

REVIEW

Bilingualism reconfigures brain attentional networks through neuroplasticity across the lifespan

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ABSTRACT

The researcher Dr. Ellen Bialystok presents data about the effect of bilingualism on the brain across lifespan, regarding the relationship between the mastery of more than one language and attentional systems. Bialystok reflects on the lack of agreement on the bilingual advantages of studies with adults, listing the facts and myths about the theme, such as the problems with the definition of bilingual, the different age groups of participants, the different contexts investigated, the limitations of the tasks and the models of executive functions and the difficult replicability of studies, which lead investigations to a great controversy. The researcher points out that, even with little consensus, the effects of bilingualism on the brain are related to the reconfiguration of attentional systems. The researcher suggests that bilingualism may be a source of neuroplasticity, which re-adapts these systems, resulting in differences in the executive functions found in research in recent years, which are easy to identify and verify, especially in children and elderly bilinguals.

RESUMO

A pesquisadora canadense Dra. Ellen Bialystok apresenta dados a respeito do efeito do bilinguismo no cérebro ao longo da vida, atinentes às relações entre o domínio de mais de uma língua e os sistemas atencionais. Bialystok reflete sobre a falta de concordância sobre as vantagens bilíngues de

estudos com adultos, elencando os fatos e mitos acerca do tema, como os problemas com a definição de bilíngue, as distintas faixas etárias dos participantes, os diversos contextos investigados, as limitações das tarefas e dos modelos de funções executivas e a difícil replicabilidade dos estudos, que levam as investigações a uma grande polêmica. A pesquisadora ressalta que os efeitos do bilinguismo no cérebro estão relacionados à reconfiguração dos sistemas atencionais. Bialystok sugere que o bilinguismo seja uma fonte de neuroplasticidade, a qual readapta os sistemas atencionais, acarretando em diferenças nas funções executivas encontradas nas pesquisas com bilíngues nos últimos anos, de fácil identificação e constatação principalmente em crianças e idosos bilíngues.

KEYWORDS

Bilingualism. Attention networks. Neuroplasticity.

PALAVRAS-CHAVE

Bilinguismo. Atenção. Neuroplasticidade.

Most of the world population can communicate in another language and can be characterized as bilingual (BAKER, 2006). A bilingual has two languages operating in his/her cognitive system, as a continuous line from the monolingual towards the bilingual mode (GROSJEAN, 1985)¹. It is about this topic that the Canadian professor and researcher Dr. Ellen Bialystok gives the conference *Does Bilingualism Affect Cognitive and Brain Structures? Facts and Fictions* on June 30th, in the series of online lectures promoted by the Brazilian Linguistics Association (ABRALIN) during the coronavirus pandemic (COVID -19). The lecture was mediated by Dr. Ingrid Finger (UFRGS). Professor Bialystok presents the controversy behind the facts and myths about brain changes derived from bilingualism. For 2 hours, the researcher points out empirical data indicating that mastering more than one language modifies the brain's cognitive structure.

For Professor Bialystok, bilingualism is a source of cerebral neuroplasticity that allows reconfiguration of the attentional systems in the brain, leading to the differences in executive functions found in research over the past few decades. In this critical review, our goal is to discuss the evidence presented by Bialystok. The use of language is intense and recruits broad brain networks and cognitive systems. This use of more than one language is a source of brain plasticity through the joint activation of languages and the conflict between them that leads to constant selection between

¹ This view is opposed to the idea that a bilingual is an individual who uses two languages in the same way and intensity, with similar fluency in both languages (Hypothesis of the double monolingual, SAER, 1922).

languages. The researcher argues throughout her lecture that the consequence of the processes involved in the continuous demands for selection between languages is the reorganization of the attentional brain networks in bilingual subjects.

Cognition is a dynamic system, changing according to stimuli, making new connections with each other (brain plasticity phenomenon) (STERN, 2002). For this reason, factors such as: educational level, social environment, socioeconomic status, profession and bilingualism can significantly affect the brain (BIALYSTOK *et al.*, 2007). These elements help to form a cognitive reserve, a positive balance in the face of cognitive declines in aging. According to Bialystok, one of the main mechanisms that plays a role in compensating for cognitive losses is the frontal-parietal control system. The cognitive reserve (hypothesis) proposes that it can be derived from reconfigurations of the attentional systems and brain networks responsible for it, like the prefrontal cortex.

Attentional and executive processes underlie the bilingual experience. There is a need for attention, concentration, selectivity of stimuli, capacity for abstraction, planning, flexibility, mental control, self-control, working memory (HANDAM; BUENO, 2005), in addition to the linguistic capacity necessary to speak (or to read and to understand) in one of the languages that the individual knows. During reading, for example, you need a dynamic filtering of relevant information and, in parallel, an inhibition of irrelevant information for the reading in the proper language and not in the other one. In the case of adaptive control (GREEN; ABUTALEBI, 2013), linguistic control processes adapt to the demands of an interactive context, therefore, there is a recruitment of the entire attentional systems. It is precisely the continuous exercise of these attentional systems that helps in the formation of the cognitive reserve, that is, in the reconfiguration of the attentional system of the bilingual individual that Professor Bialystok talks about. The bilingual must constantly select the language relevant to the communicative context and inhibit the non-relevant language.

According to Bialystok, the scientific evidence is quite clear in children and the elderly, but there is an inconsistency in replicating results of studies with adult participants. According to the researcher, We are looking at the wrong side, as there are contradictions regarding the concept of bilingual, age of the group of participants, contexts investigated, limitations of tasks such as Simon / Stroop task and Flanker test and there are also problems in the theoretical scope about executive functions (the researcher questions the Unified and Diversified model of Miyake *et al.* (2000)). Therefore, when asked about the importance of replicability of research results, a relevant issue in the experimental research area, the scientist alludes to an impossible repetition of a cake recipe, since each bilingual is endowed with unique characteristics - a cake, in fact, with its own peculiarities.

In this sense, the dichotomy about the bilingualism advantages *versus* disadvantages in the different stages of life converges to the acceptance that there is still much to be explored and that this precept may explain the lack of results corroboration, especially regarding adulthood. When we look carefully at the elements mentioned by Professor Bialystok, these variables are more difficult to be controlled in experimental studies with adult participants. Bilingual children in the studies are usually bilingual at an early age, which makes them similar participants to the research study. In the elderly, there are well known standardized tests of cognitive decline due to neurodegenerative

diseases like Alzheimer's, which helps in conducting experimental research. In research with adults, it becomes more difficult to standardize among participants the amount of use of each language, the age when the participant learned the language, their educational level and also their socioeconomic level, the context investigated, the executive functions skills of each of the participants, among other elements cited by Bialystok.

Bilingual children usually outperform monolinguals in executive functions (MARTIN-RHEE; BIALYSTOK, 2008), may have greater mental flexibility (PEAL; LAMBERT, 1962), metalinguistic awareness (CUMMINS, 1978) and greater creativity (KESSLER; QUINN, 1987), but they may have a smaller vocabulary (BIALYSTOK; FENG, 2011), less speed in lexical access (GOLLAN *et al.*, 2005) and less verbal fluency (BIALYSTOK; FENG, 2011). This is probably because both languages of the bilingual person share brain networks, so access to lexical items may be slower due to the competition between the two languages, two terms - one in each language - with similar semantic meanings. And the number of lexical items in each language may be less compared to the vocabulary of a monolingual, but greater if we consider the lexical items of the two languages. The Canadian researcher points out that in congruent and incongruent stimuli decision tasks (Simon's task, for example), bilingual children systematically obtain shorter response times, as seen in the research by Martin-Rhee and Bialystok (2008) and Emmorey, Luk, Pyers and Bialystok (2008). This result is consistent with the attentional system reconfiguration of the bilinguals that brings them advantages and faster responses, even in the congruent items of these selective attention tasks.

In adults, there are positive differences for bilinguals in executive functions related to inhibitory control (BIALYSTOK *et al.*, 2004) and greater promotion of cognitive reserve (BIALYSTOK *et al.*, 2007), but they are faced with problems in lexical access (GOLLAN *et al.*, 2005), in the lexical decision (RANDELL; FISCHLER, 1987), in the semantic fluency (GOLLAN *et al.*, 2002) and with the *on the tip of the tongue effect*² (GOLLAN; ACENAS, 2004). Bialystok reports that most studies with adult individuals investigate young university students, impairing the generalization of the results. When presenting data from Paap and Greenberg (2013) on response times of young bilinguals in Simon's Task, the Professor argues that the Paap and Greenberg (2013) replication of Bialystok *et al.* (2005) results is probably due to the context that is the same in both studies. The differences in response time between monolinguals and bilinguals disappear when it comes to a young population with a high educational level, also exemplified in Grundy *et al.* (2017) data. It happens, according to the Bialystok, due to the lack of sensitivity of the tasks that leads to a ceiling effect. And it is one of the answers to the controversial data found in the cognitive advantages (or not) of bilingual adults.

Bialystok highlights the most positive balance of reconfiguring attentional processes at the last phase of life. It is known that, as you get older, there may be a decrease in cognitive skills, such as attention, control and memory. However, factors such as the bilinguals exercise of attention can compute more quality of life for them. More precisely, bilingualism provides a delay of approximately

² The on the tip of the tongue effect is a universal phenomenon that causes a failure in the immediate recovery of a word or name that the individual knows well. It is possible that you may know facts related to it, but recovery does not happen fast. The feeling is that the word or name is blocked at the "tip of the tongue", on the verge of being remembered at any time.

4 years in the onset of Alzheimer's symptoms in an elderly population predisposed to the disease (BIALYSTOK *et al.*, 2007). The bilingual advantage comes into play as we age, when we most need the compensatory resources of attention.

The search for differences between bilingual and monolingual still persists. Ellen Bialystok showed us the evolution of scientific data and gave us some directions to next research. Perhaps, over the years, we have not observed yet bilingual under all possible perspectives. We may need to reflect more on the topic, considering the context, for example. In Brazil, the country's continental dimensions, the proximity and knowledge about different languages besides Brazilian Portuguese depending on the country's region, the social, cultural and socioeconomic characteristics of the population, the educational and literacy level of the bilinguals imposes different elements to our attempt for a Brazilian cake recipe, so it is still under construction. Much research has been done lately, however, there is still a long way journey towards answers about the view of bilingualism of new era.

REFERENCES

- DOES Bilingualism Affect Cognitive and Brain Structures? Facts and Fictions. Conference presented by Ellen Bialystok [S.l., s.n], 2020. 1 video (1h39min 00s). Published by Brazilian Linguistics Association Channel. Available at: https://www.youtube.com/watch?v=DpuqI9pa_5U. Accessed on: June 30th, 2020.
- BAILER, C. *The neural processing of sentences in bilinguals and monolinguals: an fMRI study of Portuguese-English bilinguals and Portuguese monolinguals reading comprehension effects on brain activation*. 2016. (P.h.d. Thesis) – Federal University of Santa Catarina, Communication and Expression Center, English Language Post-Graduation Program: Literary and Linguistics studies, Florianópolis, 2016.
- BAKER, C. *Foundations of bilingual education and bilingualism*. (5 ed.). Clevedon: Multilingual Matters Ltda, 2006.
- BIALYSTOK, E.; CRAIK, F.; GRADY, C.; CHAU, W.; ISHII, R.; GUNJI, A.; PANTEV, C. Effect of bilingualism on cognitive control in the Simon task: evidence from MEG. *Neuroimage*, n. 24, p. 40-49, 2005.
- BIALYSTOK, E.; CRAIK, F. I. M.; FREEDMAN, M. Bilingualism as a protection against the onset of symptoms of dementia. *Neuropsychology*, n. 45, p. 459-464, 2007.
- BIALYSTOK, E.; FENG, X. Language proficiency and its implications for monolingual and bilingual children. In: DURGUNOGLU, A.; GOLDENBERG, C. (Eds.). *Challenges for language learners in language and literacy development*. Guilford Press, 2011. p. 121-140.
- BIALYSTOK, E.; KLEIN, R.; CRAIK, F. I. M.; VISWANATHAN, M. Bilingualism, aging and cognitive control: Evidence from the Simon task. *Psychology and Aging*, v. 19, n. 2, p. 290-303, 2004.
- CUMMINS, J. Bilingualism and the development of metalinguistic awareness. *Journal of Cross-Cultural Psychology*, n. 9, p. 131-149, 1978.
- EMMOREY, K.; LUK, G.; PYERS, J. E.; BIALYSTOK, E. The source of enhanced cognitive control in bilinguals: Evidence from bimodal bilinguals. *Psychological Science*, v. 19, p. 1201-1206, 2009.

- GOLLAN, T. H.; ACENAS, L. A. R. What is a TOT? Cognate and translation effects on tip-of-the-tongue states in Spanish-English and Tagalog-English bilinguals. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, n. 30, p. 246-269, 2004.
- GOLLAN, T. H.; MONTOYA, R. I.; FENNEMA-NOTESTINE, C.; MORRIS, S. K. Bilingualism affects picture naming but not picture classification. *Memory & Cognition*, n. 33, p. 1220-1234, 2005.
- GOLLAN, T. H.; MONTOYA, R. I.; WERNER, G. Semantic and letter fluency in Spanish English bilinguals. *Neuropsychology*, v. 16, p. 562-576, 2002.
- GREEN, D.; ABUTALEBI, J. Language control in bilinguals: The adaptative control hypothesis. *Journal of Cognitive Psychology*, v. 25, n. 5, p. 515-530, 2013. <https://doi.org/10.1080/20445911.2013.796377>
- GROSJEAN, F. The bilingual as a competent but specific speaker-hearer. *Journal of Multilingual and Multicultural Development*, n. 6, p. 467-477, 1985.
- GRUNDY, J. G., CHUNG-FAT-YIM, A., FRIESEN, D. C., MAK, L., AND BIALYSTOK, E. Sequential congruency effects reveal differences in disengagement of attention for monolingual and bilingual young adults. *Cognition*, n. 163, p. 42-55, 2017. <https://doi.org/10.1016/j.cognition.2017.02.010>
- HAMDAN, A. C.; BUENO, O. F. A. Relations between executive control and episodic memory in mild cognitive impairment and in Alzheimer disease. *Estudos de Psicologia*, v. 10, n. 1, p. 63-71, 2005.
- KESSLER, C.; QUINN, M. E. Language minority children's linguistic and cognitive creativity. *Journal of Multilingual and Multicultural Development*, n. 8, p. 173-186, 1987.
- LU, C-H.; PROCTOR, R. W. The influence of irrelevant location information on performance: A review of the Simon and spatial Stroop effects. *Psychonomic Bulletin & Review*, n. 2, p. 174-207, 1995.
- MARTIN-RHEE, M. M.; BIALYSTOK, E. The development of two types of inhibitory control in monolingual and bilingual children. *Bilingualism: Language and Cognition*, v. 11, p. 1-13, 2008.
- MIYAKE, A.; FRIEDMAN, N. P.; EMERSON, M. J.; WITZKI, A.H.; HOWERTER, A.; WAGER, T. D. The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology*, v. 41, p. 49-100, 2000.
- PAAP, K. R.; GREENBERG, Z. I. There is no coherent evidence for a bilingual advantage in executive processing. *Cognitive Psychology*, n. 66, p. 232-258, 2013.
- PEAL, E.; LAMBERT, W. The relation of bilingualism to intelligence. *Psychological Monographs*, v. 76, n. 546, p. 1-23, 1962.
- RANSDALL, S. E.; FISCHLER, I. Memory in a monolingual mode: When are bilinguals at a disadvantage? *Journal of Memory & Language*, v. 26, p. 392-405, 1987.
- SAER, D. J. The Effects of Bilingualism on Intelligence. *British Journal of Psychology*, v. 14, p. 25-38, 1922.
- STERN, Y. What is cognitive reserve? Theory and research application of the reserve concept. *Journal of the International Neuropsychological Society*, v. 8, n. 3, p. 448-460, 2002. <http://doi:10.1017/S1355617702813248>.