addressee must select among competing object names (e.g., at the lemma level). The addressee must also potentially exert greater control of oculomotor processes in order to fixate the correct target. Mercier, Pivneva, and Titone (2014) show that these two kinds of control processes dissociate.

My purpose has been to sketch out some of the sources of interactional variance that an effective profile of language use in bilingual speakers might cover. There is a related requirement. We need to know how individual profiles relate to standard clinical markers (e.g., letter and semantic fluency tests) and cognitive control tests. If long-term experience affects performance on these tests then such decontextualized tests offer a proxy for such experience. In addition, we are then in position to see which aspects of the profile explain additional variability in the structural and connectivity data and so develop further standardized tests. In short, the effort to produce a meaningful characterization of language use in bilingual speakers may lead to more efficient and ecologically valid clinical instruments pertinent to language control that are globally applicable.

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Commentary on Baum and Titone

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Baum and Titone address several issues related to bilingual advantages in executive control that are often overlooked in this literature but warrant further consideration and empirical investigation. We limit our comments to two issues: the problem of establishing the directional relationship between bilingualism and executive control and the problem of decomposing executive control.

Baum and Titone acknowledge the challenges inherent in establishing a clear directional relationship between bilingualism and cognitive advantages. As the

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authors note, the bilingual advantage view largely assumes that the bilingual experience of engaging domain-general executive control processes in order to manage two linguistic systems leads to improvements in these control processes, but to date most of the evidence supporting a bilingual advantage is correlational. The general assumption is that bilinguals and monolinguals begin with equivalent executive control capacities but that bilinguals improve these skills through their linguistic experience and surpass monolinguals.

However, as the authors suggest, it is possible that individuals who become proficient bilinguals have stronger executive control skills prior to acquiring a second language (L2). In other words, the causal relationship between executive control and bilingualism may be reversed. In considering this possibility, it is important to note that not all bilingual adults who are tested demonstrate bilingual cognitive advantages (e.g., Hilchey & Klein, 2011; Paap & Greenberg, 2013), and within bilingual participant groups, individuals with higher L2 proficiency demonstrate larger cognitive advantages compared to less proficient bilinguals (Bialystok, Craik, & Ruocco, 2006; Mishra, Hilchey, Singh, & Klein, 2012) or L2 learners (Bialystok, 1988; Carlson & Meltzoff, 2008). Individuals with better executive control prior to acquiring an L2 may be better equipped to manage their two linguistic systems compared with individuals with poorer executive control. The majority of studies demonstrating a bilingual advantage in executive control limit participants to include only proficient bilinguals (for a review, see Adesope, Lavin, Thompson, & Ungerleider, 2010); however, not all individuals who are exposed to an L2 become proficient bilinguals. The bilingual advantage in executive control may be partly because individuals with better executive control are more likely to become the proficient bilinguals who are included as participants in studies demonstrating bilingual advantages.

An argument against the influence of individual differences in executive control on L2 learning outcomes is that child bilinguals often have no choice in the matter of their dual language exposure. Therefore, children with better executive control abilities cannot self-select to become bilingual. The authors present a counterargument by suggesting that differences in cognitive abilities may lead children to seek differential social experiences, which may in turn affect their L2 outcomes. A mediating role of social experience is certainly possible, but the authors may be overlooking the possibility that executive control abilities have a more direct influence on L2 learning even among child bilinguals.

This argument assumes that all children who are exposed to an L2 will become proficient bilinguals. However, children who are immersed in an bilingual environment achieve various outcomes with respect to bilingual proficiency in adulthood, with some children maintaining relative dominance in their first language (L1) with lower L2 proficiency, others achieving balanced proficiency between their L1 and L2, and still others experiencing L1 attrition as their L2 becomes dominant (Genesee, Paradis, & Crago, 2004). These L2 learning outcomes are certainly influenced by sociolinguistic factors (e.g., additive vs, subtractive bilingualism), but they may also vary as a function of individual differences in executive control between learners. This possibility is consistent with evidence cited by the authors that executive control training can improve performance on an L1 syntactic ambiguity task (Hussey & Novick, 2012). As Baum and Titone point out,

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longitudinal studies tracking the development of cognitive control and L2 acquisition, which are currently lacking in the literature, will provide the best empirical evidence for disentangling the directional relationship between cognitive control and bilingualism.

A second important issue that Baum and Titone raise that also deserves further comment is that of executive control decomposing into distinct subcomponents with distinct developmental trajectories. Executive control is typically defined very broadly as "those capacities that enable a person to engage successfully in independent, purposive, self-serving behavior" (Lezak, Howieson, Loring, Hannay, & Fischer, 2004, p. 35), as "a multidimensional construct referring to a variety of loosely related higher order cognitive processes, including initiation, planning, hypothesis generation, cognitive flexibility, decision making, regulation, judgment, feedback utilization, and self perception" (Spreen & Strauss, 1998, p. 171), or as a bundle of "general purpose control mechanisms that modulate the operation of various cognitive subprocesses" (Miyake, Friedman, Emerson, Witzki, & Howerter, 2000, p. 50). There is no single measure that serves as the gold standard for the assessment of bilingual executive control advantage.

Salthouse, Atkinson, and Berish (2003), noting the complexity and breadth of notions of executive control, examined convergent and discriminant validity among a set of neuropsychological and cognitive tasks typically associated with executive control and also a set of psychometric tasks, including measures of verbal ability, fluid intelligence, episodic memory, and perceptual speed. A series of structural equation analyses were then conducted to look at the relations among these sets of variables. Their results indicated that the various neuropsychological measures were not very highly related to one another and were fairly highly related to other variables, particularly to fluid intelligence. They concluded that individual differences in measures of executive control may actually reflect differences in much broader abilities, such as fluid intelligence.

Miyake and colleagues (2000) have addressed similar questions but take a somewhat different approach and reach different conclusions. They found support for three separable dimensions of executive control: updating, shifting, and inhibition. These three dimensions of executive control were "clearly distinguishable," and each was differentially associated with more complex tasks, such as the Wisconsin Card Sorting Test and the Tower of Hanoi problem.

Thus, a major challenge to understanding the role of executive control in bilingualism is the multiplicity of tests and assessments used to measure executive control, including such neuropsychological tests such as the Wisconsin Card Sorting Test, the Tower of Hanoi problem, the Trail Making Test, and tests of verbal fluency, as well as specific tests of individual subcomponents, such as inhibition, time-sharing, updating, and switching (for an overview of these tests, see Kemper, 2009). Executive control tests tend to have low reliability (Rabbitt, 1997) and limited construct validity (Phillips, 1997). These problems are further complicated by the challenges of assessing executive control in children. Although many child-appropriate variants of executive control tests have been developed by adapting adult tests (Espy & Cwik, 2004; Espy, Kaufmann, Glisky, & McDiarmid, 2001), few have been normed or standardized to permit age-group comparisons. Little is known about the developmental trajectories of executive control and its

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subcomponents in childhood (Diamond & Taylor, 1996; Espy, 2004) or across the life span.

These problems notwithstanding, bilingualism has been linked to a multiplicity of executive functions, including response inhibition (Bialystok, Craik, Klein, & Viswanathan, 2004), task switching (Bialystok, 2010; Garbin et al., 2010; Philipp & Koch, 2009; Prior, 2012; Prior & MacWhinney, 2010), attentional monitoring (Colzato et al., 2008; Costa, Hernández, & Sebastián-Gallés, 2008, Tao, Marzecova, Taft, Asanowicz, & Wodniecka, 2011), and negative priming (Treccani, Argyri, Sorace, & Della Sala 2009). A flood of additional studies fractionating and dissociating these executive functions, as well as assessing bilingual advantages (or disadvantages, see, for example, Colzato et al., 2008; Prior, 2012; Treccani et al., 2009), has been unleashed. The lack of consensus on how executive control may be decomposed into specific subcomponents, which subcomponents are linked to bilingual advantages (or disadvantages), and how the coupling of executive functions and bilingualism unfolds over the life span will impede our efforts to understand the causes and consequences of bilingualism and neuroplasticity.

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