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Neuroplasticity as a model for bilingualism: Commentary on Baum and Titone

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The inevitable decline of cognitive function with aging and the high incidence of clinical impairment make understanding the process of cognitive decline and the search for remediation an urgent priority. However, in spite of massive efforts in research and development, the effectiveness of pharmacological treatments for cognitive impairment remains extremely limited (Zhu et al., in press). Therefore, there is growing interest in the set of lifestyle factors that serve to maintain cognitive function even in the presence of neuropathology. These factors, called cognitive reserve (Stern, 2002), include education, occupational status, socioeconomic class, and involvement in physical, intellectual, and social activities (Bennett, Schneider, Tang, Arnold, & Wilson, 2006; Stern et al., 1994). Bilingualism appears to be another potent source of cognitive reserve (Bialystok, Craik, Green, & Gollan, 2009). For these reasons, a comprehensive review of the small but growing literature on bilingualism and cognition in aging is timely and scientifically important.

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Baum and Titone's contribution to this literature is their proposal that research investigating the effect of bilingualism on cognitive aging might be best understood by framing it within the construct of neuroplasticity. This approach fits well with the possibility that bilingualism contributes to cognitive reserve, a concept that itself is inherently dependent on neuroplasticity. Moreover, there is a need at this point for an overarching theoretical framework within which to interpret this growing body of work. In the past 15 or 20 years, research in bilingualism has increased from a small number of isolated findings, largely in studies with children and mostly in the realm of metalinguistic awareness, to a large body of work that encompasses the life span from infancy to old age, investigates phenomena in many domains, including linguistic, executive function, perceptual and others, and employs all the methods of psychological research, including behavioral, functional magnetic resonance imaging, electroencephalography, eye tracking, and others. This body of literature is now large, with an increasing presence in psychology journals, as well as those of related fields (see Kroll & Bialystok, 2013). It is not surprising that the results of these studies are not always consistent. A framework that can not only position key concepts but also potentially account for variations in reported results is essential for further development of these ideas. Neuroplasticity is an ideal model in which to understand the research on bilingualism and the mind.

There are three aspects of the neuroplasticity paradigm that make it a productive way to understand bilingualism: the definition of terms allowable within a model of plasticity, the role of experiential variation in neuroplasticity, and the generality of the concepts recruited by the neuroplasticity model.

First, a prevailing issue in research on bilingualism is the problem of defining the term *bilingual* with sufficient precision so that reliable classifications can be made for the purpose of conducting between-subjects designs, the most common design in this type of research. It is rare to find people whose travel has not exposed them to other languages, whose education has not included a foreign language course, or whose extended family has not presented them with some exotic foreign language, however rarely it is encountered. Are these brushes with language sufficient to nudge an individual out of the box called monolingual? At the same time, it is rare for bilinguals (or multilinguals in general) to be equally fluent in all their languages so that they can use them with equal ease, interchangeably across domains and contexts, and using both spoken and written modalities. How much deviation from this ideal can be tolerated before that individual loses membership in the box called bilingual? This problem of forcing categorical classification evaporates with the neuroplasticity account because plasticity by definition refers to gradual and continual change, not to the endpoint of an experience. Hence, the neuroplasticity framework highlights the fluidity of the concept of bilingualism and its gradual variation on a dimension of experience. If we accept the notion of plasticity as continual change in response to a triggering event, then the mechanism by which bilingualism leads to cognitive change can be defined as incremental responses to ongoing experience rather than an abrupt intervention that creates chasmic differences between monolinguals and bilinguals. Moreover, the appropriate research design changes from between-groups comparisons that are currently prevalent in this field to dynamic models that describe change over time.

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Second, another benefit of using neuroplasticity as the model for bilingual effects on cognition is in the requirement to specify the environmental or cognitive conditions that lead to the transformation. The notion of plasticity implies that change is in response to some condition or set of events, without which the organism would remain static. Thus it becomes incumbent on researchers to specify how differences in the experience itself (e.g., degree or type of bilingualism), in contexts (e.g., nature of the bilingual community), and in types of instruments (e.g., various tasks) lead to different outcomes. As Baum and Titone point out, there is enormous variation in the circumstances around bilingualism, all of which may exert unique effects. The notion of neuroplasticity clearly implies that both the neural systems that are presumed to change and the environment in which that change takes place need to be specified, with the presumption that a change in either one can result in completely different outcomes.

Third, by placing a particular body of research within a general framework that has established traditions and interpretations, a more coherent and parsimonious model of mind can emerge. Rather than reinventing the theoretical structure for the particular experience, in this case bilingualism, new findings can be integrated into existing concepts allowing for greater generalization and connection to other experiences. Thus, research on the cognitive effects of bilingualism can be compared to work investigating cognitive consequences of such experiences as musical training and the effects of environmental factors, such as socioeconomic status, so that a more abstract and general set of principles may ultimately be identified.

It is interesting to understand in more detail how bilingualism potentially modifies cognitive ability, but it is especially crucial to examine these effects in the context of cognitive decline with aging. Therefore, the model of neuroplasticity is a productive approach because it makes assumptions that are consistent with the research on bilingualism and cognition. Neuroplasticity requires that the experience is described incrementally rather than categorically, that details of both the triggering experience and outcome are fully specified, and that results and interpretations must be compatible, at least in spirit, with other research embracing this framework. In that sense, we can begin to think of different trajectories for cognitive decline in response to individual circumstances. This notion is the essence of cognitive reserve: the activities in which we engage build up currency in long-term cognitive outcomes. However, it is more important that the neuroplasticity model is inherently optimistic; although cognitive decline itself may be inevitable, its course is not predetermined and may be buffeted and modified by enabling factors. Baum and Titone make a persuasive case that one such factor is bilingualism.

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Bilingual advantages, bilingual delays: Sometimes an illusion

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Studying bilingualism is complicated. Baum and Titone's Keynote Article concludes with a discussion of three particularly thorny issues in bilingualism research: (a) bilinguals are not a homogeneous group, (b) bilingualism is not randomly assigned, and (c) the effects of bilingualism are often more complicated than simple advantages or disadvantages/delays. On this latter point, Baum and Titone consider how binary thinking about bilingualism as good or bad can limit the kinds of research questions that we ask. Here, I expand on this issue by showing how some apparent bilingual advantages and disadvantages can be illusory. I describe two examples of reasonable, justifiable, and prudent experimental designs that initially led to misleading conclusions about the effects of bilingualism on development. While both of these examples are drawn from research with bilingual infants, they nonetheless have implications for how we interpret the results of studies of bilingualism across the life span.

The first example illustrates how the same task does not always measure the same thing in monolinguals and bilinguals. Bosch and Sebastián-Gallés (2003) were interested in the development of phonetic perception in bilingual infants. Decades of research with monolinguals had pointed to a consistent developmental pattern: in the first year of life, infants' sensitivity to native language phonetic contrasts is maintained and sharpened (Kuhl et al., 2007), while their sensitivity to nonnative contrasts declines (Werker & Tees, 1984). Would bilinguals show a similar developmental trajectory?

Spanish–Catalan bilingual and Catalan monolingual infants were tested on their discrimination of a Catalan vowel contrast, /e/–/ɛ/. Because this contrast was native to all infants (i.e., it was meaningful in Catalan, a language all infants

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