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The bilingualism wars: Is the bilingual advantage out of (executive) control?

María Fernández-López[1] and Manuel Perea[1,2*]

[1]*Universitat de València, Spain*

[2]*Universidad Nebrija, Spain*

Whether bilingualism has an effect on the executive function of non-verbal representations is probably one of the most controversial issues in cognitive psychology and cognitive neuroscience. As bilinguals have to alternate between two languages that compete for selection in their daily lives, they make use of selection, inhibition, and monitoring (i.e., components of executive function) more often than monolinguals. Thus, it would not be surprising that these highly trained abilities at selecting and monitoring the linguistic processes would also help the processing of non-linguistic representations. Although the "bilingual advantage" in executive control (Bialystok, 1999) has been repeatedly demonstrated, a number of recent studies—in particular since the publication of the Paap and Greenberg (2013) study—have questioned this effect. Both positive and null findings are currently being published from each of the two sides, thus making it difficult to reach consensus in the scientific community. Here, we propose a plausible solution to this debate: a group of independent researches should carry out a carefully planned large-scale study.

According to the Oxford English dictionary (Oxford University Press, 1989), bilinguals are individuals who are able to speak two languages fluently. Everyday more and more individuals become bilinguals, either because they are born in a bilingual home/region or because of the necessity of communicating with people from other regions or countries (e.g., business, education, migration, or travel). Thus, it is not surprising that bilingualism

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has been a subject of debate in the past decades, from politicians and scientists to educators. Here we focus on an issue, namely, whether being bilingual has consequences in executive control, that is under heated disputenot only in the academic world (e.g., debates in journals and top-notch cognitive psychology and cognitive neuroscience conferences) but also in the media (e.g., see the article "The bitter fight over the benefits of bilingualism", published in The Atlantic [Yong, 2016]). We will first offer a brief description of both sides in this debate and then we will propose a feasible solution to help resolve this debate.

Arguments in favor of the bilingual advantage in executive function

The key underlying idea is that bilinguals have to manage with—and switch between—two or more languages that compete for selection. This involves not only focusing the attention to the target language but also inhibiting the other language (i.e., to avoid the interference of the non-target language) while evaluating constantly the demands of the context (i.e., monitoring) so that "the target language proceeds fluently" (Byalistok, 2017, p. 234). That is, bilinguals would be using executive function components (i.e., conflict resolution mechanisms; see Miyake & Friedman, 2012) to a greater degree than monolinguals, and this real-life training would extend to—and enhance—cognitive control processes of non-linguistic representations (i.e., a "mental gymnasium" for the brain). As Byalistok (2017) recently put it, "lifelong bilingualism impacts a set of processes subsumed under the category of executive attention" (p. 249).

Indeed, since the Peal and Lambert (1962) study, which showed an advantage of bilinguals over monolinguals in several non-verbal intelligence tests, a large number of experiments have reported cognitive advantages of bilingualism on executive function. The improvement of executive function in bilinguals has usually been named the "bilingual advantage" (Bialystok, 1999). This hypothesis has often been tested using a number of attentional tasks (e.g., Simon task, flanker task, among others) that require resolving the conflict between two codes in the incongruent trials. In the Simon task, the participants' responses are faster and more accurate when the stimulus occurs in the same relative location as the response (congruent stimulus-response association) than when the stimulus and the response occur in opposite locations (incongruent stimulus-response association). Notably, Bialystok (2006; see also Bialystok, Martin, & Viswanathan, 2005; Bialystok, Craik, Klein, & Viswanathan, 2004) showed that the differences between congruent and incongruent trials (i.e., the conflict effect) in reaction times and accuracy are smaller for bilinguals than for monolinguals in all age ranges. That is, bilingual participants can handle the conflict more quickly than the monolingual participants.

Likewise, Costa, Hernández, Costa-Faidella, and Sebastián-Gallés (2009; see also Costa, Hernández, & Sebastián-Gallés, 2008) examined control resolution by using an attentional network task (i.e., a combination of a cue reaction time task and a flanker task). Results showed that not only the conflict effect was smaller for bilinguals, as in previous studies, but also that bilinguals were overall faster than monolinguals when performing the task. The bilingual advantage in overall response times was related with an ability of bilinguals to handle tasks that involve mixing trials of different types (i.e., trials that require implementing conflict resolution and those that are free of conflict). Costa et al. (2009) suggested that part of the bilingual advantage observed in conflict resolution tasks is due to a more efficient monitoring system in bilinguals. The idea is that the continuous engagement of this monitoring and selecting the appropriate language for every communicative interaction in bilinguals would have a beneficial effect at a general level of (domain-free) executive function.

Is the bilingual advantage reliable?

Despite the findings cited above, the bilingual advantage has been put into question in the past years. The skeptics with the bilingual advantage posited that the continuous language alternation in bilinguals affects cognitive control processes related to language processing, but it does not alter non-linguistic executive control components. In this line, a number of researchers have suggested that some of the findings showing a bilingual advantage could have been due to of demographic factors such as socio-economic status, educational level, or immigrant status (see Morton & Harper, 2007; Paap, Johnson, & Sawi, 2015, for discussion). For instance, Morton and Harper (2007) failed to replicate the findings from Bialystok et al. (2004) in the Simon task when matching the bilingual and the monolingual groups on socio-economic status, immigrant status, and ethnicity. Furthermore, in several series of experiments with a large number of participants, Paap and colleagues (Paap & Greenberg, 2013; Paap et al., 2015; Paap, Anders-Jefferson, Mason, Alvarado, & Zimiga 2018) found no bilingual advantage in tasks involving inhibition or selective attention when the monolingual and bilingual groups were carefully matched in these characteristics.

Is this an instance of the reproducibility crisis in psychology?

Overall, the findings that have supported the bilingual advantage have not been easily replicated (e.g., see Antón et al., 2014; Duñabeitia et al., 2014; Paap & Greenberg, 2013; Van der Linden, Van de Putte, Woumans, Duyck, & Szmalec, 2018, for a few examples). Furthermore, the studies that reported a null effect have employed much larger samples than those studies that

reported a bilingual advantage (i.e., they had a higher statistical power; see Antón et al., 2014; Paap & Greenberg, 2013; Paap et al., 2018). Of course, one might argue that positive evidence is more meaningful than a null finding in the tradition of null hypothesis testing (i.e., a null effect has typically been considered as "absence of evidence"). Nevertheless, the use of Bayesian statistical methods in the past years (e.g., Bayes Factors) has allowed researchers to determine not only the amount of evidence in favor of the alternate hypothesis, but also the amount of evidence in favor of the null hypothesis (i.e., the "evidence of absence") (see Rouder, Speckman, Sun, Morey, & Iverson, 2012). For instance, a null effect with a $BF_{01} = 30$ does provide very strong evidence in favor of the null hypothesis (i.e., it would reflect that, with the collected data, the null hypothesis [Model 0] is 30 times more likely than the alternate hypothesis [Model 1]). However, at the same time, we cannot discredit the original studies on the basis of failed replications. As de Bruin and Della Sala (2015) pointed out, there may be many circumstances why two attempts to conduct the same experiment may yield different results.

Is this a deadlock situation?

Is shown in the Sánchez-Azanza, López-Penadés, Buil-Legaz, Aguilar-Mediavilla and Androver-Roig (2017) study, since the publication of the Paap and Greenberg (2013) study, there are fewer papers supporting the bilingual advantage than papers contesting it, but the battle is far from over. Both positive and null studies on the bilingual advantage are being published at present and, unsurprisingly, just by looking at the list of authors, one can easily anticipate the pattern of findings (see, however, the null effect reported by Van der Linden et al., 2018, which was against their pre-existent position). Clearly, there are two opposing groups that coexist and, far of trying to find a comprehensive picture of the consequences of bilingualism, which would be the most interesting issue, most of these researchers perseverate in trying to show their own side of the truth. Worst of all, this scenario creates an aura of distrust in the goals of scientific discovery (see Duñabeitia & Carreiras, 2015, for a similar claim).

Searching for a solution

This current scenario is somewhat out of (executive) control as, needless to say, research rivalry can easily turn into personal rivalry. Our aim is not to take sides in this on-going debate, but to reach a sensible resolution on whether or not bilingualism affects cognitive control—and if so, under which specific circumstances. Importantly, we need to move beyond a simplistic "yes" or "no" response to the bilingual advantage debate, as it is necessary to consider the numerous relations between bilingualism and

executive control—for instance, Costa et al. (2009) found a "bilingual advantage" in an attentional task but only in a restricted scenario (i.e., a high-monitoring condition).

To resolve the issue at stake, Wagenmakers (2015) proposed an "adversarial collaboration" as a helpful method of conflict resolution in the bilingual advantage debate. Nevertheless, while Ken Paap was open to participate (see Paap, Johnson, & Sawi, 2016), Ellen Bialystok appeared to be reluctant to collaborate in the project (see Yong, 2016). Thus, given the state of affairs, "adversarial collaboration" does not seem to be a feasible option.

Our proposal is that this issue has to be solved by a group of independent researchers in cognitive psychology and cognitive neuroscience, not contaminated by a priori beliefs, using fully transparent methods. It would be ideal—but not necessary—that this external group of researchers could have all the data and materials from preceding studies. The help from the researchers of both sides would be also a signal that they are prepared to bury the hatchet and not perpetuate the confrontation. In this manner, a large-sample study could examine all the previous assumptions, methods and findings. Importantly, it is necessary to assess how the components of executive function (e.g., monitoring, working memory, switching, attention, among others, see Kenworthy, Yerys, Anthony, & Wallace, 2008, for review) are potentially influenced by bilingualism, and whether some populations are more sensitive to these effects (e.g., children or older adults). All these components would have to be perfectly defined (see Paap et al., 2018, for discussion) and assessed in several tasks (i.e., ensuring a high degree of control and replicability).

This study would be conducted by OpenScience groups—note that they have already replicated previous psychology works (e.g., Open Science Collaboration, 2015). The study would have to be pre-registered and follow the Transparency and Openness Promotion guidelines (Nosek et al., 2015). Furthermore, as registered studies are accepted before actually running the experiments, this would prevent the journal's tendency to publish a manuscript on the basis of catchy findings. Once conducted the study, the materials and data would be uploaded to Open Science databases, making it easy for others to verify and re-examine the data. Critically, this study would have a great impact in the literature on bilingualism, so it would be a fair investment for those researchers participating in the study.

All in all, while we acknowledge that the above-proposed independent study may face some challenges (e.g., funding, agreement on the key aspects to study across the participating labs, to cite just two potential limitations),

we believe that it would be the most rational solution to end the ongoing debate on the bilingual advantage in executive function. Furthermore, this study would help other cognitive psychologists and cognitive neuroscientists to focus their careers on other more exciting phenomena that underlie cognitive processing in bilinguals.

RESUMEN

¿Está el desacuerdo sobre la ventaja bilingüe fuera de control (ejecutivo)?

Uno de los temas actuales más controvertidos en psicología cognitiva y neurociencia cognitiva es si el bilingüismo tiene un efecto sobre el control ejecutivo de las representaciones no verbales. En su vida diaria, los bilingües tienen que alternar entre dos (o más) idiomas que compiten por su selección, por lo que han de seleccionar, monitorizar e inhibir (es decir, emplear componentes de la función ejecutiva) con más frecuencia que los monolingües. Por lo tanto, no sería sorprendente que estas habilidades empleadas para seleccionar/monitorear los procesos lingüísticos en bilingües también ayudaran al procesamiento de representaciones no lingüísticas. Aunque la "ventaja bilingüe" en control ejecutivo (Bialystok, 1999) se ha demostrado repetidamente, varios estudios recientes, especialmente desde la publicación del estudio de Paap y Greenberg (2013), han cuestionado este efecto. En la actualidad, tanto resultados positivos como resultados nulos se están publicando por cada una de ambas partes, lo que dificulta el consenso en la comunidad científica. Proponemos una solución plausible a este debate: que un grupo de investigadores independientes lleve a cabo un estudio cuidadosamente planificado a gran escala.

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