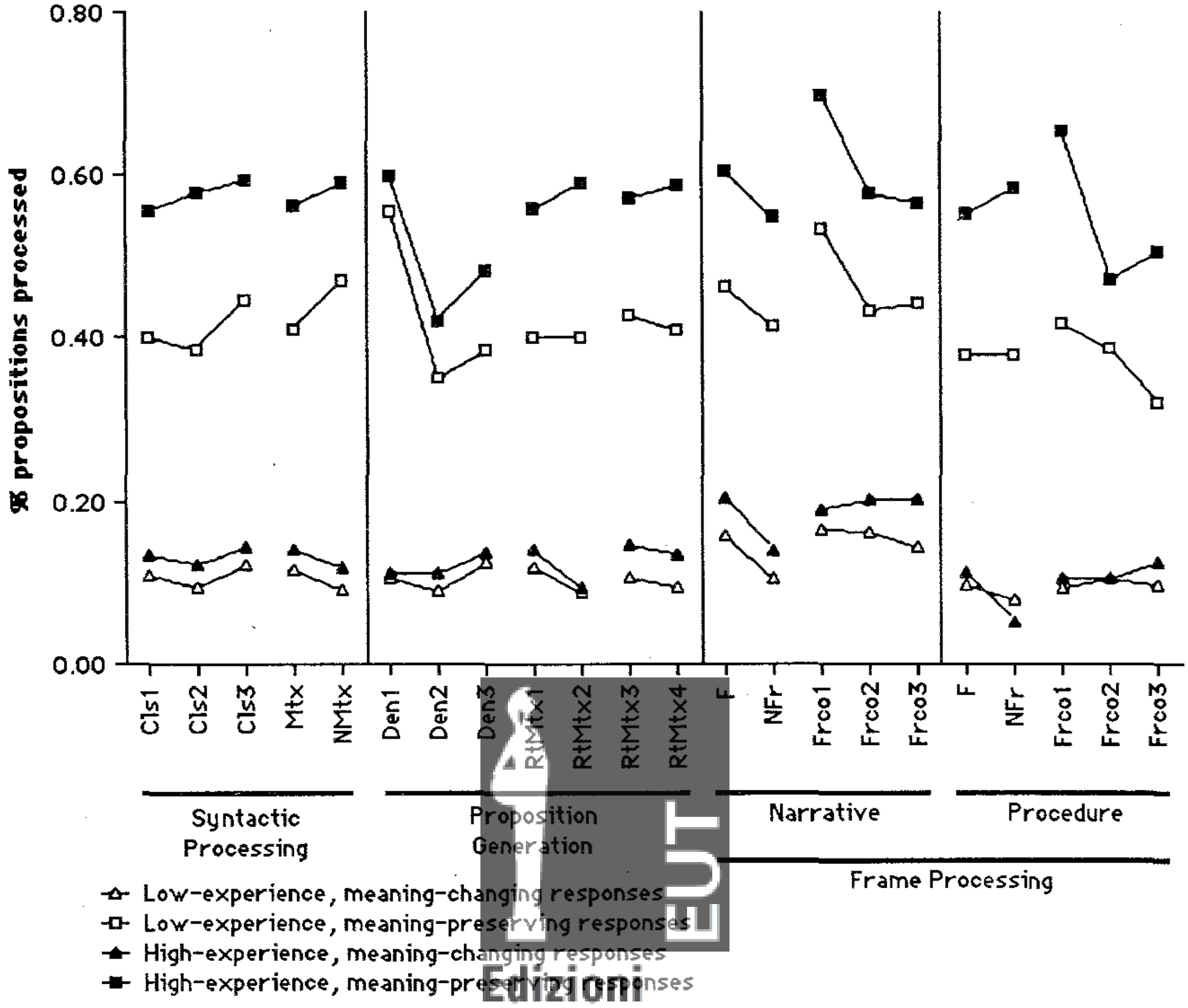

Figure 8. Interpreting performance (means) by Experience, Text-structure and Response-type variables.

interpreter may work well in the booth with the types of pre-prepared materials used here, but not perform so well with conversational dialogue, or vice versa.

Furthermore, it must be made clear that although there were only very subtle differences in the comprehension processes used by experienced and inexperienced subjects, this does not mean that they may not be important. Some of the differences appeared in relation to the more difficult procedural text, and showed up under very specific conditions, which suggests that any special comprehension abilities of experienced interpreters may only appear clearly with more difficult materials or at faster rates of presentation. The variables indexing proposition generation interacted with experience and this suggests that the possible differences may bear on this poorly understood component of comprehension.

Perhaps even more importantly, it would be misleading to conclude that there are no differences at all between expert and novice interpreters: the main finding of this study bears on their comprehension processes only, and the importance of production processes is not to be underestimated. Quite clearly, "it is one thing to have comprehended a passage in the original and quite another to reproduce it within the given time constraints in the target language" (B. Moser-Mercer, personal communication). It is quite possible that expert interpreters may differ from novices principally with respect to their production processes, which have not been studied here. For example, it may be the case that experienced interpreters will show more independence in their production; that is, the novices will tend to follow the surface features of the original, whereas the experts will produce target-language texts whose formal features are nearly independent of those of the original. Answers to this await further research. The point of the present study was to discover whether the apparent differences between experienced and inexperienced interpreters are due to differences in comprehension; of course to complement these findings, differences in production ability also have to be studied.

Conclusion.

The fact that simultaneous interpreting is possible at all provides evidence for the modularity and parallel execution of the component processes of discourse comprehension.

The present study has provided evidence that:

(a) comprehension in interpreting is not a specialized ability, but the application of an existing skill under more unusual circumstances;

(b) comprehension in interpreting is characterized by all of the same component processes as listening — processing is not curtailed (as Nida in Gerver, 1976 suggested) — with an emphasis on semantic processing, in particular proposition generation.

The findings suggest that it is not a special, acquired skill, but an ability that seems to accompany bilingualism naturally, and this supports the view that this same modularity and parallelism are features of text processing generally.

These findings may also have some important practical and methodological consequences. They provide principled, empirical support for the intuition current in interpreter training programs that selection is of the utmost importance. If interpreting skill is a function more of general text processing ability than of specific training (i.e., the view that "interpreters are born, not made"), then selection is more important than course work. In particular, if 8.5 years' experience only affords a 17% improvement in accuracy of interpreting, then how much of that is provided by formal training, and how much by experience with the task itself? Indeed, the results reported here suggest that a program of training in simultaneous interpreting (assuming the necessary language skills) need be neither extensive nor complex.

These findings also suggest that interpreters' performance is limited by the same broad parameters that limit text comprehension in general: the nature of the text itself and the prior knowledge that they can bring to bear on understanding it. If, in general, the main factor limiting the efficiency of communication is the difference between the knowledge of the comprehender and the knowledge presupposed by the text, then there are at least two ways to improve communication involving an interpreter: (a) the interpreter has to have the same knowledge as presupposed by the speaker, which suggests greater specialization of interpreters and the inclusion of specific domain knowledge in their training, and (b) the speaker/writer has to design the text so that the interpreter, rather than the speaker's equally knowledgeable peers, can understand it.

Finally, these findings raise a series of new questions to be answered. Will the results be the same with more complex materials or at higher rates of presentation? Will they be replicated with other text types? How does the process of proposition generation work during interpreting? Is interpreting so demanding as to interfere with memory for the text that was interpreted? Is this interference greater for inexperienced interpreters? What sorts of differences in translation or production processes characterize experienced and inexperienced interpreters? How can one best go about studying production?

Note

* This research was carried out at McGill University's Laboratory of Applied Cognitive Science as part of the author's doctoral dissertation. Current mailing address: Fundação de Ensino Superior de São João del-Rei — FUNREI Departamento de Artes, Letras e Cultura Campus Dom Bosco 36.300 São João del-Rei, MG BRASIL.

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Appendix A: Experimental Texts

Narrative

I have a friend named Alex who is a nuclear physicist, but he works in a public hospital instead of at some big university's reactor. He spends a lot of his time shooting protons at glucose and other things. Alex makes several different isotopes with the old cyclotron which is in his lab, and he often helps one of the computer programmers who works in the hospital's brain scanning center. Yesterday I visited Alex at the hospital.

When I found the right office, it was already 10 o'clock. Alex was reading a collection of technical articles, but he put his book on a nearby shelf when I arrived and he showed me all around the lab. He turned on the small cyclotron which was in one corner and made some fluorine isotope to demonstrate how simply it worked. The small machine made noises while Alex explained what it was doing. Afterwards, Alex made some terrible coffee. We talked about the local news for a little while, until a staff doctor asked for some carbon-eleven glucose in a hurry. He said he would call as soon as he was ready for it. Then he prepared the next patient for her scan. Alex explained that since the glucose isotope was only hot (or radioactive) for about a half an hour, he could just set up what was in the lab. He would only start to make the isotope itself when the doctor called again. Not long after Alex was all ready, the doctor called back to confirm his previous request and Alex began to prepare his magic potion right away. When he had finished it, he checked whether it was hot (or radioactive) enough for the scanner. Then we ran up to the scanner room on the third floor, with the solution in a lead bucket.

The scanner was a big aluminium ring with millions of wires connecting it to a big computer in the next room. The patient was waiting nervously for an injection on a long table, with her head inside the ring. As we walked back down the stairs together, Alex explained that scanners detect gamma rays coming from inside the patient's brain. I didn't really understand very much of what he was talking about. It sounded really crazy to me.

After lunch, Alex checked in at the lab. Then we visited his friend Yoshio who ran the brain scanner's computer system. Even before he greeted us, Yoshio pointed at the two TV screens on a large desk and then asked which image was clearer. Yoshio was working on a new program to make the images sharper. Then he pointed at another screen with the same brain image, but it had two handles connected to it, like a video game. He suggested how we should play around with the handles, and when we moved them, the image changed in color and brightness. Yoshio explained that it was better for the doctors to manipulate the color and brightness of the important parts of the image.

The telephone rang, interrupting him. The call was for Alex He had to go back to the lab, and it was time I left, too. We thanked Yoshio for his explanation of the new program, and walked to the main entrance together. Then Alex went to make some other kind of isotope and I went to the bank to pay some bills. It was a very interesting visit.

Procedure

A man goes to visit his doctor. He complains that his head often aches. He feels weakness in his arms and nausea. The symptoms make the doctor suspect that the patient has a brain tumor. He cannot be sure, though, without finding out what's happening inside the patient's skull. How is it possible to discover, causing no damage, what's going on inside someone's brain? Technology has provided us with a safe way of getting this information: the PET scanner. Let me explain how it works.

First, the patient is prepared: he lies on his back, his eyes and his ears are covered by wrapping them with gauze, and his head is secured with plastic pins so it can't move at all. Finally, his head is placed inside a donut-shaped machine and he is given an injection of a radioactive solution. This is made from a kind of glucose with a radioactive marker attached to some of its molecules. The marker is usually a carbon isotope produced in a cyclotron. This apparatus shoots protons into the nuclei of carbon atoms so they end up with an extra proton. This makes the atoms unstable, but only for a while: after half an hour most of them are normal again. These unstable atoms are attached to the glucose and injected into the patient's neck.

After the injection, scanning begins. The scanner has gamma ray detectors around the patient's head. That's why it's shaped like a donut: so his head can fit in the middle. The unstable atoms eject positrons to become stable again. The positrons each emit two gamma rays when they hit electrons in the patient's tissue, and this is called annihilation. The gamma rays leave the annihilation site in opposite directions and they have enough energy to leave the brain through the skull. When they hit two detectors simultaneously, a signal is sent to a computer. Because each of the detectors has a tube in front of it, it can only see straight ahead. Thus each pair of these detectors only gives information

about a small area of tissue. The scanner then collects these signals and registers which of the detectors they came from.
When the scanner finishes its job, the computer starts reconstructing an image of the region that was scanned. A program compares the number of signals sent by each pair of detectors and those sent by all the others, and then it calculates the number of gamma rays emitted by each of the regions of the brain. The image appears on a screen as some colored squares that represent a cross-section of the brain, and this image is what the doctor interprets to perform his diagnosis.

Since the different colors represent different amounts of gamma rays and the rays are produced by the radioactive glucose, he can see where the glucose concentrated. Doctors already know that tumors consume more energy than normal tissue, and that they get this energy from glucose, so the doctor can spot the tumor because it will have a brighter color. Other disorders also show typical patterns on the image, and with different isotopes we can get information about the processes happening in the brain. The isotopes are safe, since they're only radioactive for a short while. The doctor doesn't have to open the skull, so he doesn't cause any damage. Thus, this technique allows him to see what's happening inside the brain easily and safely.

Appendix B: Summary of Significant Statistical Tests

Table 1
Summary of Effects of Experience on Interpreting

Contrast name	F (1,12)	p
Experience	6.9911	.0215
Exp x RT3-2	5.7652	.0335
Exp x Text x RT2+3-1	5.3876	.0387
Exp x RM2-1	7.9886	.0153
Exp x RM2-1x Text	6.1834	.0287
Exp x RM2-1 x RT3-2	5.6753	.0347
Exp x RM2-1 x RT2+3-1x Text	12.3588	.0043

Table 2
Summary of Effects of Text Frame Type on Interpreting

Contrast name	F (1,12)	p
Text	40.6818	.0001
Clause density		
Text x Cls 2-1	8.2180	.0142
Clause embedding		
Text x Mtx-NMtx	17.1142	.0014
Text x Mtx-NMtx x RT3-2	6.5773	.0248
Proposition density		
Text x DenMid-Lo	12.6654	.0040
Text x DenHi-Mid	67.7256	.0001
Text x DenHi-Mid x RT3-2	37.7185	.0001
Text x DenHi-Mid x RT2+3-1	52.6748	.0001
Directness of mapping		
Text x RM2-1	244.9252	.0001
Text x RM4-3	11.9140	.0048
Text x RM2-1 x RT2+3-1	7.9555	.0155
Text x RM4-3 x RT2+3-1	6.5147	.0254

Table 3

Summary of Effects of Text-structure Variables on Interpreting

Contrast name	*F* (1,12)	*p*
Clause Density		
Cls 3-2	7.6067	.0174
Cls 2-1 x Text	8.2180	.0142
Clause Embedding		
Mtx-NMtx x Text	17.1142	.0014
Mtx-NMtx x Text x RT3-2	6.5773	.0248
Proposition Density		
DenMid-Lo	134.7180	.0001
DenHi-Mid	11.7727	.0050
DenMid-Lo x Text	12.6654	.0040
DenHi-Mid x Text	67.7256	.0001
DenMid-Lo x RT3-2	131.3964	.0001
DenMid-Lo x RT2+3-1	104.9934	.0001
DenHi-Mid x Text x RT3-2	37.7185	.0001
DenHi-Mid x Text x RT2+3-1	52.6748	.0001
Directness of Mapping		
RM2-1	184.7604	.0001
RM4-3	131.7132	.0001
RM2-1 x Text	244.9252	.0001
RM4-3 x Text	11.9140	.0048
RM2-1 x RT3-2	178.0147	.0001
RM4-3 x RT3-2	18.0132	.0012
RM2-1 x RT2+3-1	101.5333	.0001
RM2-1 x Text x RT2+3-1	7.9555	.0155
RM4-3 x Text x RT2+3-1	6.5147	.0254

Frame Processing Variables

	Narrative		Procedure	
Contrast name	*F* (1,12)	*p*	*F* (1,12)	*p*
Frame/non-Frame Information				
FNF	66.7674	.0001	<1.0	ns
FNF x RT3-2	14.6537	.0025	<1.0	ns
FNF x RT2+3-1	<1.0	ns	6.9552	.0217
Frame Components				
Frco2-1	6.4072	.0264	5.3365	.0391
Frco2-1 x RT2+3-1	6.1986	.0285	6.5224	.0253