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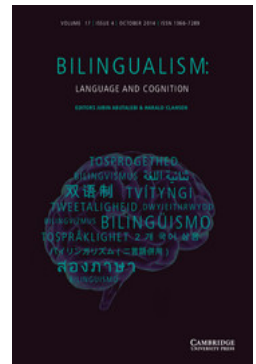
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COMMENTARY

Variability in the effects of bilingualism on cognition: It is not just about cognition, it is also about bilingualism

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Valian (2014) suggests that the messy state of the literature examining the effects of bilingualism on executive functioning (EF) stems from lack of clarity in how EFs are defined and measured, and from lack of control over other factors that can modulate EF. We argue that the lack of clarity in how bilingualism is defined and measured is no less problematic. We focus our commentary on two related issues.

1. The challenges that group-based approaches pose to isolating the effects of bilingualism on EF.

Inconsistent findings in prior studies of bilingualism–EF connections stem in part from the interactive or additive influences of other experiences upon EF (SES being the factor that has received the most attention). Given the unfeasibility of a training approach where bilingualism is manipulated via random assignment, the next best solution in the existing literature has been either to match bilingual and monolingual groups on factors other than bilingualism, or to statistically control for them.

Such post facto solutions to the impurity problem are not satisfactory. The approach taken by some studies to match the levels of SES across monolingual and bilingual participants (e.g. Engel de Abreu et al., 2012) does not eliminate the problem of comparing groups that likely differ on other variables that may influence the development of EFs (e.g., broad language skills, family size, etc.; see also Paap, 2014). Statistical approaches where such factors are covaried in group analyses (e.g., Carlson & Meltzoff, 2008; Prior & Gollan, 2011) might also be problematic because these covariates are likely strongly associated with EF, challenging the assumptions of ANCOVAs.

So, what is one to do? We suggest that instead of treating bilingualism as a monolithic categorical variable, we begin treating bilingualism as the inherently variable experience that it is. By applying individual-variability approaches to the question of bilingual influences on EF, the heterogeneity of bilingualism becomes central to the research question, rather than being treated as unwanted noise. Such a tactic will empower experimental designs where the effects of bilingualism on cognition can be examined in a continuous manner, and allow

the simultaneous consideration of other factors in EF development. Further, it will encourage scientists to precisely define bilingualism and thus to delineate a theoretical framework identifying which aspects of bilingualism might influence specific facets of EF.

2. The challenges that heterogeneity of bilingualism poses to studies of bilingual EF.

Different types of bilingual experience may influence the development of EF in different ways. Bilingual individuals and communities can differ on multiple dimensions – including, but not limited to, L1/L2 age of acquisition and proficiency, patterns of language use including language switching and mixing, typological distance between L1 and L2, etc. These dimensions, in isolation or in combination, may exert distinct influences upon different aspects of EF.

As delineated by Valian, there have been various attempts to explain the mechanisms through which bilingualism can modulate EFs. However, for all proposed mechanisms, only a few empirical studies have examined which aspects of bilingual experience impact performance on specific measures of EF. For example, Pelham and Abrams (2014) compared early and late bilinguals who differed in their age of achieving bilingual fluency but not in their proficiency, and found both groups equally outperformed monolinguals on an EF measure, suggesting that age of acquisition may be irrelevant to EF outcomes. Unfortunately, this study (and others like it) invariably fall prey to the problem highlighted in the keynote: namely, that groups differing in the dimension of interest (e.g., L2 proficiency) most likely also differ on other dimensions of bilingualism (e.g., language-switching frequency) and other factors (e.g., SES). Controlling for one of these factors is possible, but controlling for all possible factors is not.

In order to delineate the effects of bilingualism on EF, we must become more specific not just in how we define and measure EF, but also in how we define and measure bilingualism. We urge researchers to move away from attempting to equate experimental groups on extraneous variables in order to pinpoint the effects of bilingualism on EF, and to move toward distilling bilingualism to a few key

continuous variables, linking these variables to EF using individual-variability approaches. Attempts along these lines have revealed that the length of bilingual experience is linearly related to cognitive control (e.g., Bialystok & Barac, 2012), and that bilinguals' ability to control their two languages is related to their ability to manage non-linguistic competition (Prior & Gollan, 2011). Once group-based constraints are lifted, the multi-dimensional effects of bilingualism on EF can be considered within the broader milieu of human experience.

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