



## Research Networking Programmes

Short Visit Grant  or Exchange Visit Grant

*(please tick the relevant box)*

### Scientific Report

**The scientific report (WORD or PDF file – maximum of eight A4 pages) should be submitted online within one month of the event. It will be published on the ESF website.**

***Proposal Title:*** Investigating the relation between bilingualism and reading skills through the use of TSOMs.

***Application Reference N°:*** 7179

#### 1) Purpose of the visit

The main purpose of my visit to the Institute for Computational Linguistics and Communication Physiology Lab of CNR (Pisa) was to identify alternative ways and research tools to investigate the intriguing parallel, emerging from the literature, between the effects of bilingualism and those produced by a specific reading disorder (dyslexia), at the linguistic and cognitive level. According to the findings of the last 20 years, there are several cognitive processes and sub-processes whose functioning seems to be enhanced in bilingual people but are compromised in dyslexic subjects. Metalinguistic abilities (like semantic, morpho-syntactic and phonological awareness), for example, tend to be stronger in bilinguals [5], but weaker in people with dyslexia [7, 15, 11, 10, 16]; similarly, working memory is generally more efficient in bilinguals [12] but compromised in dislexics [9, 1]. The same is true for other executive functions, like selective attention or other executive processes, which are very efficient in bilinguals [3, 6], but poor in dyslexic subjects [4].

In order to dig deeper into this issue, researchers from ILC-CNR and CPL-CNR, dr. Vito Pirrelli, dr. Marcello Ferro and Dr. Claudia Marzi helped me explore and obtain a better understanding of Temporal Self

Organizing Maps (TSOMs) as a research tool that, while simulating multilingual lexical acquisition, could be used for the assessment of a number of factors underlying lexical development, like metalinguistic awareness, working memory and executive control capacity, and for establishing a relation between these cognitive processes and those involved in reading.

## 2) Description of the work carried out during the visit

The work carried out during my visit consisted of workshop sessions in which researchers from ILC and CPL helped me familiarise with the functioning of TSOMs, and with some other crucial concepts and principles relating to them and to lexical modelling. In particular, presentations, discussions and reflections revolved mostly around the following:

i. TSOMs, as grids of organised and interconnected memory nodes representing a neuron layer with sensitivity to time-bound stimuli (strings of symbols, words), that can be stored and classified. The maps respond to input stimuli through patterns of overlapping node activation. Each node of the map is connected with all elements of the input layer through communication channel that have different levels of strength, the latter being modified through "training". When an input stimulus is presented, all map nodes are activated synchronously, but only the node that is most highly activated (the so-called Best-Matching Unit) prevails over the others [14, 8, 13].

ii. Principles of word self-organization

- Frequency: every time a lexical item is presented to a map, that item's representation is modified and the probability that the item will be accessed in the future is increased.
- Symbol identity: memory traces are activated by similar symbols.
- Time: symbol representation is time-bound and context sensitive.

iii. Dimensions of memory self organization

- A short-term dynamic, horizontal, syntagmatic dimension: words take time to be produced and recognised, and their recognition implies the serial activation of the relevant nodes.
- A long term dynamic, vertical, paradigmatic dimension: the nodes activated in the recognition of an input word are the same units responsible for its remembered representation. The latter establish long term relations with words they never appear with, since all words are memorised concurrently.

iv. The notion of wordlikeness, namely the extent to which a sequence of symbols can be a typical word of a language.

v. The quantitative correlates of wordlikeness in TSOMs [2]:  
- Phonotactic likelihood: the probability that a particular string of symbols results from the concatenation of smaller word-internal chunks (bigrams or trigrams), given their distribution in the entire lexicon.

- Neighbourhood density: strongly correlated with phonotactic likelihood, it is the number of words that can be obtained from a target word, through deletion, insertion or substitution of one or more symbols.

vi. Examples of neighbourhood effects, like those relating to co-activation and connection strength and to levels of activation filtering.

vii. Examples of simulations of bilingual acquisition of the lexicon.

### **3) Description of the main results obtained**

The visit was not meant to lead to scientific results, but to allow exchange of competences necessary to investigate the research topic described in the proposal. Under this point of view, the visit turned out to be highly interesting and useful.

### **4) Future collaboration with host institution (if applicable)**

The ideas outlined in the proposal concerning the relation between dyslexia and language learning stem from the collaboration with dr. Claudia Cappa (from CPL-CNR and ILC-CNR), who was present during the entire length of my visit. The collaboration with her and with the other researchers of the host Institution on this research and on other research projects is currently active and will continue in the future.

### **5) Projected publications / articles resulting or to result from the grant (ESF must be acknowledged in publications resulting from the grantee's work in relation with the grant)**

The visit to ILC-CNR and CPL-CNR was productive in the sense that the competence exchange it entailed was crucial to start new research work on the relation between bilingualism and reading disorders, as described in the proposal.

### **6) Other comments (if any)**

The NetWords short grant was a great opportunity to broaden my background and explore alternative research tools for future research. It was also a great occasion for networking and for an interesting exchange of ideas that will be the basis for future research projects.

## References

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