Bilingualism: Language and Cognition 18 (1), 2015, 29–31 © Cambridge University Press 2014 doi:10.1017/S1366728914000613

Is there a benefit of bilingualism for executive functioning?*

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Scholars and educators were once concerned that encouraging children to learn more than one language might have adverse cognitive consequences (Darcy, 1953). And for some linguistic capacities (e.g., fluency, vocabulary) this is often true (Bialystok, Craik & Luk, 2012). Unfortunately, such individual costs might discourage governmental policies that are aimed at fostering multilingualism, despite its widely acknowledged societal benefits. Peal & Lambert (1962) helped overcome this concern and through her "myth-dispelling" efforts and prodigious empirical output, Bialystok[1] has pushed the pendulum of opinion in the opposite direction.

Valian (Valian), like many other scholars, wants to believe that the answer to the *question* that is my commentary's title is: "yes." So do I[2]. There is an exciting narrative here that meshes nicely with adages from both popular culture – "use it or lose it", "practice makes perfect" – and contemporary cognitive neuroscience – "neurons that fire together wire together," derived from Hebb's cell-assembly theory (Hebb, 1949; Klein, 1999). I became engaged in this narrative during my 2000–2001 sabbatical spent partly at the Rotman Research Institute where my office was next to that of Ellen Bialystok who was also on sabbatical. I attended lab meetings with Ellen, her Rotman colleague, Gus Craik and her students and, because of my interest and expertise in attention, the Simon effect and cognitive inhibition (e.g., Klein & Taylor, 1994), became a collaborator and co-author on the empirical paper (Bialystok, Craik, Klein & Viswanathan, 2004) that has become seminal for the literature exploring the theme of this special issue[3].

In 2010 when he was a first year graduate student in my seminar *Human information processing: in the real world*, I encouraged Matt Hilchey to write his term paper on "Costs & Benefits of Bilingualism" because, while I had had several opportunities to highlight the "exciting" Bialystok et al. (2004) findings on the "benefits of bilingualism for executive processing"[4], I had not closely followed the literature spawned by that paper.

Hilchey's outstanding term paper was refined and transformed into a major, comprehensive review of the literature on bilingualism and executive control (Hilchey & Klein, 2011) which revealed scant evidence for a bilingual inhibitory control advantage (BICA[5]) but robust evidence, across the lifespan, for a global advantage (bilingual executive processing advantage, BEPA) – measured using performance on congruent trials – so long as the task itself entailed a sufficient level of response conflict.

Recently, when invited to write a chapter for the Cambridge University Press's Handbook of Bilingualism (Hilchey, Saint-Aubin & Klein, in press), we used the opportunity to place the *question* into a broader historical context and to update our 2011 review by focussing on the many studies that had appeared since that review was written. As in our earlier paper, our graphic meta-analyses focus on two non-linguistic effects, Simon (including spatial Stroop) and flanker, that entail conflict resolution. These tasks are not the only ones that have been conducted to answer the key *question* and in both papers we discuss findings from other non-linguistic tasks that might also assess executive functioning. Importantly, however, Simon and flanker tasks have been used frequently enough in published papers to support confident empirical generalizations.

As can be seen in Figure 1, although the more recent literature considered as a whole continued to disconfirm

* This commentary was made possible by a Natural Science and Engineering Research Council of Canada Discovery Grant to R. M. Klein. I am grateful to Matthew Hilchey for his useful comments on an earlier version.

[1] See Bialystock's citation for the 2011 Donald O. Hebb Distinguished Contribution Award at https://www.csbbcs.org/awards/distinguished-contribution/24-awards-main/hebb/26-hebb-award-2011

[2] The personal perspective of this commentary is stimulated, in part, by Kroll and Bialystok's (2013) misguided (see Paap, 2014, p. 246) assertion that Hilchey & Klein (2011) used their "documentation of the failures of the inhibition hypothesis . . . to discredit the entire body of work . . . ".

[3] This paper was the second most frequently cited paper in a search using "bilingualism" as the subject.

[4] At a 2008 symposium (later published in Acta Psychologica, Klein & Ivanoff, 2011) honoring Dick Simon (for whom the Simon effect was named) and in the language chapter of my Canadianization of Ashcraft's Cognitive Psychology (Ashcraft & Klein, 2010).

[5] In elderly participants some bilingual advantages were compromised either by an unusually small number of trials (Bialystok et al, 2004, studies 1 and 2) or by the difference being rooted in a *monolingual advantage* on compatible trials (Bialystok, Craik & Luk, 2008) – hence we resisted a BICA interpretation.

https://doi.org/10.1017/S1366728914000613 Published online by Cambridge University Press

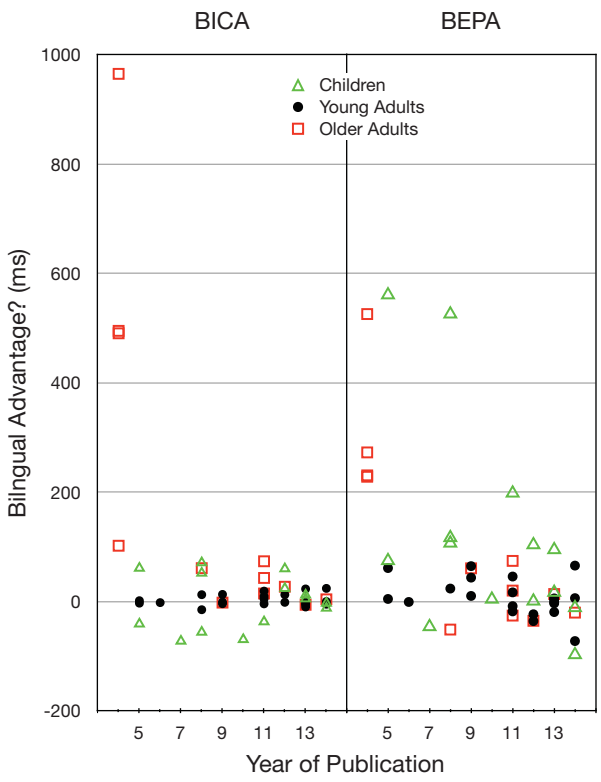


Figure 1. (Colour online) The BICA and BEPA effects from all the studies reviewed by Hilchey & Klein (2011) and Hilchey, Saint-Aubin & Klein (in press) are presented here as a function of year of publication from 2004–2014. BICA = interference score for monolinguals minus that for bilinguals (interference = incongruent minus congruent). BEPA = congruent RT for monolinguals minus that for bilinguals. For every study in which the same participants were tested more than once (e.g. with 2- and 4-alternative tasks) or one group of monolinguals were compared to 2 groups of bilinguals, the data from the two tasks and two groups of bilinguals (respectively) have been combined. Triangles (children aged <14); disks (young adults aged 15 to 30); squares (older adults aged > 30).

BICA, support for BEPA had surprisingly more or less evaporated.

Presenting the data by year of publication highlights how anomalous were the results from the seminal paper[6] and reinforces the suggestion (see Paap, 2014) that the early (pre-2011) evidence in favour of a BEPA may have been generated by a dual-edged publication bias: *for* papers whose narrative is consistent with that of an exciting series of studies by a world-famous expert and *against* papers reporting null results. A recent on-line article about the "replication crisis" in (social) Psychology rings true for the present discussion:

"As Carl Sagan famously warned, and as students are now taught, extraordinary claims require extraordinary evidence. This means that original findings that are surprising, that feature large effects, or that seem to conflict with other established findings should be subject to greater scrutiny—including replication." (Meyer & Chabris, 2014)

Indeed, in the keynote article (Valian, 2014), after reviewing a wide range of tasks assessing various components of executive function, Valian concludes:

"Studies of children with large samples have tended to show weaker effects, or no effects, compared to studies with small samples" (p. 20); "Especially when young adults are tested, effects have been inconsistent" (p. 23); "The data overall, although mixed, suggest a benefit in older adults for being bilingual on tasks of executive function" (p. 30)

These descriptions of the extant corpus of data on the question, *Is there a benefit of bilingualism for executive functioning?*, reinforce the conclusions drawn by Hilchey and colleagues (Hilchey & Klein, 2011; Hilchey et al., in press) which are highlighted in Figure 1. Mindful of Sagan's cautionary note, and in light of the data reviewed here and by Valian (2014), it is recommended that the pendulum of scientific opinion on this question be put into neutral.

[6] Reviewing the literature on aging and the Simon effect, Proctor, Vu & Pick (2005, Table 2) found that the Simon effect for elderly participants ranged from 21 to 48 ms. The Simon effects of Bialystok et al.'s (2004) older monolinguals were between 100 and 1000 ms *greater* than those for older bilinguals (see 2004 data from BICA panel of Figure 1). This is strikingly anomolous when Simon effects for the elderly are typically less than 50 ms.

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https://doi.org/10.1017/S1366728914000613 Published online by Cambridge University Press

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https://doi.org/10.1017/S1366728914000613 Published online by Cambridge University Press