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Commentary

Can a Second Language Help You in More Ways Than One?

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Abstract: In response to the review article written by Paap et al. [1], we will examine the reasons why one would expect some behavioral and cognitive advantages of bilingualism. Then we will explain why such advantages may not be apparent in certain experiments. We will conclude that bilingualism is a skill that can entail neuroplastic changes, thus improving cognitive load processing abilities. However, the extent to which bilingualism may or may not lead to cognitive advantages or disadvantages relates to several factors. Finally, we argue that the optimal approach in studying the potential cognitive advantages of bilingualism is to link behavior to brain function, as a given behavior may be subserved by different neural mechanisms in bilingual and monolingual populations, reflecting distinct processing strategies.

Keywords: bilingual; cognitive; executive function; advantage; controversy

1. Introduction

Can speaking a second language help you in more ways than one? This question has been examined by several scientific papers in the last 50 years, but the issue remains controversial. Some authors have cast doubt on the benefits associated with bilingualism [1]. Nevertheless, speaking a second language is rewarding for many people around the world for its social benefits, including economic gains, better job opportunities, and openness to other cultures and mindsets. More recently, cognitive advantages have also been linked to bilingualism. For example, bilinguals respond faster and more accurately than monolinguals to cognitive tasks requiring selective attention, inhibition, switching, and executive function abilities. Of all the cognitive advantages associated with bilingualism, perhaps a delay in the onset of signs of neurodegenerative disease represents the most important benefit, if it is proven to be true [2–4]. Many authors have shown the positive impact of bilingualism at the behavioral level, using the Simon or Stroop tasks [5–11], but others failed to replicate these results, using the same tasks, with different populations [12–14]. This suggests that the bilingual advantage may appear under certain circumstances but not others.

Moreover, given the extensive neuroimaging literature on bilingualism, some authors have attempted to reveal the neuroplastic changes associated with a potential bilingual advantage [8,15–17]. Discrepancies in the literature have triggered many controversies and, to some extent, skepticism [1,18]. In particular, Paap and his colleagues have recently raised a number of concerns in a commentary, as well as in their recent review article in *AIMS Neuroscience* [1,18]. These authors doubt the external validity of the results reported in the literature regarding the cognitive advantages of bilinguals. Thus, these authors consider that conclusions about the bilingual advantage are overly optimistic, because they are drawn from the results of small-sample studies, measured the wrong components and relied on non-convergent behavioral and neuroimaging results [1,18].

While we acknowledge the validity of some of these points, we would like to offer an alternative interpretation of the apparent contradictions in the literature. In fact, it is true that most of the studies reporting neurofunctional differences across bilinguals and monolinguals concern relatively small cohorts; however, the fact that these differences appear even in small cohorts shows the robustness of the effect. Moreover, the claim that neuroimaging and behavioral results are not always aligned is also true, but this may in fact reveal different cognitive strategies underlying cognitive control mechanisms across the target populations [17].

In this commentary, in response to the review article written by Paap et al. [1], we will examine the reasons why one would expect bilinguals to have some behavioral and cognitive advantages. Then we will explain why such advantages may not be apparent in some experiments. Finally, we argue that the optimal approach to study the question of whether bilingualism entails cognitive advantages or not is to link behavior to brain function, as a given behavior may be subserved by different neural mechanisms in bilingual and monolingual populations, thus reflecting distinct processing strategies.

2. Why can bilingualism be advantageous?

A neurocognitive perspective can contribute to a better understanding of the potential advantages of bilingualism. The rationale behind the assumption that a cognitive advantage is associated with bilingualism stems from the effect of the recurrent practicing of voluntary inhibition of one language when using another. Such inhibition involves cognitive control abilities and processes including selective attention, inhibition, executive function and conflict management. According to Abutalebi and Green's theoretical model [19] and evidence of functional connectivity from Ghazi Saidi et al. [20], cognitive control processing areas are recruited at low second language (L2) proficiency levels. In line with principles of experience-dependent neuroplasticity [21], the recurrence of this recruitment is expected to have an impact on the cognitive control network. Thus, research shows that prefrontal areas, such as the prefrontal cortex and the cingulate cortex, both of which are normally involved in tasks that demand cognitive control, are less activated in bilinguals than in monolinguals. This finding has been taken as evidence for a neurocognitive advantage in bilinguals, reflecting a more economical use of brain resources, which could also make a bilingual person more resistant to the effects of age and related cognitive deficits. This latter effect has been reported in some epidemiological studies, in which bilingual speakers typically show signs of neurodegenerative diseases as much as four years later than their monolingual peers [4,22,23].

3. Why are the results of different experiments controversial?

Still, it is true that the literature on this topic is quite controversial. There are a number of reasons why the performance of bilingual and monolingual speakers should not be significantly different, as reported in many studies that sought evidence of the advantages for bilingualism. The first reason is that it may be difficult to distinguish between monolingual and bilingual speakers, unless the bilingual group is perfectly proficient in both languages and the monolinguals have never (even passively) been exposed to a second language. For example, in a study that reported no difference in the onset of Alzheimer's disease in a group of bilinguals and a group of monolinguals [24], the monolinguals did not meet the criteria for true monolingualism, in that they were exposed to a second language because they lived in a bilingual city. Inaccurate categorization of monolinguals and bilinguals (also including L1 attrition) is a pitfall of many studies that did not report any significant differences between monolingual and bilingual speakers. Moreover, this highlights the limitations of the categorization approach. Positing a continuum of bilingualism, instead, could change the interpretation of reported results and conclusions. In addition, the controversy over the results reported in this literature requires one to account for other confounding factors, such as age of L2 acquisition, L2 use and exposure, linguistic distance between L1 and L2, immigration status, socioeconomic status, mastery in a third language, education level, or the presence of cardiovascular disease, all of which could prevent the advantage from becoming evident.

Moreover, most studies that failed to report any cognitive advantage for bilingualism had samples of young adults. Studies on elderly bilinguals and children seem to be convergent in indicating a bilingual advantage. This dichotomy may express the fact that the cognitive advantages of bilingualism may be highlighted or become particularly evident at stages of life when cognitive capacity is not at its maximum, such as in childhood or old age. Conversely, in young adults who are at their peak of cognitive capacity, a bilingual advantage might fade in the ceiling effect of high cognitive performance.

Another important factor influencing cognitive performance in bilinguals relates to proficiency level. Based on the theoretical model by Abutalebi and Green [19], supported by functional connectivity evidence from Ghazi-Saidi et al. [20], the involvement of the control network in processing a second language is dynamic and is correlated with L2 proficiency level. This means that increasing proficiency is associated with better cognitive control. Interestingly, studies reporting a cognitive advantage associated with bilingualism or the absence of any such advantage differ in their participants' proficiency level (e.g., [7] vs. [13]). The former included proficient participants, while the latters included less proficient bilingual speakers. Further, L2 proficiency in the monolingual control group matters as well. While in studies that reported a bilingual advantage the monolingual group did not have any knowledge of L2, in studies that failed to find an advantage (e.g., [13]), the monolingual speakers were not really monolingual because they had some knowledge of and exposure to L2. Moreover, in the latter studies, language proficiency is most frequently determined on the basis of questionnaires and self-evaluations, whereas only objective tests are reliable measures of L2 proficiency.

Some authors believe that the cognitive advantages associated with bilingualism actually stem from immigration [1,25], as the capacity to face the numerous challenges of immigration might well reflect higher cognitive abilities. However, there have been no experimental studies on this issue. It has also been argued that the bilingual advantage may in fact result from higher education, which is frequent among bilinguals. However, a recent study has demonstrated that the bilingual cognitive effect can be observed even in illiterate societies and in settings where bilingualism occurs as a natural characteristic of the society rather than because individuals are forced to be bilingual as a result of immigration [22].

Another factor related to both proficiency and bilingualism is the age of acquisition of each language spoken by the bilingual person. The definition of L1 and L2 may differ in bilinguals based on their language dominance. This is another factor that can influence the cognitive advantage. Not all bilinguals are equally proficient in both languages or equally proficient in different language domains (comprehension vs. production and written vs. spoken); they can also differ in regard to the setting in which each language was learned (formal vs. informal), or vary in the use of and exposure to each language. To become proficient, an individual has to deal with a considerable amount of interference or competition between L1 and L2, for a considerable length of time. The impact that this pressure imposes on the control system may modify the strategies and the neural substrates subserving interference control.

On the other hand, some authors argue that the bilingual advantage is specific to the language domain, and more particularly to the auditory modality as compared to the visual modality [26], since bilingualism provides more practice with the inhibition of auditory stimuli than of visual stimuli. While this might be a good justification, it leads us to another fundamental question: If there is an advantage, is it a domain-specific effect? Is the advantage related to verbal (linguistic) tasks or nonverbal (nonlinguistic) tasks? The results reported for verbal and nonverbal tasks provide evidence of an advantage in nonverbal tasks [27], such as the Simon task or the Flanker task. This suggests that the advantage is a general one. If we assume that there is one control network, which undergoes neuroplastic changes due to bilingualism, then we could expect bilingualism to have a more general effect on cognitive control abilities, which should be reflected by better performance on a variety of tasks that demand cognitive control.

Recent evidence suggests that comparing bilinguals and monolinguals at both the behavioral and neurofunctional levels might be the key to solving the apparent controversies in behavioral studies. Hence, bilingualism is a matter of behavior, but it is also a matter of brain function. Recent evidence shows that the bilingual brain can be proficient at dealing with interference control, at a minimal cost, a strength that may become an advantage under certain circumstances. Our recent work [17] showed that equivalent behavior on a visuospatial interference control task required a group of monolingual elderly people to recruit prefrontal areas, whereas their bilingual peers were able to solve the task by recruiting visuospatial processing areas alone; they simply did not need to recruit the prefrontal complex to solve the interference challenge imposed by the task. Given that the prefrontal cortex is particularly vulnerable to aging, not needing to recruit it may become an advantage for older people; it may also explain the delay in Alzheimer's disease symptoms that has been reported in bilinguals. Thus, behavior is the tip of the iceberg, but below it there is the bilingual brain, and the advantage could reside in its networks.

4. Conclusion

To conclude, we argue that controversies in the behavioral literature regarding a potential bilingual advantage in dealing with interference control result from a lack of comparable experimental conditions across studies, and from a failure to control for relevant experimental variables in some of this work. Moreover, this appearance of controversy may well be solved by combining behavioral and neurofunctional tools. Thus, functional neuroimaging evidence suggests that speaking more than one language may lead to neuroplastic changes that can become advantageous in cognitively demanding situations. These advantages may not always be apparent, but they may become evident in situations when the system is taxed by the complexity of the task, by aging, or by brain disease.

Despite the abundant literature on bilingualism, our understanding of the cognitive and neurocognitive mechanisms related to bilingual language processing remains incomplete. More research is necessary to gain a comprehensive view of this issue. This knowledge will allow us to measure the potential of bilingualism to enhance cognitive abilities. It can also be a tool in designing interventions for a number of developmental (e.g., specific language impairment) and acquired (e.g., aphasia) language disorders or of neurodegenerative diseases (e.g., Alzheimer's disease). This knowledge could also have a dramatic influence on education and social system policies.

Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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