Published in final edited form as:

Phys Life Rev. 2013 December ; 10(4): 450–456. doi:10.1016/j.plrev.2013.09.006.

What factors influence how two languages are coded in one brain Comment on “The Bilingual Brain: Flexibility and Control in the Human Cortex”

Buchweitz, Prat, and Arturo E. Hernandez

Department of Psychology, University of Houston

For many years, researchers have wondered how two languages are represented in one brain. Of particular interest is the finding of selective impairment of a single language in bilinguals [1, 2]. Naturally, this leads to the question of what factors might be determining which language is preserved and which is lost. It also leads to the possibility that each language may have different neural representations.

Neuropsychologists around the turn of the twentieth century identified three factors that help to determine the brain bases of bilingualism: age of acquisition, language proficiency and cognitive control. Ribot, considered by many to be the father of French psychology, found that patients often forgot their most recent memories first and the oldest memories last [3–5]. Based on this he proposed the idea that “age of acquisition” was crucial for the formation of memories, a finding that is still relevant today [6, 7]. Shortly thereafter, Pitres suggested that familiarity would play a crucial role in the resistance of language to breakdown [8]. Language proficiency, as it has been termed today, has been found to play a central role in the neural representation of bilingualism [9–11]. Finally, Otto Pötzl, an Austrian neurologist, based on work with patients was the first to suggest a switch mechanism that was responsible for controlling the language that was used at that moment [12]. The importance of control has come to the forefront of bilingual language research when switching between languages [13], overcoming interference from a more dominant language [14], and the possible benefits of verbal control on non-verbal control tasks [15]. What emerges from this literature is both a richness of history in neuropsychology coupled with newfound interest in this field with the emergence of new technologies with which brain activity can be measured and manipulated.

Buchweitz and Prat [16] piece on the bilingual brain adds significantly to this growing body of work while at the same time allowing further examination of the factors identified by neuropsychologists many years ago. The authors discuss issues of neural representation with regard to semantic processing, orthographic representation, and finally executive control. It is on this final topic that the current piece provides its strongest contribution. One aspect that deserves considerable consideration is the distinction between learning via experience relative to learning through instruction. The distinction between experience which involves the basal ganglia relative to explicit instruction which involves the cortex is particularly fascinating. This distinction also carries implications for the other two main issues that frame the literature. Do these two systems help to differentiate high and low proficiency bilinguals? What about child learners and adults? Does learning a language early in life or

later in life involve the basal ganglia and cortex differentially? This review provides us with concepts that should help guide future research with respect to these additional questions.

References

1. Paradis, M. The assessment of bilingual aphasia. Hillsdale, NJ: Erlbaum; 1987.
2. Gomez-Tortosa E, et al. Selective deficit of one language in a bilingual patient following surgery in the left perisylvian area. *Brain and Language*. 1995; 48:320–325. [PubMed: 7757449]
3. Ribot, T. Les maladie de la memoire. 2. Paris: Baillere; 1881.
4. Lorch MP. History of aphasia: Multiple languages, memory, and regression: An examination of Ribot, Aôs Law. *Aphasiology*. 2009; 23(5):643–654.
5. Ribot, T. Diseases of memory: an essay in the positive psychology. New York: D. Appleton and company; 1882.
6. Hernandez AE, Li P. Age of acquisition: its neural and computational mechanisms. *Psychological bulletin*. 2007; 133(4):638–650. [PubMed: 17592959]
7. Hernandez, AE. The Bilingual Brain. New York: Oxford University Press; 2013.
8. Pitres, A. Aphasia in polyglots. In: Paradis, M., editor. Readings on aphasia in bilinguals and polyglots. Marcel Didier; Montreal: 1983. p. 26-49.
9. Perani D, et al. The bilingual brain: Proficiency and age of acquisition of the second language. *Brain*. 1998; 121(10):1841–1852. [PubMed: 9798741]
10. Abutalebi J, Cappa SF, Perani D. The bilingual brain as revealed by functional neuroimaging. *Bilingualism: Language and Cognition*. 2001; 4(2):179–190.
11. Meschyan G, Hernandez AE. Impact of language proficiency and orthographic transparency on bilingual word reading: an fMRI investigation. *Neuroimage*. 2006; 29(4):1135–40. [PubMed: 16242351]
12. Potzl, O. Aphasia and mutilingualism. In: Paradis, M., editor. Readings on aphasia in bilinguals and polyglots. Marcel Didier; Montreal; 1983. p. 301-316.
13. Fabbro F, Skrap M, Aglioti S. Pathological switching between languages after frontal lesions in a bilingual patient. *Journal of Neurology, Neurosurgery and Psychiatry*. 2000; 68(5):650–2.
14. Hernandez AE, Meschyan G. Executive function is necessary to enhance lexical processing in a less proficient L2: Evidence from fMRI during picture naming. *Bilingualism: Language and Cognition*. 2006; 9(2):177–188.
15. Bialystok E. Bilingualism: The good, the bad, and the indifferent. *Bilingualism: Language and Cognition*. 2009; 12(1):3–11.
16. Buchweitz, A., Prat, CS. *Physics of Life Reviews*. 2013. The Bilingual Brain: Flexibility and Control in the Human Cortex. this issue