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# Does learning a language in the elderly enhance switching ability?

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ABSTRACT

The bilingual advantage has been subject of research repeatedly over the last decade. Many studies have supported the idea of the existence of a higher functioning in domain general cognitive abilities among bilingual samples as compared to monolingual samples. However, this idea has been recently challenged by a number of scholars, and a recent body of evidence suggests that the acquisition of a new language does not necessarily involve an enhancement of domain-general non-linguistic abilities. In the current study we aimed at exploring the relationship between language learning and switching ability in elderly monolingual participants who learned a second language during a whole academic year. A colour-shape switching task was used as a measure of switching ability and was administered twice in a pre-test/post-test design, both to the critical group of seniors attending a language-learning course on a regular basis and to a group of age-matched monolingual seniors who did not attend to any language-learning course and that served as controls. Results showed that switching costs in the post-test were not significantly different from those in the pre-test in either the experimental or the control groups, demonstrating that the acquisition of a second language in the elderly does not necessarily lead to an enhancement of switching ability as measured by switching costs. We acknowledge the need of further longitudinal L2 training studies to reach clear conclusions on the effects of language learning in domain-general executive control.



## 1. Introduction

The so-called bilingual advantage hypothesis suggests that bilingualism may lead to an improvement in domain-general executive control abilities as compared to monolinguals. Updating, switching and inhibition are components of this not unitary construct known as executive functions (EF) (Miyake & Friedman, 2012), and bilingualism has been often linked with a specific enhancement of these components, suggesting that bilinguals outperform monolinguals in monitoring (as the ability to update the information in the working memory), in shifting (as the ability to switch between tasks), and/or in

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inhibition (as the ability to suppress dominant responses). Due to the fact that using two languages on a daily basis requires updating the information of the relevant language depending on the context, shifting from one language to another and suppressing the non-relevant language, it has been hypothesized that bilingualism could have an impact on domain-general executive functions.

In the last decade a surge of studies have confirmed the effects of bilingualism on domain-general cognitive functions using several non-linguistic executive control tasks in different age populations (e.g., Bialystok, Craik, & Luk, 2008; Bialystok, Craik, Klein, & Viswanathan, 2004; Bialystok, Craik, & Luk, 2012; Gold, Kim, Johnson, Kryscio, & Smith, 2013; Hernández, Costa, Fuentes, Vivas, & Sebastian-Galles, 2010; Kroll & Bialystok, 2013). There is also research showing that lifelong bilingualism attenuates age-related cognitive control decline (Bak, Nissan, Allerhand, & Deary, 2014; Bialystok & Craik, 2010; Wilson, Boyle, Yang, James, & Bennett, 2015), and that bilingualism contributes to cognitive reserve in aging populations including a delay in the onset of dementia symptoms (see Bialystok, Abutalebi, Bak, Burke, & Kroll, 2016; for review).

However, a whole body of evidence against this so-called bilingual advantage at the behavioral and neural level has emerged recently, arguing that these differential effects do not exist, or that they are restricted to specific undetermined circumstances (Antón et al., 2014; Antón, Fernández García, Carreiras, & Duñabeitia, 2016; Duñabeitia et al., 2014; Gathercole et al., 2014; Paap & Greenberg, 2013; Paap, Johnson, & Sawi, 2015; Paap, Johnson, & Sawi, 2016; de Bruin, Bak, & Della Sala, 2015). Also, several longitudinal studies following individuals that had no signs of dementia at the initial test moment have reported non-significant results in the delay of the emergence of dementia-related symptomatology related to bilingualism (Crane et al., 2010; Lawton, Gasquoine, & Weimer, 2015; Sanders, Hall, Katz, & Lipton, 2012; Zahodne, Schofield, Farrell, Stern, & Manly, 2014), thus questioning the validity of the so-called bilingual advantage.

Together, the studies mentioned above studying differences between bilinguals and monolinguals in different age populations and the relationship between lifelong bilingualism and cognitive reserve in older populations have used tasks that require active processing of incongruent or salient irrelevant information. Among the paradigms that have been mainly used in order to investigate the set of executive control abilities (monitoring, switching and inhibition) the most commonly used ones are the Simon task (Simon & Rudell, 1967), the flanker task (Eriksen & Eriksen, 1974), the Stroop task (Stroop, 1935), and several forms of switching tasks (see Rubin & Meiran, 2005; see also; Prior & MacWhinney, 2010). The evidence from these tasks in the bilingual domain stems from different behavioral and electrophysiological studies, and interestingly, several versions of all these tasks using linguistic and non-linguistic stimuli have been used in fMRI designs to study the relationship between brain activation and the specific conditions of interest (e.g., the switch trials in a switching paradigm; see Luk, Green, Abutalebi, & Grady, 2011; see also Pliatsikas & Luk, 2016, for a review). Nevertheless, the finding of a difference at the level of brain activity does not necessarily imply a bilingual advantage, nor does the existence of relatively inconsistent structural evidence in favor of an anatomical difference between bilinguals and monolinguals at the neural level (see García-Pentón, Fernández García, Costello, Duñabeitia, & Carreiras, 2016a; García-Pentón, Fernández García, Costello, Duñabeitia, & Carreiras, 2016b; for extensive discussion).

As seen, nowadays the existence of a real bilingual advantage at the non-linguistic level of cognitive control is under debate, and the evidence in its support has been shown to be inconsistent (see Paap et al., 2015; among many others). This issue has drawn the attention of many researchers, and there is current convergence in highlighting the need for more longitudinal studies, including training studies, as well as more theory-driven approaches to investigate the potential effects of bilingualism on different forms or components of executive functioning at behavioral and neural levels (García-Pentón et al., 2016b, 2016a; Li & Grant, 2015; Paap, 2015; de Bruin & Della Sala, 2015). In the current study we will address this issue by exploring the manner in which the acquisition of a language in the elderly shapes monolingual seniors' switching abilities by comparing their performance before and after the linguistic training with that of a group of matched monolingual seniors that have not received any formal linguistic training in a new language. To do so, we focused on a classic task-switching paradigm (i.e., the colour-shape switching task).

One of the most frequently used paradigms to explore the potential advantages bilingualism may yield is the task-switching paradigm, and more specifically the colour-shape switching task (for an example of the colour-shape switching paradigm see Rubin & Meiran, 2005; see also; Prior & MacWhinney, 2010).[2] In this task colourful geometric figures are presented to participants who are asked to respond either according to the colour or to the shape criterion of the figure. This task evaluates, primarily, the shifting ability between different mental sets (Miyake, Friedman, Emerson, Witzki, & Howerter, 2000), providing a quantitative measure of the switching cost. While the switching cost is a relatively neat measure of shifting abilities, it should be also acknowledged that this index also reflects the ability to inhibit the previous trial rule, as inhibition and switching may be indivisible in this type of paradigms (see Paap & Sawi, 2014). Switching cost gauges the level of interference that is created in participants' performance by the change from a non-switch trial (where the response criterion remains equal to the previous trial) to a switch trial (where the response criterion is different from the previous trial) in mixed-task blocks in which the response criteria are intermixed. The switching cost can be calculated by subtracting the

[2] In the current study we solely focused on the colour-shape switching paradigm, and for simplicity's sake we avoided lengthy discussion of other paradigms that have also been used to explore the broad concept of "cognitive flexibility", such as the Wisconsin Card Sorting Test -WCST- (Grant & Berg, 1948; see Yudes, Macizo, & Bajo, 2011, for an implementation with different groups of bilinguals and monolinguals). Even if the WCST has been taken as a proxy to some aspects of executive functioning (see Miyake et al., 2000), there are also clear-cut limitations imposed by this paradigm in terms of experimental outcomes (e.g., lack of RTs, impossibility to compute switching costs).

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