LANGUAGE IN THE ACCESS OF CULTURE AND ONLINE EDUCATION: FUNCTION AND DYSFUNCTION

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Abstract: Oral and written language is the main mode of cultural exchange, but it is often done in a secondary language. Our study explored reading strategies in bilingual subjects and how dyslexic subjects can compensate for their deficits. Our data show that bilingual subjects, as well as dyslexic subjects, exhibit reorganization and cerebral plasticity.

Résumé: Le langage, oral ou écrit, est le moyen principal d'échange interculturel, mais il est le plus souvent effectué dans une seconde langue. Notre étude a exploré les stratégies de lecture de sujets bilingues et comment des sujets dyslexiques pouvaient compenser leurs troubles. Nos résultats mettent en évidence, tant chez les bilingues que chez les dyslexiques, une réorganisation et une plasticité cérébrale.

Keywords: cerebral plasticity, Arabophone, Francophone, dyslexia, event-related potentials, language

Mots clés: plasticité cérébrale, Arabophone, Francophone, duslexie, potentiels évoqués, langue

1 INTRODUCTION

Cultural activities on the Internet are accessible through several modalities, including auditory (music, spoken language), visual (images and reading), and mixed forms. A certain level of mastery of verbal forms is necessary to attain it, such as the alphabet, vocabulary, grammar, and syntax. When online education implies the use of a secondary language, it is legitimate to ask whether the same language processes are involved. If so, what are the consequences of the differences in cultural interchange?

Access depends on whether the communication is in the subject's maternal tongue, whether the site includes a translation in that language, or whether a common language is used (e.g. English for a French student learning Arabic culture). Depending on these conditions, the subject's level of effort varies, as well as his performances. Prerequisites include mastery of his maternal tongue or the language used on the site, motivation, and attention. When these prerequisites are not met, he or she may fail to understand key elements or make false inferences because of similar sounding words, or unrelated words spelled similarly.

In addition to knowledge of letter forms (orthographic aspect), vocabulary (semantic aspect), grammar (syntaxic aspect), and pronunciation (phonologic aspect), each language possesses its own characteristics. Alphabetic languages (French, Russian, and Arabic) are distinguishable from non-alphabetic (Japanese, Chinese) forms, the first represented by a succession of letters with different sounds forming words and the second with ideograms directly forming words. Different types of alphabet exist: Latin, Arab, Hebrew, Greek, etc...Some languages have tight links between spoken and written forms, such as Italian, others are less transparent, such as French and English. According to Beland & Mimouni (2001), semantic and phonological ambiguities are more prevalent in Arabic than in French, which can slow down the identification of some words relative to many other languages (Ibrahim, Eviatar, & Aharon-Peretz, 2002). Paulesu & al. (2000) suggest that orthographic transparency affects phonologic processing. Thus, the French tongue should favour phonologic processing.

The primary objective of our study was to determine how an individual integrates French and Arabic languages by means of event-related potentials (ERPs). Electrophysiological exploration of the brain gives some information about reading processes. Is reading strategy the same or different in bilingual subjects? Is reading speed and comprehension as effective in the secondary language as the maternal tongue? If so, this should favour intercultural exchanges in both languages. If equal mastery is not attained, compensatory strategies must be used, perhaps similar to those used by dyslexic subjects with specific reading deficits.

The secondary objective of our study was to determine how dyslexic subjects surmount their deficits. This may help answer the question on whether dyslexic subjects can attain the same level of online education as non-dyslexic subjects.

2 EXPERIMENT 1

2.1 Population

28 monolingual French-speaking subjects and 23 bilingual Arab-speaking subjects, understanding French since 6 years of age, approximately half of each sex, were used. The subjects were from 23 to 30 years of age and right-handed, with normal or corrected to normal vision and no neuropsychological deficit.

2.2 Material and methods

Lists of 50 frequently used French or Arabic words and 50 pseudowords (pronouncable in French, e.g. proimeau) were presented on a computer screen. Since the French subjects did not know the Arabic language, the stimuli were presumably treated as non-orthographic pseudo-letters. Subjects performed a lexical decision task, words and non-words chosen by pressing different computer keys. Behavioral measures included reaction times (RTs) and number of correct responses in association with ERPs obtained with scalp electrodes.

2.3 Results

2.3.1 Behavioral measures

A group effect was found for correct responses ($F(1,49)=20.57$; $P<0.001$), lower in Arabophones than Francophones (Figure 1), as well as RTs ($F(1,49)=34.19$; $P<0.001$), higher in Arabophones. The group x item interaction ($F(1,49)=7.82$; $P<0.01$) for RTs is due to a wider disparity for pseudowords (Figure 2).

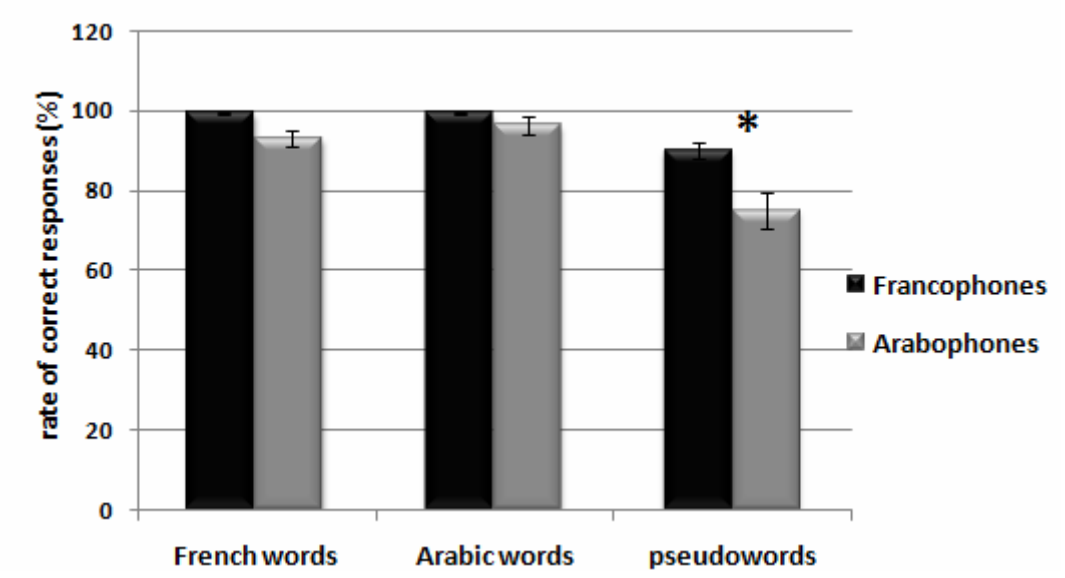

Figure 1: Correct responses in Arabophones and Francophones for different verbal stimuli.

***P<0.05**

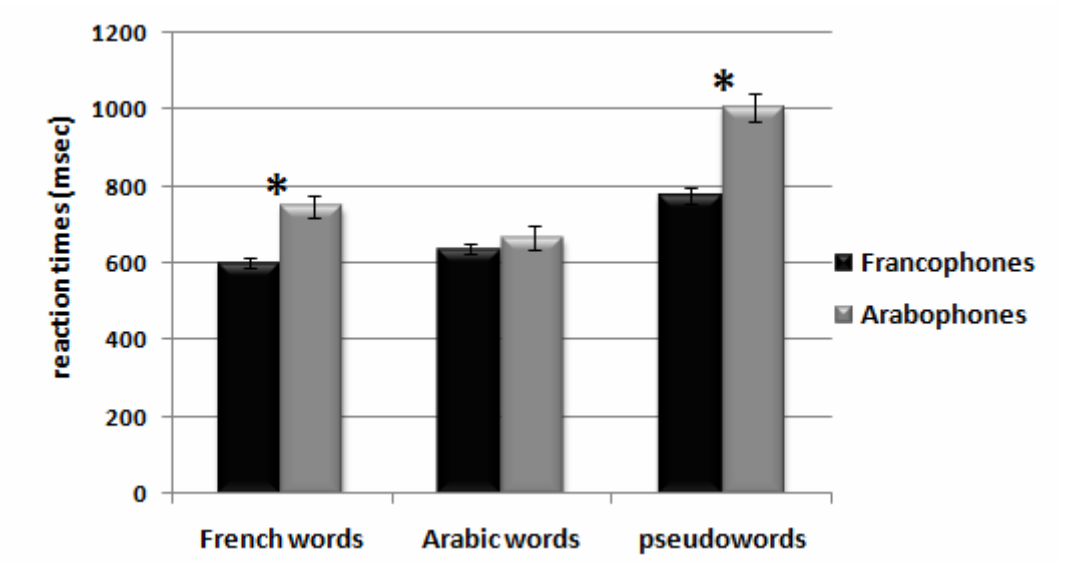

Figure 2: Reaction times in Arabophones and Francophones for different verbal stimuli.

*P<0.05

2.3.2 ERPs

Words and pseudowords evoke a P100 component (Figure 3) associated with physical properties of stimuli, such as color, size, and contrast, as well as selective attention (Hillyard & al, 1998). The N170 component

reflects orthographic processing (Bentin & al, 1999; Simon & al, 2004) and the N320 component phonologic processing, i.e. letter-sound conversion (Bentin & al, 1999; Simon & al, 2004). Our analyses concern the latter two.

- N170 component

There were no intergroup effects. In Francophones, the item factor was significant ($F(2,18)=7.05$: $P<0.01$), the N170 wavelength being larger for orthographic (French words and pseudowords) than non-orthographic (Arabic) items and larger in the left than in the right hemisphere, especially for orthographic stimuli, as indicated by the item x hemisphere interaction ($F(2,18)=3.80$; $P<0.05$). On the contrary, no such effects were found in Arabophones.

- N320 component

There were no intergroup effects. In Francophones, the item factor was again significant ($F(2,18)=5.68$; $P<0.05$), the N320 wavelength being larger for French words and pseudowords (Figure 3). In Arabophones, the item factor was significant as well ($F(2,18)=46.42$; $P<0.001$), positivities being progressively transformed into negativities for French words and pseudowords.

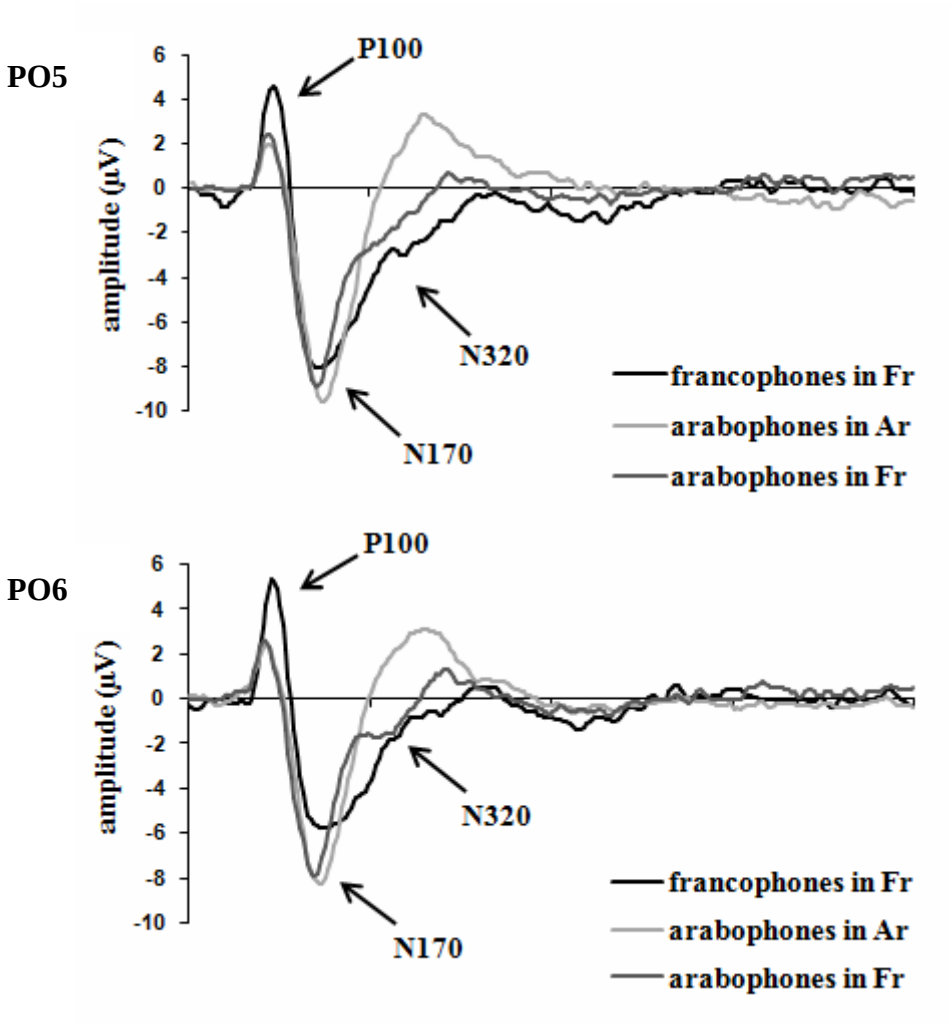

Figure 3: ERPs in Francophones reading in French (Fr), Arabophones reading in Arabic (Ar) and French (Fr) languages recorded at the PO5 electrode situated on the left hemisphere and the PO6 electrode on the right.

2.4 Discussion

2.4.1 Behavioral measures

Arabophones committed more errors and responded more slowly than Francophones, especially for French words and pseudowords. Despite their mastery of the language, Arabophones were less efficient in processing French, indicating the use of different strategies relative to the maternal tongue (Perani & Abutalebi, 2005). The question remains on whether this delay is due to a different form of cerebral organization or to characteristics inherent in the language. The orthographic complexity of the Arabic language (Ibrahim & al, 2002) is likely involved in different types of processing of Arabophones with knowledge of French.

2.4.2 ERPs

- Orthographic processing (N170) in different languages

In Francophones, the N170 component was larger in the left hemisphere, indicating hemispheric lateralization for verbal stimuli (Vigneau & al, 2005). This result was not found in Arabophones. The complex structure of the Arabic language (Ibrahim & al, 2002) appears to engage more visuospatial processing and consequently the involvement of the right side of the brain. This form of bilaterality is observable for French words and pseudowords, implying the existence of a transfer in orthographic strategies.

- Grapheme-phoneme conversion (N320) in different languages

The absence of the N320 component in Arabic subjects reading Arabic words is a strong indication that the lack in transparency causes a different type or the absence of phonologic processing. In contrast, the N320 appears for French words and pseudowords in both groups. Thus, Francophones and Arabophones use similar phonologic processing strategies while reading French, with Arabophones showing adaption to the French language (Ziegler & al, 2003). Thus, bilingual subjects use different reading strategies depending on the language.

2.5 Conclusion

Arabic subjects adapt to the French language in terms of phonologic processing, but also transfer the characteristics of their maternal tongue in terms of a more elaborate visuospatial or bilateral form of orthographic processing. These are likely responsible for their delayed RTs, Arabic subjects needing to switch from one form of processing to the other.

3 EXPERIMENT 2

A group of 16 control subjects was compared to 5 dyslexic subjects diagnosed by an orthophonist during their first few years, due to a deficit in phonologic processing. Lists of frequently or infrequently used French words and pseudowords, repeated twice or 100 times were presented on a computer screen in a lexical decision task.

As expected, dyslexic subjects had longer RTs ($F(1,18)=25.53$; $P<0.001$). RTs decreased with massive repetition, especially for the dyslexic group ($F(1,18)=35.70$; $P<0.001$) (Figure 4). This result indicates that visual repetition alone can help this condition.

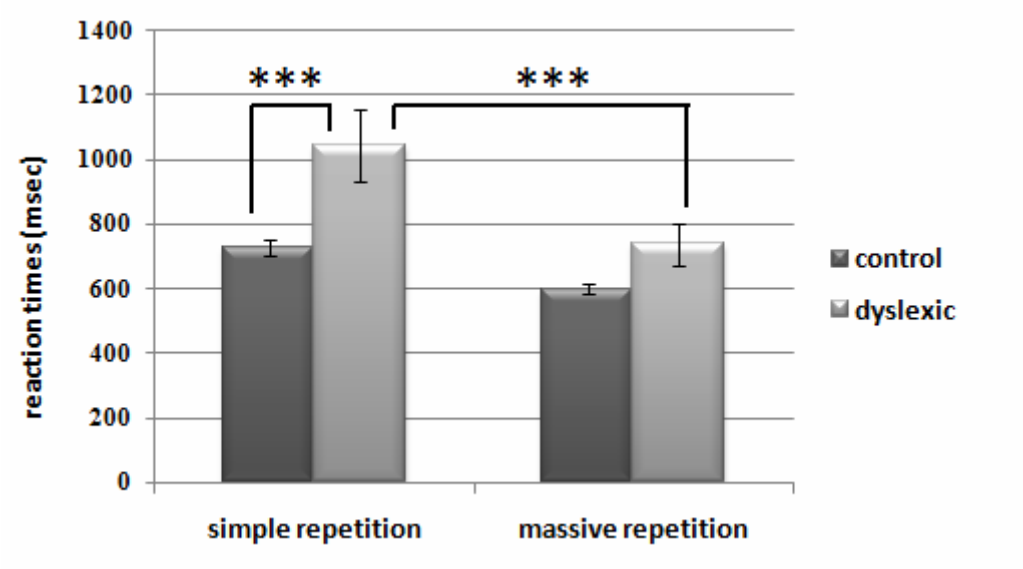

Figure 4: Reaction times for dyslexic and control subjects relative to repetition.

The N170 wavelength, associated with orthographic processing (Bentin & al, 1999; Simon & al, 2004), was larger in dyslexic subjects ($F(1,19)=9.54$; $P<0,01$) (Figure 5). In dyslexic subjects, the N170 was bilateralized when presented twice but lateralized to the left after massive repetition ($F(1,4)=22.13$; $P<0.01$). Dyslexic subjects have been shown to engage more elaborate visuospatial orthographic processing involving the right hemisphere as a compensatory response (Shaywitz et al, 2004). This appears to be counteracted by massive repetition.

Unlike controls, the N320 wavelength was not observed in dyslexic subjects, the next component tending towards negativity (Figure 5). The N320 reflects phonologic processing (Bentin & al, 1999), gravely disturbed in dyslexic subjects, where it is superimposed on the next treatment stage of reading.

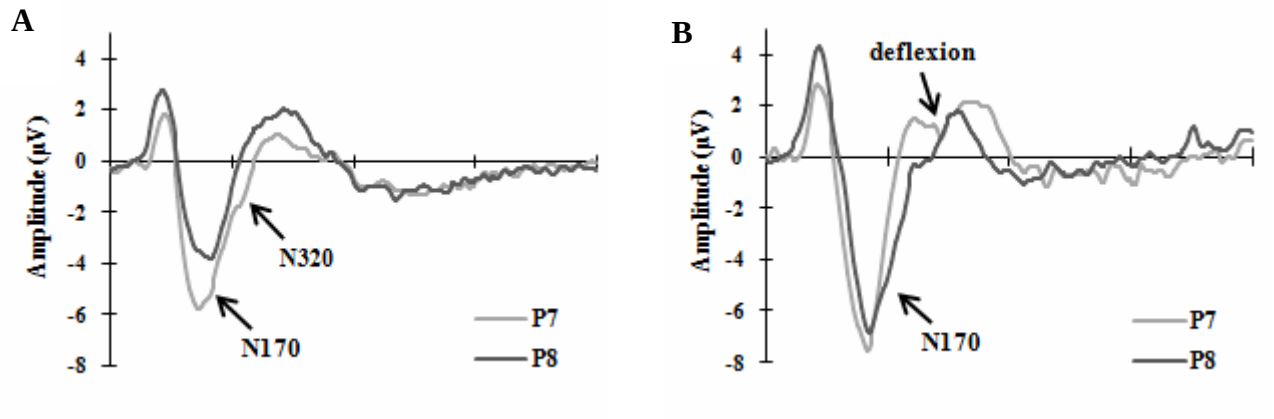

Figure 5: ERPs of control (A) and dyslexic (B) subjects recorded at P7 (left hemisphere) and P8 (right hemisphere) electrodes during reading of infrequently used words.

4 GENERAL CONCLUSION

Bilateral processing in Arabophones reading French and dyslexic subjects may be considered as a form of adaptation to difficulties in processing.

Since the two languages possess different characteristics, Arabophones adapt to each. Compensatory strategies lead to slowed responding, probably as a result of bilateral treatment and callosal exchange.

Cerebral plasticity implying reorganization of synapses may play an important role in the integration of different languages and thereby cultural information. The possibility of more fruitful exchanges must take into account language characteristics as well as level of expertise in the second language.

5 REFERENCES

BELAND R., MIMOUNI Z. *Deep dyslexia in the two languages of Arabic/French bilingual patient.* Cognition, 2001, vol.82, n°2, pp.77-126.

BENTIN S., MOUCHETANT-ROSTAING Y. *ERP manifestations of processing printed words at different psycholinguistic levels : time course and scalp distribution*. Journal of Cognitive Neuroscience, 1999, vol.11, pp.235-260.

HILLYARD S.A., TEDER-SÄLEJÄRVI W.A. et al. *Temporal dynamics of early perceptual processing*. Current Opinion in Neurobiology, 1998, vol.8, pp.202-210.

IBRAHIM R. EVIATAR Z. et al. *The characteristics of arabic orthography slow its processing.* Neuropsychology, 2002, vol.16, n°3, pp.322-326.

PAULESU E., McCRORY E. Et al. *A cultural effect on brain function.* Nature Neuroscience, vol.3, pp.91-96.

PERANI D. ABUTALEBI J. *The neural basis of first and second language processing*. Curr. Opin. Neurobiol., 2005, vol.15, pp.202-206.

SHAYWITZ B.A. SHAYWITZ S.E. et al. *Development of left occipitotemporal systems for skilled reading in children after a phonologically based intervention*. Biological Psychiatry, 2004, vol.55, pp.926-933.

SIMON G., BERNARD C. et al. *Chronometry of visual word recognition during passive and lexical decision task: an ERP investigation*. Journal of Neuroscience, 2004, vol.114, pp.1401-1432.

VIGNEAU M. JOBARD G. et al. *Word and non-word reading: what role for the Visual Word Form Area?* NeuroImage, vol.27, pp.694-705.

ZIEGLER J. C., PERRY C. Et al. *Speed of lexical and nonlexical processing in French: the case of the regularity effect*. Psychonomic Bulletin and review, vol.10, n°4, pp.947-953.