

The bilingual advantage: Elusive but worth the effort?

Shanna Kousaie¹ & Vanessa Taler²

¹Montreal Neurological Institute, McGill University, 3801 University Street, Montreal,
Quebec, H3A 2B4, Canada

²School of Psychology, University of Ottawa, 136 Jean Jacques Lussier, Ottawa,
Ontario, K1N 6N5, Canada

The notion of a bilingual advantage in cognitive function is an attractive hypothesis that has clearly garnered significant interest from the scientific community. Beyond simply implying that the ability to communicate in more than one language in a relatively proficient way over many years leads to advantages in cognition, it suggests that training in one domain, i.e., language, results in advantages in a domain-general faculty, i.e., general executive control. Beyond this, and not discussed in detail in by Paap, Johnson, and Sawi (in press), the bilingual advantage has been purported to confer advantages as people age and experience changes in cognitive function (e.g., Bialystok, Craik, Klein, & Viswanathan, 2004; Gold, Kim, Johnson, Kryscio, & Smith, 2013; Luk, Bialystok, Craik, & Grady, 2011). Furthermore, some research suggests that merely being bilingual can result in a delay in the onset of Alzheimer's disease symptoms (e.g., Bialystok, Craik, Binns, Osher, & Freedman, 2014; Bialystok, Craik, & Freedman, 2007; but see Chertkow et al., 2010; Crane et al., 2010; Zahodne, Schofield, Farrell, Stern, & Manly, 2014 for alternate findings). It is exciting to think that something as natural as language could have such dramatic effects on cognitive functioning over the course of the lifespan, and potentially buffer against age-related cognitive decline. It is not surprising that many researchers have pursued this hypothesis in an attempt to understand its magnitude and mechanism(s).

Paap et al. provide an extensive review of the published findings, and conclude that current evidence does not support the hypothesis of a cognitive advantage for bilinguals. We agree that the effects of bilingualism may have been overstated in the literature, although we believe that there are indeed undeniable differences between monolinguals and bilinguals. What remains unclear is whether these differences lead to measurable changes in domain-general executive function and, if so, under what circumstances. One important consideration with respect to the failure to find behavioural advantages in executive control for bilinguals is that much of the research uses samples of young adults, who are at the peak of their cognitive functioning. However, it is probable that differences emerge most clearly in cases where cognitive functioning is sub-optimal, such as in older adults who may be experiencing age-related cognitive declines. That is, when cognition is sub-optimal there is room for bilingualism to exert an effect, whereas in young adults there is no room for improvement because they are at the height of cognitive function.

A second major issue raised in the target article relates to brain-based evidence that ostensibly supports an advantage for bilinguals in the absence of behavioural evidence. Paap et al. point out that "reorganization to accommodate bilingualism does not logically need to result in more efficient performance" (p. 29). We agree that behavioural advantages are required in order to ascertain that a brain-based difference represents a true advantage. However, brain-based differences, even in the absence of behavioural advantages, remain an interesting and important area of study. Even in the absence of behavioural differences, any observed differences in measures of brain structure or function suggest that bilinguals and monolinguals are performing the same tasks differently, despite arriving at the same endpoint. This speaks to language-induced brain plasticity and suggests a possible source of cognitive differences later in the lifespan. In

addition, advances in cognitive neuroscience methods that are potentially more sensitive and/or of higher resolution (e.g., resting-state functional connectivity, global and local efficiency measures) may prove useful in further elucidating differences in brain structure and function that are related to language experience, and providing insight into how these differences may be advantageous.

In addition, Paap et al. discuss several issues with current research in the area of bilingual advantages. It thus seems appropriate to mention some additional caveats and indicate some important considerations for future research in the area. Bilingualism is typically treated as a dichotomous variable; however, this is an inaccurate representation of actual language attainment, and we suggest that bilingualism should be treated as a continuous variable in more sophisticated statistical models such as regression-based analyses. Greater attention should also be paid to the way in which bilingualism is measured. The majority of research relies on subjective self-report measures, and the few studies that do use objective measures (e.g., animacy judgement or confrontation naming) do not use the same tasks, rendering comparisons across studies difficult. The development of a standardized self-report and objective battery to measure bilingualism should be a priority in future research. Finally, some research has suggested that there may be socio-cultural effects that are not strictly related to bilingual/immigration status. For example, Kousaie, Sheppard, Lemieux, Monetta, and Taler (2014) examined the bilingual advantage in executive function by comparing bilinguals (from Ottawa) to two groups of monolinguals, anglophones from Ottawa and francophones from Quebec City, and found differential effects of bilingualism on executive function. Specifically, there was no strong evidence of an advantage for bilinguals, and in some cases bilinguals showed superior performance relative to only one group of monolinguals (e.g., total score on the Stroop task), while for other tasks one monolingual group outperformed the other (e.g., Simon interference). These findings imply that factors such as the language environment and language-switching behaviour should be given more consideration, as has been suggested by others (see, e.g., Green, 2011).

To conclude, if bilingual advantages in executive function do indeed exist, these advantages may be restricted to a specific set of as-yet-undetermined circumstances. However, defining the circumstances under which bilinguals may demonstrate advantages in executive control or cognitive functioning later in life is an important undertaking with the potential to inform other areas of cognitive science. Furthermore, the possibility that bilingualism may produce cognitive advantages in populations experiencing pathological cognitive decline is of great interest to the aging population and is relevant to public health policy. Although we agree that bilingual advantages are elusive, at least using current methodologies, we believe that the hypothesis of bilingual advantages is worth pursuing, and advocate the approach suggested by Baum and Titone (2014).

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