Original Paper

A Preliminary Review of Neurolinguistics Research in Simultaneous Interpreting (SI)

Riccardo Moratto[1*]

[1] Department of Translation and Interpreting, Hunan Normal University, Changsha, China

[*] Riccardo Moratto, Department of Translation and Interpreting, Hunan Normal University, Changsha, China

Abstract

The present review article, with no pretense of being exhaustive, aims at shedding light on some of the major empirical studies conducted in recent years in Simultaneous Interpreting (SI) from a neurolinguistics point of view.

Some of the issues that will be covered include the definition and development of expertise in SI, neuronal adaptation and the cognitive complexity of SI. The present preliminary review will end with some questions that future research could focus on and, hopefully, provide some answers to.

Keywords

neurolinguistics, Simultaneous Interpreting (SI), expertise, language switching, neuronal adaptation

1. Introduction

The present introductory review paper will focus on neurolinguistics research in Simultaneous Interpreting (SI). In the first part a brief definition of SI is provided, emphasizing the underlying reasons of its cognitive complexity. After that, the present article will move to an overview of what general issues can be encountered when dealing with SI from a cognitive point of view and will provide the reader with a quick excursus on neurolinguistics research on translation and interpreting in the bilingual brain. The first part will conclude with an analysis of a study conducted by Rinne et al. (2000): the translating brain.

In the second part of the review, the present article will mainly introduce two ERP studies on language processing in SI. The paper will end with a brief discussion on the development of expertise in SI and the possibility of searching for neural correlates.

2. Simultaneous Interpreting (SI)

Simultaneous Interpreting (SI) is one of the different types of interpreting modes, along with consecutive, whispered, relay and liaison interpreting. In SI interpreters sit in a booth where they listen to a source language and simultaneously interpret the speech into a target language. Ideally, they should have a clear view of the meeting room and the speaker(s), and their booth (fixed or mobile) should meet ISO standards of acoustic isolation, dimensions, air quality and accessibility as well as appropriate equipment.

SI is a cognitive task, with a high cognitive load, which may also represent an interesting field of research for neurolinguists (Fabbro & Gran, 1997). However, experimental studies in SI have some basic issues which ought to be tackled in order to design experiments. A critical issue, for example, is the fact that professional interpreters do not abound, which means that it is not always possible to obtain an adequate sample for any given study. This may result in studies which are prone to a lack of statistical power. Other methodological problems concern the lack of ecological validity of the experimental setting and the stimulus material. For a further discussion on methodological issues, which is out of the scope of the present review paper, readers can refer to Frauenfelder and Schriefers (1997) and Gile (2000).

Many scholars have argued on the cognitive complexity of SI. In order to provide experimental support for the hypothesis that SI is a complex cognitive task, Darò and Fabbro (1994) conducted a study with 24 student interpreters who were asked to perform a digit span task under four different conditions: listening, shadowing, articulatory suppression, and SI. According to the results, performance turned out to be poorer after SI. That was interpreted as suggesting that SI was, indeed, the most complex task, from a cognitive point of view.

3. The Beginning of Neurolinguistics Research in Translation Studies and the Issue of Translation Direction

SI is a type of oral translation and as such it is directional, i.e., it proceeds from one language (source) into another (target). According to Roman Jakobson (1971), translation skills are related to posterior language areas (temporo-parietal regions), as can be proven by the fact that a lesion in these areas impairs the ability to translate from one language into the other. However, as early as in 1951, Gastaldi reported that some polyglot aphasics had lost the ability to translate in both directions (Gastaldi, 1951). This seems to be in line with the hypothesis postulated by Paradis according to which there are two different translation components, one for L1 to L2 and another for L2 to L1 (Paradis, 1985, 1993).

In the literature there are many neurolinguistics reports further establishing the validity of the translation directional components. For instance, Aglioti and Fabbro (1993) reported the case of a patient who, due to a vascular lesion to the basal ganglia, a subcortical structure of the frontal-lobe system of the left hemisphere, was no longer able to translate passively (for further examples, see

Fabbro & Paradis, 1995).

However, in interpreting studies there is little experimental evidence in support of any directional effect. In one of the few neurolinguistics studies available, Rinne et al. (2000) compared interpreting from and into the native language. They found more extensive activation during active translation, i.e., into L2, possibly reflecting differences in difficulty between the two translation directions. Similarly, in another study using Positron Emission Tomography (PET) (Price et al., 1999), it was reported that during SI interpreters indeed exhibited brain activation patterns that were modulated by the direction of translation. In other words, there was more extensive activation in the left dorso-lateral frontal cortex during L1 to L2 than during passive translation. To the author's best knowledge, there have been only two electrophysiological studies investigating SI, however none of them applied auditorily presented material as stimuli or compared SI with matched controls to see if there was training-related neural adaptation. The first study was carried out by Proverbio et al. (2004). They explored native Italian SI and monolingual control subjects during a semantic congruency processing task, namely eleven right-handed professional interpreters whose L1 was Italian and whose average Age of Acquisition (AOA) of L2 was 9.6. In this study, code-switching was perceived as SI-specific and analyzed by way of ERP. The interpreters were presented with four conditions in a block design, i.e., Italian unmixed, English unmixed, English mixed (English final words), and Italian mixed (Italian final words). Each block included semantically congruent and incongruent trials. The SI N400 responses were significantly larger to L2 than to L1, due to the differences between mixed and unmixed conditions. There also seemed to be a different functional organization of semantic integration, due to the later age of acquisition of L2. Later, in Proverbio et al. (2008), the research team also investigated the temporal dynamic of the brain responses of SI while they processed a visually presented letter-detection-task (i.e., word vs. non-word discrimination). According to the results, there seemed to be a faster and more efficient access to lexicon for L1 regardless of L2 proficiency.

4. The Translating Brain

The study conducted by Rinne et al. (2000) is the only study, to the author's best knowledge, using Positron Emission Tomography (PET) and focusing not just on the single word-level (like Klein et al., 1995 or Price et al., 1999) but rather on SI as a global complex cognitive task.

In this study, brain activation patterns of eight right-handed healthy professional Finnish-English interpreters (32-56 years, four women and four men), were measured with PET while simultaneously interpreting auditorily presented texts (in both directions), shadowing (in both languages), or resting in silence. According to the results, passive translation recruited a region anterior to Broca's area as well as the left supplementary motor area. Left prefrontal activations, including area 46, are often observed during various verbal encoding and working memory tasks. Therefore, the brain areas that were selectively activated during SI (after the subtraction of the areas activated in shadowing) were those

263

that are typically associated with lexical retrieval, working memory, and semantic processing. Active interpretation, on the other hand, yielded more extensive activation increases in and around the above-mentioned left frontal regions. Left inferior temporal activity was also observed: it is the basal temporal language area which is related to word-finding and semantic processing. To conclude, this study shows that, in SI, cerebral activation patterns vary according to the direction of interpretation, and it is more extensive in the language dominant hemisphere when the interpreters translate into their L2.

5. Neuronal Adaptation in Interpreters

The AOA and level of proficiency are indeed two factors affecting bilinguals' neuronal networks in language processing tasks. Many interpreting teachers argue whether SI training could play a role in neuronal adaptation for interpreters or not.

Elmer et al. (2010) examined the impact of professional and long-term language training on auditory word processing and tried to disentangle its effect from that of proficiency and AOA. The participants had to judge whether auditory presented disyllabic noun pairs both within and across German and English were semantically congruent or not. According to the results, SI could not benefit from a German prime word when English was their target language. Furthermore, long-term L2 to L1 SI training makes active translation more troublesome, which is consistent with previous studies, like Rinne et al. (2000) and Proverbio et al. (2004) and which somehow shows training-related functional reorganization, although further research is warranted.

6. Expertise in SI and Neural Correlates

SI is a complex cognitive task made up of several sub-components and sub-skills, such as language comprehension, production, output monitoring and transfer mechanisms from source to target language, plus a general coordination of these different processes. It is quite understandable, then, that SI requires a long and intensive period of training. However, it is assumed that changes might occur in brain activities or functional structure during the period in which there is the acquisition of interpreting skills. Future research could further elaborate on this aspect with longitudinal studies focusing on the development of expertise in interpreting which, in turn, could shed some light on the brain plasticity of interpreters.

7. Conclusion

The present article was a brief review aimed at providing the reader with a short excursus on some of the main studies concerning neurolinguistics research in SI.

The PET study briefly reviewed identified brain correlates of SI, namely the fact that the left dorso-lateral frontal cortex is implicated in lexical search, verbal working memory and in semantic

analysis tasks. On the other hand, the ERP studies investigated the time course of semantic processing, the mechanisms of switching control in interpreters and training-induced plasticity in language processing.

As previously mentioned, further research is warranted to develop longitudinal studies which might possibly focus on the development of expertise in interpreting, thus shedding light on the brain plasticity of interpreters.

References

Aglioti S., & Fabbro, F. (1993). Paradoxical selective recovery in a bilingual following subcortical lesions. *Neuroreport*, *4*, 1359-1362. https://doi.org/10.1097/00001756-199309150-00019

Darò, V., & Fabbro, F. (1994). Verbal memory during simultaneous interpretation: Effects of phonological interference. *Applied Linguistics*, *15*(1), 365-381. https://doi.org/10.1093/applin/15.4.365

Elmer, S., Meyer, M., & Jancke, L. (2010). Simultaneous interpreters as a model for neural adaptation in the domain of language processing. *Brain research*, *1317*, 147-156. https://doi.org/10.1016/j.brainres.2009.12.052

Fabbro, F., & Gran, L. (1997). Neurolinguistic research in simultaneous interpretation. In Y. Gambier et al. (Eds.), *Conference Interpreting: Current Trends in Research: Proceedings of the International Conference on Interpreting: What do we know and how?* Amsterdam: John Benjamins Publishing Company. https://doi.org/10.1075/btl.23.02fab

Fabbro, F., & Paradis, M. (1995). Differential impairments in four multilingual patients with subcortical lesions. In M. Paradis (Ed.), *Aspects of bilingual aphasia*. Oxford: Perganion Press, 139-176.

Frauenfelder, U., & Schriefers, H. (1997). A psycholinguistic perspective on Simultaneous Interpretation. *Interpreting*, *2*(1-2), 55-89. https://doi.org/10.1075/intp.2.1-2.03fra

Gastaldi, G. (1951). Osservazioni su un afasico bilingue. *Sistema Nervoso*, *2*, 175-180.

Gile, D. (2000). Issues in interdisciplinary research into conference interpreting. In B. E. Dimitrova, & K. Hyltenstam (Eds.), *Language Processing and Simultaneous Interpreting: Interdisciplinary Perspectives*. Amsterdam: John Benjamins Publishing Company. https://doi.org/10.1075/btl.40.07gil

Jakobson, R. (1971). In S. Rudy (Ed.), *Selected Writings (Vol. 2): Word and language*. Berlin & New York: Mouton de Gruyter.

Klein, D., Zatorre, R. J., Milner, B., Meyer, E., & Evans, A. C. (1995). The neural substrates of bilingual language processing: Evidence from positron emission tomography. In M. Paradis (Ed.), *Aspects of Bilingual Aphasia* (pp. 23-36). Oxford, UK: Pergamon Press.

Paradis, M. (1985). On the representation of two languages in one brain. *Language Sciences*, *7*, 1-39. https://doi.org/10.1016/S0388-0001(85)80010-3

Paradis, M. (1993). Linguistic, psycholinguistic, and neurolinguistic aspects of "interference" in bilingual speakers: The Activation Threshold Hypothesis. *International Journal of Psycholinguistics*, *9*, 133-145.

Price, C. J., Green, D. W., & von Studnitz, R. (1999). A functional imaging study of translation and language switching. *Brain*, *122*, 221-235. https://doi.org/10.1093/brain/122.12.2221

Proverbio, A. M., Leoni, G., & Zani, A. (2004). Language switching mechanisms in simultaneous interpreters: An ERP study. *Neuropsychologia*, *42*(12), 1636-1656. https://doi.org/10.1016/j.neuropsychologia.2004.04.013

Proverbio, A. M., Adorni, R., & Zani, A. (2008). Inferring native language from early bio-electrical activity. *Biological Psychology*, *80*(1), 52-63. https://doi.org/10.1016/j.biopsycho.2008.02.006

Rinne, J. O., Tommola, J., Laine, M., Krause, B. J., Schmidt, D., Kaasinen, V., & Sunnari, M. (2000). The translating brain: Cerebral activation patterns during simultaneous interpreting. *Neuroscience letters*, *294*(2), 85-88. https://doi.org/10.1016/S0304-3940(00)01540-8