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Dominance and Age in Bilingualism

DAVID BIRDSONG

Department of French and Italian, The University of Texas at Austin, Austin, TX 78712, USA
E-mail: birdsong@austin.utexas.edu

The present article examines the relationship between age and dominance in bilingual populations. Age in bilingualism is understood as the point in development at which second language (L2) acquisition begins and as the chronological age of users of two languages. Age of acquisition (AoA) is a factor in determining which of a bilingual's two languages is dominant and to what degree, and it, along with age of first language (L1) attrition, may be associated with shifts in dominance from the L1 to the L2. In turn, dominance and chronological age, independently and in interaction with lexical frequency, predict performance on naming tasks. The article also considers the relevance of critical-period accounts of the relationships of AoA and age of L1 attrition to L2 dominance, and of usage-based and cognitive-aging accounts of the roles of age and dominance in naming.

In the context of bilingualism, dominance refers to observed asymmetries of skill in, or use of, one language over the other. Thus, a Spanish–English bilingual who is Spanish-dominant may process Spanish speech more easily than English speech, access lexical items faster in Spanish than in English, and use Spanish more often on a daily basis than English.[1]

The present article examines the relationship of age to dominance in bilingualism. Age may be understood along two separable dimensions. The first is the age at which bilinguals begin to learn their second language (L2). In this article, age of acquisition (AoA) refers to the age at which immersion in the L2 begins in earnest, with routine use of the L2 and interactions with speakers of that language. Increasing AoA is among the factors that have been linked to declines in attained proficiency in the L2 (e.g. Muñoz and Singleton 2011 and references therein). The second dimension is chronological age. Aging populations, monolingual, and bilingual, are known to have depressed performance on cognitive measures when compared with younger populations (e.g. Bialystok and Hakuta 1999: 171–3; Stine-Morrow and Shake 2009; see, however, Ramscar *et al.* 2014). At the same time, bilingualism confers advantages in executive control and memory function for aging individuals (e.g. Bialystok 2011; see, however, Zahodne *et al.* 2014).

In this article, I examine the roles of both AoA and aging in linguistic dominance. The first major section considers how AoA is associated with, yet dissociable from, dominance. For example, AoA is thought to constrain the potential for L2 dominance, yet the earlier-learned (L1) language is not

always the dominant language. Another topic addressed here is dominance shifts, typically from L1-dominance to L2-dominance. This shift is often precipitated by L1 attrition. As we will see, the probability, speed, and depth of L1 attrition may be affected by the age at which attrition begins, with the degree of L2 dominance being affected accordingly (e.g. Köpke and Schmid 2004). In this context, I look at critical period accounts of L1 attrition and L2 attainment as they relate L1-to-L2 dominance shifts. For consistency, throughout this section, I consider the relationship between AoA and language dominance in terms of attained proficiency in the L1 and L2.

In the second part of the article, I turn to aging in bilingualism, with a focus on naming performance by younger and older bilinguals in their dominant and nondominant languages. A fundamental question is which language, the dominant or the nondominant, is more susceptible to age effects. A related question is whether balanced bilinguals, who are known to outperform language-dominant bilinguals on naming tasks, maintain this advantage over age. Another issue is the interaction of age, dominance, and lexical frequency in naming tasks. One might expect bilinguals to perform best in their dominant language for high-frequency items, and that, given aging effects on naming, younger bilinguals should outperform older bilinguals. As we will see, however, this predicted interaction of age, dominance, and lexical frequency is not entirely borne out.

The two main sections of this article are preceded by a set of preliminary notes. These include the distinction between dimensions and domains of language dominance, the gradient and relative nature of dominance, assessments of dominance, and the often-misunderstood relationship between dominance and proficiency. I conclude with a critical overview, followed by suggestions for future studies of age and dominance in bilingualism.

PRELIMINARIES: TERMINOLOGY, ASSESSMENT, AND THE CONSTRUCT OF DOMINANCE

Dimensions and domains of dominance

Language dominance can be determined along two conceptually distinct axes: dimensions and domains. Dimensions of dominance relate to linguistic competence, production, and processing. Thus, fluency of speech, lexical diversity, morphosyntactic knowledge, length of utterances, parsing speed and accuracy, etc. are dimensions of language ability that can be compared in the two languages to reveal levels of dimension-based dominance. In contrast, domains are situations and contexts of language use; these may be compared between the two languages of a bilingual to determine domain-based dominance. Domains include counting, conversations with elder relatives, child-directed speech, watching TV news, interactions in the workplace, etc.

Broadly speaking, the notion of domain of language is associated with activities involving choice or purpose, whereas dimensions of language reference

the inherent abilities of a bilingual. To put a fine point on these considerations, and to connect dimensions and domains, one may look upon domains as the contexts and activities in which various dimensions of language ability are engaged.

Indices of dominance: gradience and relativity

Dominance is a relative construct, in the sense that assessments of dimensions or domains in one language are compared with assessments in the other language. The quantified difference between the assessments for each language is usually referred to as an index of dominance, an expression of the degree to which a bilingual is dominant in one language. Dominance is thus understood to be a gradient or continuous construct, as opposed to a nominal or categorical construct. A bilingual is not simply dominant in a language, but is dominant in that language to a measurable degree. The relativity and gradience of dominance also come into play when bilinguals are compared with one another. For example, two Dutch-dominant Dutch–German bilinguals may not be dominant in Dutch to equal degrees.

Indices of dominance may be computed by subtraction-based or ratio-based methods. To illustrate the two methods with the dimension of reading speed, consider a French–English bilingual resident of Montréal whose average reading-aloud speed is 150 words per minute in French and 100 words per minute in English. By the subtraction method, the French-dominance index is 50 (150 − 100). By the ratio method, the French-dominance index is .67 (100/150). Now consider a different bilingual in Montréal, whose average reading-aloud speed is the same in the two languages (e.g. 150 words per minute in French and in English). By subtraction this individual's dominance index would be 0 (150 − 150 = 0), whereas by the ratio method this person would have a dominance index of 1 (150/150 = 1). Calculations of dominance indices and balanced bilingualism are evaluated by Birdsong (To appear) and Treffers–Daller and Korybski (To appear).

That dominance is not a categorical variable must be kept in mind when bilingual populations are studied. For example, with the understanding that the magnitude of dominance matters, researchers should group bilinguals along specific and well-motivated ranges of dominance. In addition, as with other continuous participant variables such as AoA and education, dominance level may be entered as a factor into regression analyses (see Conclusion and Birdsong To appear).

Dominance and proficiency

Proficiency in the L2 is referenced to standards outside the individual L2 user, usually monolingual native speaker controls or presumed norms of the L2. In contrast, dominance is a matter of internal reference and relativity, in the

sense that assessments of domains and dimensions of the L2 are compared with corresponding assessments in the L1.

The relativistic nature of dominance means that a bilingual who is dominant in one language does not necessarily have high proficiency in that language, only lower proficiency in the other language. By the same token, a high level of proficiency in one language does not imply a high dominance index except in cases where proficiencies in the two languages are quite discrepant.[2]

The fact that dominance does not imply high proficiency is further illustrated in the case of balanced bilinguals. Consider two bilingual individuals, both of whom are balanced in terms of their respective proficiencies in their two languages. As an example, the first of these balanced bilinguals may be proficient to the same high level in the two languages, while the second may be proficient in both languages but to a relatively low level by comparison with the first.

In short, proficiency and dominance are separable constructs (Birdsong 2006; Montrul To appear). Proficiency is one dimension of dominance and is no different in this respect from reading speed or speech rate. Each of these dimensions can be independently assessed. However, the assessed values do not necessarily correlate. As a hypothetical example, a given bilingual individual may be strongly dominant in one language in terms of speech rate, but at the same time display poor knowledge of that language's inflectional morphology. Another hypothetical bilingual may have a faultless command of formal features of agreement in one language, but find it more difficult to understand phone conversations in that language relative to the other.

To wrap up the discussion of proficiency and dominance, it should be borne in mind that a bilingual's proficiency in the dominant language cannot be expected to be identical to that of a monolingual native speaker of that language. Because of well-understood bidirectional influences in the two languages, nonmonolingual-likeness in terms of proficiency (and likewise on other assessed dimensions) is a defining characteristic of bilingualism (Grosjean 1989; Cook 2003; Ortega 2009).

AoA AND L2 DOMINANCE

Associating and dissociating AoA and dominance

It is commonly believed that the second (later-learned) language is not, nor will ever be, the dominant language. This perception derives in part from findings that the ultimate levels of grammatical, lexical, phonetic, and processing proficiency in the L2 are generally predictable from a learner's age of immersion in the L2, and the related observation that linguistic measures in the late-learned L2 will not match those of the L1.

The prevalence of L1 dominance is illustrated by Gertken (2013). In her syntactic priming study involving French–English bilinguals whose L1 was

English, Gertken found that only 3 of her 46 participants with French AoA over 12 were French-dominant, as assessed in a bilingual administration of *A Quick Test of Cognitive Speed* (AQT), a measure of executive control in dual-dimension (color-object) naming (Wiig *et al.* 2002). In the same study, AoA was found to be a significant predictor ($r = .31$, $p < .05$) of dominance indices on the *Bilingual Language Profile* (Birdsong *et al.* 2012), a global measure of bilingual dominance, and only one of Gertken's 46 late L2 learners was assessed as L2 dominant on this instrument.

In this light, it is tempting to simply assume that the L1 is the dominant language. However, the equation of the L1 with dominance is not a given. For example, in the heritage language context, the L2 is demonstrably dominant in various dimensions and domains. The shift to L2 dominance occurs as individuals transition from the home language to the school or community language.

Another example of the dissociation of AoA and dominance are adult bilinguals from birth who are not balanced bilinguals. That is, the AoA of the two languages is identical, yet one of the languages is dominant. Still another instance is the immigration context, where some L2 users become L2-dominant after extensive immersion in communities where the L2 is spoken. The level of L2 dominance may reflect psycho-social factors, such as identification with L2 speakers and the L2 culture and morays.

The dissociation of AoA and dominance is further exemplified in individuals whose dominant language is unstable to the point of experiencing multiple shifts of dominance. Such individuals may move from the L2 environment back to the first, then back again or to a third linguistic environment, with extensive immersion in the new language each time, and with consequent shifts of language dominance.

Grosjean (2010: Ch. 8) characterizes this dynamic nature of dominance across the lifespan of bilinguals as the 'wax and wane of languages'. With respect to his personal history with languages, Grosjean expresses his dominance patterns quantitatively in terms of relative use of and fluency in French, English, Italian, and ASL at ages 7, 17, 27, 39, and 60. Age appears not to be a constraining factor, inasmuch as English (Grosjean's L2, with immersion starting at age 8) displaces French (the language from birth) as the dominant language at some point between ages 8 and 17 and then again between 27 and 39. By age 60, there is little difference between the two languages with respect to use and fluency. In Grosjean's case, the switching of dominance was directly attributable to his immigration history, but he points out that changes in dominance may also be linked to the language of schooling, work, the spouse, or other close family members (Grosjean 2010: 89).

In addition, AoA and dominance are independent with respect to domains of language use, such as counting, talking with family members, or religious activities. For example, a French–English bilingual Catholic may be globally dominant in the L2 English, but the L1 French may be dominant (or used exclusively) when this person privately prays.

Finally, dominance, AoA, *and proficiency* must be decoupled in certain instances, as illustrated in the following description of a dominance shift among bilingual immigrants (whose L2 is perforce later learned): 'For immigrants with many years of immersion in their second language, the second language can come to be the most dominant language, even if it remains the less proficient language, as measured by tests of grammar and vocabulary' (Harris *et al*. 2006: 264). This observation underscores the fallacy of assuming that AoA, dominance, and proficiency are necessarily in a mutually implicative relationship.

AoA-related potential for L2 dominance

For the purposes of illustration, and for continuity with earlier sections of this article, the discussion here will focus on morphosyntactic proficiency. As mentioned above, it is well known that ultimate levels of L2 proficiency are negatively correlated with AoA. A hypothesized association of AoA and dominance may be derived from the simple logic that the later the L2 is learned, the lower the L2 proficiency; the lower the L2 proficiency, the higher the dominance index for the L1. Stated somewhat differently, as attained L2 proficiency declines over AoA (and assuming L1 proficiency does not decline; see below), the gap between L1 proficiency and L2 proficiency should widen, and the L1-dominance index would increase accordingly.

The notion that the potential for L1 dominance increases as L2 AoA increases must be adjusted to take into account claims that the function that relates L2 AoA to attained L2 proficiency is not linear (see Birdsong 2005 for an overview of proposed geometries of AoA–L2 proficiency functions). Figure 1a represents a linear decline in L2 attained proficiency across all AoA. (In Figure 1a–c, increasing age is abstractly represented on the horizontal axis, with attained L2 proficiency on the vertical axis.) If, on the other hand, the function takes the 'stretched-7' shape (Figure 1b), where declines in L2 proficiency do not begin for months or years after birth, the potential for a shift

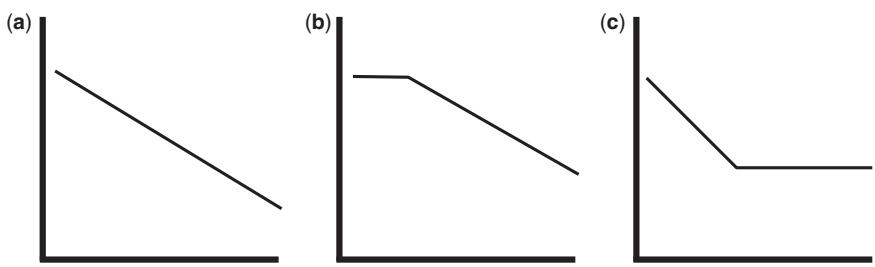

Figure 1: Schematic representations of L2 proficiency (vertical axis) declines over AoA (horizontal axis). (a) Linear function; (b) 'stretched-7' discontinuous function; (c) 'stretched-L' discontinuous function

from L1 dominance to L2 dominance is not diminished until the function breaks downward. From that inflection point on, the likelihood of L2 dominance continues to decrease over increasing AoA.

On another view of AoA effects on L2 proficiency, declines in ultimate proficiency potential start at early AoA but level off after a presumed maturational milestone is reached. Under this 'stretched-L' geometry (Figure 1c), the likelihood of L2 dominance in attained morphosyntactic proficiency declines up to the point of articulation, but does not decrease further with increasing age.

Two points of clarification should be made. First, the likelihood of L2 dominance depends on the slope of the AoA—L2 proficiency function. More bilinguals will perform near ceiling if the slope of the function is relatively shallow, fewer if the slope is steeper (see Birdsong 2005: 122 and Figure 6.8). Increasingly slimmer chances for L2 dominance are predicted as a consequence of an increasingly steep slope in the function. Secondly, recall that the illustrative scenarios offered so far assume no decline in L1 proficiency. This matter is taken up in the following section.

L1 attrition, age, and dominance shifts

How does L1 attrition figure in the longitudinal dynamic of L2 dominance? As was suggested for L2 proficiency attainment, there is a presumptive trading relationship between L1 attrition and L2 dominance. That is, to the degree that the first language is lost, the chances that L2 will become the dominant language are heightened. The question then becomes whether L1 attrition, like L2 attainment, is an age-related phenomenon. More to the point, does the age at which L1 attrition begins predict the possibility of L2 dominance?

In their review, Köpke and Schmid (2004: 23) connect age, immigration situations favoring L1 attrition, and L2 dominance: 'attrition data suggest that the younger a child is when she changes her linguistic environment, the higher the probability that the L2 will replace the L1' (as the dominant language). Adding L2 attainment to the mix, Bylund *et al.* (2012: 232) relate age, L1 attrition, and L2 gains to dominance shifts. On the Bylund *et al.* maturational account, 'during the first decade of life, the heightened plasticity of a child's language processing system not only allows the child to acquire an additional language at a high rate of success but also makes the child's L1 highly susceptible to attrition'. Thus at early ages, the confluent factors of L1 loss and L2 gain promote 'inverse L1 and L2 levels', or dominance shifts.[3]

A follow-on concern is the nature of the function that associates age and L1 attrition, and how this function compares with the one that associates AoA and L2 attainment. Posing the question in simple terms, does the geometry of age-related L1 attrition parallel the geometry of AoA-related L2 attainment?

Pallier (2007)'s review of the L2 acquisition literature leads him to conclude that the relationship between AoA and L2 attainment manifests early in development and is linear over the lifespan. At the same time, Pallier's work on complete L1 attrition (Pallier *et al.* 2003), along with studies

by Ammerlaan (1996) and Pelc (2001), lead him to posit that age effects in L1 attrition are nonlinear. The specific claim is that age effects in L1 attrition do not commence until around 10 years of age, thus aligning geometrically with the 'stretched-7' function represented in Figure 1b. According to Pallier (2007: 165) 'language attrition, contrary to L2 acquisition, may show a discontinuity around puberty'. One may envision the nonlinearity of the age–L1 attrition function as an articulation downward following something of a 'window of opportunity' for attrition. For Pallier then, both L2 attainment and L1 attrition are age constrained; however, L2 attainment, unlike L1 attrition, does not display the nonlinearity of a critical period.

In contrast, Bylund *et al.* (2012) point out that both the potential for L2 attainment and the potential for L1 attrition are heightened during the first decade of life and decline thereafter.[4] Under the idea that L1 attrition and L2 attainment are phenomenologically related, both would map onto the same nonlinear geometric function over the lifespan.

The question of what is the actual geometric nature of the age function in L2 attainment remains at the heart of the L2 critical period debate (for recent discussions, see Granena and Long 2013; Vanhove 2013). The general developmental geometry of L1 attrition, on the other hand, appears somewhat less controversial (cf. Bylund 2009). As for the theoretical relevance of these concerns to L1-to-L2 dominance shifts, the question is whether dominance shifts in the first decade of life are enabled synchronously and equally by L2 gains and by L1 attrition (à la Bylund *et al.* 2012), or mostly by L1 loss, with a linearly decreasing role played by L2 attainment from early infancy onward (à la Pallier 2007).

Dominance shifts and age: beyond probability

Thus far we have looked at L1-to-L2 dominance shifts in terms of the *probability* that the L2 can become dominant before and after a certain age. Köpke and Schmid (2004) identify *speed* of L1 attrition and *depth* of L1 attrition as additional parameters of an L1-to-L2 dominance shift. The speed with which L1 attrition takes place tends to slow with age, artifactually retarding the point at which an L1-to-L2 dominance shift could begin. Depth of attrition, understood as the degree to which a certain L1 skill dimension or domain of use is affected in attrition, is shallower with increasing age. (Breadth of attrition, that is, the number of skill dimensions and domains of use affected by L1 attrition, should similarly decrease with age.) As the depth and breadth of L1 attrition decrease, so would the corresponding depth and breadth of L2 dominance.

As a consequence of these combined age-related influences on L1 attrition, one would expect that the overall extent to which the L2 is dominant would decrease with the age at which the shift begins. In other words, the eventual magnitude of a given L2-dominance index would be smaller as the L1-to-L2 dominance shift takes place later in life.

THE RELATIONSHIP OF AGING TO DOMINANCE

This second main part of the article looks at aging in bilingualism, in particular how aging effects play out in the dominant and nondominant languages. The examples of bilingual performance cited here relate to naming speed and accuracy. This focus is chosen in the interest of comparing various studies and their results, and because of the prevalence of naming paradigms in the experimental literature.

Three fundamental questions are considered. First, does age affect naming in the dominant and nondominant languages differently? Secondly, does age differentially affect naming performance among balanced bilinguals versus language-dominant bilinguals? Thirdly, what are the (separate and interactive) effects on naming of dominance, age, and lexical frequency? The last question touches on the idea that one sense of language use—conceived of in terms of language dominance and lexical frequency—is associated with enhanced naming performance, while another formulation of language use—cumulative use of language over time—is associated with lower levels of performance.[5]

Age and naming performance

Naming performance decrements over age are not unique to the bilingual context. For example, Tombaugh and Hubley (1997) administered the *Boston Naming Test* (BNT: Kaplan *et al.* 1983) to 219 monolingual English speakers ranging in age from 25 to 88 years, and divided them into nine age groups: 25–34, 35–44, 45–54, 55–59, 60–64, 65–69, 70–74, 75–79, and 80–88. Using the lower figure in the age group cohorts (i.e. 25, 35, etc.), I performed a simple correlation of age with naming times and found a significant relationship ($r = .77$, $p < .001$.). Tombaugh and Hubley cite several studies showing that the greatest increases in naming times occur after age 70.

Finer-grained but less robust results were reported by Jacobson *et al.* (2004) in their study of performance on the AQT (Wiig *et al.* 2002). The AQT tests naming speed for single-dimension items such as numbers, colors, forms, objects, and animals, as well as speeds for naming dual-dimension items (e.g. colored animals such as 'red snake', colored forms such as 'yellow triangle'). Each subtest consists of 40 items presented at once. Mean naming times ranged from 14.11 s for simple colors to 48.29 s for colored animals. A significant correlation between age and color naming times was reported ($r = .29$, $p < .001$), with a projection that color naming speed would become slower by about 1 s for every 16 years of aging. For dual-dimension stimuli, the correlation of age and naming speed was significant as well ($r = .21$, $p < .001$); naming times for these more difficult items were projected to slow by 1 s per 10 years of aging. For the subset of participants 60 years of age or older, the correlation between age and dual-dimension naming times was significant ($r = .32$, $p < .01$); for participants younger than 60, the corresponding correlation was significant but weaker ($r = .11$, $p < .01$).

Among bilinguals, a more cogent question than age effects *tout court* is how age effects on naming play out in the dominant and nondominant languages. This issue can be framed in two ways. First, are the effects of age equal (the dominant and nondominant languages are similarly affected) or asymmetrical (one language is more affected)? This question speaks to the perception that, over time, the dominant language strengthens and the nondominant language weakens. The second way of framing the issue compares bilinguals who are dominant in one language with bilinguals who are dominant in neither language, that is balanced bilinguals. By definition, bilinguals who are dominant in a language are measurably different from balanced bilinguals. The issue is whether patterns of performance in both types of bilingualism are affected by age, and if so, whether the effects are similar or different.

Age effects in the dominant versus nondominant language. Which language of a bilingual, the dominant or the nondominant, is more affected by age? Numerous studies have indicated that performance in the nondominant language is more subject to effects of aging than the dominant language (e.g. Köpke and Schmid 2004; DeBot 2007; Gollan *et al.* 2012).

Two types of evidence speak to the impact of age on the nondominant language. First, with advancing age there is a retreat to use of the dominant language, a phenomenon commonly reported by caregivers for the elderly (Ardila and Ramos 2008). This reversion may be connected to an overall decrease in the domains in which language is used. For example, retired immigrants no longer have access to the workplace environment, where the L2 might have predominated. Those domains that are most likely to be preserved (e.g. conversations with certain family members) are associated with the first or dominant language.

Secondly, with age come greater declines in inhibitory control in the nondominant language relative to the dominant language.[6] For example, Mohamed Zied *et al.* (2004, cited by Ardila and Ramos 2008) found that older French–Arabic bilinguals were slower in Stroop performance in their nondominant language versus their dominant language. Interestingly, older balanced bilinguals were faster across all bilingual Stroop tasks than either French-dominant or Arabic-dominant bilinguals. Similar effects for younger balanced bilinguals were also observed. The authors suggest that, for balanced bilinguals, 'mastering two languages contributed to the improvement of inhibitory processing' (256), irrespective of age.

As suggested by the quote from Mohamed Zied *et al.*, balanced bilingualism may erroneously be conflated with mastery. (In that study, the conflation occurred despite the fact that balanced bilinguals had been defined in terms of comparable scores on the Arabic and French versions of the BNT, not in terms of comparably *high* scores.) As noted in the Preliminaries section of the present article, balanced bilingualism does not imply high levels (or any other particular level) of proficiency. Accordingly, in research on age-related differences and dominance, as well as in studies of dominant versus balanced

bilinguals more generally, the nominal level of proficiency in each language should be made explicit.

Young and old bilinguals, balanced and language-dominant bilinguals. The second question posed above is whether performance among balanced bilinguals and language-dominant bilinguals changes over age, or is similar in younger and older bilingual populations.

An answer is suggested by the findings of Kohnert *et al.* (1998) in combination with those of Gollan *et al.* (2007). In Gollan *et al.* (2007), 29 older Spanish–English bilinguals (mean age = 74.0 years) from the San Diego area were administered the BNT, first in their self-assessed dominant language, then in their nondominant language. Correct answers were calculated along four response permutations: total items correctly named in the dominant language, total correct in the nondominant language, total correct in both languages, and total correct in either language. (As a clarification, either-language scoring refers to the total number of items out of 60 that were correctly named in one or the other of the two languages; both-correct scoring refers to the total number of items named in both the dominant and the nondominant language.) In this study, individual participants' observed either-language scores (range = 42–60) were consistently higher than (or, in some cases, equal to) their dominant language scores (range = 35–60), which were always higher than their nondominant language scores (range = 9–52). In turn, participants' scores in their nondominant language were higher than or equal to their number correct in both languages (range = 9–49). In group analyses of the 10 most balanced bilinguals and the 10 least balanced bilinguals, balanced bilinguals were found to benefit more than unbalanced bilinguals from the either-language scoring method, versus scores in their weaker language. In other words, in older bilingual populations, balanced bilingualism confers a naming advantage when naming scores take into account performance in both languages.

A subsequent regression analysis using scores from all 29 participants looked at the relationship between degree of dominance and the benefit of the either-language scoring. Consistent with the group analysis, a significant correlation was found whereby the more similar the naming skills in the two languages (i.e. the greater the degree of balanced bilingualism), the larger the difference between scores by the either-language scoring method versus the simple dominant-language scoring method.

In an earlier study, Kohnert *et al.* (1998) had administered the BNT to a younger sample of 100 Spanish–English bilinguals, also living in California. The mean age of these participants, 20.82 years, was more than 53 years younger than those in Gollan *et al.* (2007). Of these participants, 75 were classified as English dominant and 25 were classified as balanced bilinguals. Among the English-dominant bilinguals, the difference between the BNT score for the dominant language (48.2) and the either-language BNT score (49.3) did not reach significance. In contrast, among the balanced bilinguals, there was a

significant benefit for the either-language scoring (46.5) versus scores in English (42.0) or Spanish (40.9).

Considering the results the two studies side by side, we see that dominance effects play out similarly in younger bilinguals (Kohnert *et al.* 1998) and in older bilinguals (Gollan *et al.* 2007). Specifically, both younger and older bilinguals who are classified as balanced are able to name more items in their languages combined than in one language alone, whereas this advantage is not observed among unbalanced bilinguals. Thus, to respond to the question posed in this section, the two studies cited suggest that age does not erode the naming advantage that balanced bilinguals have over dominant bilinguals. Balanced bilinguals continue to maintain a bilingual lexical store whose online retrievability exceeds that of dominants.

Age, dominance, and lexical frequency in naming

Along with age and dominance, another variable in the mix is lexical frequency. Because highly frequent names are by definition used more often, one might expect faster and more accurate naming on high-frequency items relative to low-frequency items. Looking at the three variables together, one would be particularly interested in interactions of the age variable (which predicts depressed performance) with the dominance variable and the lexical frequency variable (which predict enhanced naming performance).

These ideas are explored by Gollan *et al.* (2008) in two experiments. Participants in Experiment 1 were 57 undergraduate monolingual English speakers and 57 Spanish–English bilinguals who were either self-reported English-dominants or who reported speaking English and Spanish equally well. All the bilinguals used English less often than monolinguals on a daily basis. A picture-naming task (Snodgrass and Vanderwart 1980) was administered in both languages to test speed and accuracy of lexical access.

Several results suggested roles for frequency. Word frequency was associated with faster and more accurate naming times among monolinguals and bilinguals. In both participant groups, low-frequency words were named slower than high-frequency words. The lexical frequency effect was larger among bilinguals than monolinguals, a result consistent with the fact that monolinguals use their single language more often than bilinguals use either of theirs. Similarly reflective of overall frequency of language use, English monolinguals were significantly faster in naming times than bilinguals in either of their languages (this result was termed the bilingual effect or the bilingual disadvantage).

In Experiment 2, the age-at-testing variable in picture naming was introduced. The question now becomes how dominance effects and lexical frequency effects might vary as a function of age. Participants included 14 pairs of older Spanish–English bilinguals and 14 pairs of younger Spanish–English; all were English dominant and the younger and older participants were matched on Spanish-to-English and English-to-Spanish translation ability.

Fourteen pairs of older and younger monolinguals, matched with the bilinguals for education, also participated.

Overall, younger bilinguals outperformed older bilinguals, and monolinguals outperformed bilinguals. Of most relevance to the present discussion are two findings concerning how frequency, in interactions with dominance, conditions age effects. First, older bilinguals were slower and produced more errors than younger bilinguals when naming low-frequency items in the dominant language. Secondly, in the nondominant language, older bilinguals were slower and more error-prone than younger bilinguals for high-frequency names. However, the age effect was not observed for low frequency names, where older and younger bilinguals performed poorly and at comparably depressed levels. Thus, the locus of age effects is doubly asymmetrical in the two languages of bilinguals: age affects low-frequency items in the dominant language but affects high-frequency names in the nondominant language.

The authors discuss at length the theoretical implications of these results. One major, though tentative, suggestion is that the same general cognitive mechanisms underlie processing in both the dominant and nondominant language. With respect to aging, the overall age effect that was observed might be expected under a cognitive-aging account. However, more subtle reasoning is required to explain the finding that naming of low-frequency items in the nondominant language was similar in younger and older bilinguals. Gollan *et al.* (2008: 806) speculate that the increased experience that comes with aging counteracts age-related slowing in the weakest lexical representations. That is, where the cumulative use that comes with aging is most beneficial is where ceiling effects are least likely—in other words, where there is most room for improvement over time—specifically, low-frequency names in the nondominant language.

To summarize, in Gollan *et al.* (2008)'s Experiment 1, low-frequency items were named slower and with more errors, among all bilinguals in both their dominant and nondominant language. The effects of frequency were strongest, however, in the nondominant language. These results are straightforwardly predicted by frequency of use: low-frequency items are more difficult than high-frequency items across the board (even among monolingual controls), and are most difficult in the nondominant language, which is the less frequently used language.

The age-at-testing variable in Experiment 2 adds meaningful granularity to the discussion of dominance. Younger bilinguals and older bilinguals were indistinguishable on low-frequency items in both their dominant and nondominant language. This finding applies in a relative sense (i.e. in the nondominant language both older and younger groups were slower with low-frequency items versus other types of items) as well as in an absolute sense (the error rate and response times for low-frequency items in the nondominant language for the younger and older groups were almost identical). Where younger and older bilinguals diverged was on all other types of

items, in both their dominant and nondominant language: there, younger bilinguals were superior to older bilinguals.

Taken together, the findings of Gollan *et al.* (2008) suggest an intersection of age, dominance, and lexical frequency whereby, as the title of their article indicates, 'More use almost always means a smaller frequency effect' (787). Notably, however, by a strict 'more use' account, older bilinguals should exhibit an overall superior performance relative to younger bilinguals, given the greater cumulative language experience among older bilinguals. In Gollan *et al.* (2008), the results go in the opposite direction of this prediction: consistent with general declines in cognitive performance over age, older bilinguals generally underperform younger participants on all measures.

As mentioned above, according to Gollan *et al.* (2008) the exception to this generalization—naming speed and accuracy for low-frequency items in the nondominant language, which are equally poor for younger and older bilinguals—might possibly be attributable to cumulative use, which would bring naming performance of older bilinguals in line with that of younger bilinguals. This position entails a contradiction, however, in that a cumulative-use-over-age account would predict that performance in the younger group (which equals that of the older group) would improve over age and would thus ultimately exceed the observed performance of the older group.

CONCLUSION

The first major section of this article looked at the role of AoA in determining L1 versus L2 dominance. We saw that AoA is at once associable with, and dissociable from, dominance. AoA is associable with dominance in the sense that it is predictive of the timing and degree of L1 attrition, which in turn promotes the L2 to the dominant language. It is also associated with dominance inasmuch as AoA is predictive of ultimate levels of L2 proficiency, and hence the likelihood of L2 proficiency surpassing that of the L1. At the same time, AoA is dissociable from dominance insofar as the L1 language is not necessarily the dominant language.

A second issue is the connection of dominance shifts to critical-period accounts of L1 attrition and L2 acquisition. According to Pallier (2007), the potential for L1 attrition begins to decline around age 10, whereas L2 attainment is subject to a linear decline over AoA that begins in infancy; the two phenomena are dissociable in this respect. Bylund *et al.* (2012), on the other hand, argue for a phenomenological and temporal unification of L1 attrition and L2 attainment: 'the ease with which an L2 is acquired and the L1 undergoes attrition can be said to be manifestations of a generally heightened responsiveness to language exposure, which works both in acquisitional and attritional directions' during early childhood development (237). These divergent scenarios speak to the etiology of dominance shifts in bilingualism. In this

respect, the core consideration, which awaits further investigation, is whether L1-to-L2 dominance shifts in the first decade of life are simultaneously and coequally conditioned by both L1 attrition and L2 gains, or whether dominance shifts during this period are asymmetrically conditioned by L1 loss and L2 gains, the latter exerting a progressively smaller effect on dominance than the former.

The relationship of aging over the life span to L1 and L2 dominance was explored in the second major section of this article. With respect to naming speed, an area of linguistic performance linked to the decline of executive control over age, age effects are observed for both bilinguals and monolinguals. I considered how age might affect naming speeds in the dominant versus the nondominant language and reported that the latter is more susceptible to age effects. However, a cautionary note must be added to this generalization. In most studies examined, the L2 is, or is assumed to be, the nondominant language. It remains to be seen whether the findings presented here are replicable in instances where the L2 is the dominant language. Of additional interest would be future studies that compare late L2-dominants with early L2-dominants.

We also observed that balanced bilinguals are able to name more objects than bilinguals who are dominant in one of their languages. With age, nonbalanced bilinguals do not reach a level of naming that is commensurate with that of balanced bilinguals (Kohnert *et al.* 1998; Gollan *et al.* 2007).

Consistent with a usage-based account of bilingual language performance, the factors of dominance and lexical frequency are found to predict naming speed. Consistent with the idea of general cognitive declines over age, older bilinguals underperform younger bilinguals (Gollan *et al.* 2008).

Many of the studies reviewed here exemplified comparisons involving older versus younger bilinguals and the dominant and nondominant languages. It is common for both age and dominance to be operationalized as categorical variables under ANOVA or other group analyses. While the results are revealing, the fact that both age and dominance are continuous variables is a natural argument for using regression models to determine the weight of their contributions to performance. With continuous variables generally, regression models also eliminate the arbitrariness associated with stipulating group membership and offer more statistical power in analyses (Nelson and Zaichkowsky 1979; Altman and Royston 2006).

Finally, as with many other areas of language and cognition, our understanding of age and dominance in bilingualism will not be complete without additional fine-grained longitudinal investigations at the individual and group levels. However daunting in practical terms it may be, rigorous expansion on the longitudinal work of Caldas and Caron–Caldas (2000, 2002), Grosjean (2010), Olsson and Sullivan (2005) *inter alia* holds the promise of fully exposing the textured dynamic of linguistic dominance from childhood into old age.

NOTES

1 Dominance is examined here in terms of language use and skill, not in terms of the prevalent language in a societal context. The latter notion of dominance is associated with the lingua franca, prestige language, language of instruction in schools, numbers of speakers of a given language in a community, official language of nations and governmental communications, etc. (For further discussion, see Lazarev and Pravikova 2005; DeBot 2007.) It is understood, however, that such society-level factors may feed into individual-level bilingual dominance in the present sense of relative skill and use.

2 For the present purposes, proficiency can be understood informally in terms of knowledge of lexis and grammar, and command of basic language skills. The arguments here apply to formal assessments of proficiency as well.

3 Köpke and Schmid (2004) note that the connection between age and attrition is observed across a number of linguistic dimensions besides proficiency, including language processing and word-retrieval ability. They also point out that there are other factors besides age, and which may interact with age, that may determine the degree of L1 loss and L2 dominance. These include education level, literacy, motivation to maintain the L1, and amount of contact with the L1 and the L2. For discussion from longitudinal and sociolinguistic perspectives, see Caldas and Caron–Caldas 2000, 2002; Olsson and Sullivan 2005.

4 Note that Bylund (2009) suggests that there are mild declines in potential for both L2 attainment and L1 attrition during the first decade, that is, there is not a stable plateau of these potentials over that period.

5 For an orientation to aging, L1 attrition, L2 dominance, and naming performance, see Goral (2004). On age and naming performance in normal and cognitively impaired populations, see Nicholas *et al.* (1997). On cognitive control and lexical access among younger versus older bilinguals, see Bialystok *et al.* (2008). Zec *et al.* (2007) provide normative naming performance by age, education, and gender. Alario *et al.* (2004) evaluate the contributions of nine factors in naming latencies. An overview of language in aging populations is found in Stine–Morrow and Shake (2009). On usage-based accounts of naming, see Bedore *et al.* (2012).

6 Bialystok (2011, *inter alia*) emphasizes that, with aging, bilingualism confers an executive-function advantage over monolingualism. Within bilingualism, it would appear that this advantage attaches more strongly to the dominant language.

REFERENCES

Alario, F. X., L. Ferrand, M. Laganaro, B. New, U. H. Frauenfelder, and **J. Ségui.** 2004. 'Predictors of picture naming speed,' *Behavior Research Methods, Instruments and Computers* 36/1: 140–55.

Altman, D. G. and **P. Royston.** 2006. 'The cost of dichotomizing continuous variables,' *British Medical Journal* 332: 1080.

Ammerlaan, T. 1996. 'You get a bit wobbly . . . Exploring bilingual lexical retrieval processes in the context of first language attrition,' Doctoral dissertation, Katholeike Universteit Nijmegen.

Ardila, A. and **E. Ramos.** 2008. 'Normal and abnormal aging in bilinguals,' *Dementia and Neuropsychologia* 2/4: 242–7.

Bedore, L., E. D. Peña, C. L. Summers, K. M. Boerger, M. D. Resendiz, K. Greene, T. M. Bohman, and **R. B. Gillam.** 2012. 'The measure matters: Language dominance profiles across measures in Spanish-English bilingual children,' *Bilingualism: Language and Cognition* 15/3: 616–29.

Bialystok, E. 2011. 'Reshaping the mind: The benefits of bilingualism,' *Canadian Journal of Experimental Psychology* 66/4: 229–35.

Bialystok, E. and K. Hakuta. 1999. 'Confounded age: Linguistic and cognitive factors in age differences for second language acquisition' in D. Birdsong (ed.): *Second Language Acquisition and the Critical Period Hypothesis*. Erlbaum, pp. 161–81.

Bialystok, E., F. I. M. Craik, and **G. Luk.** 2008. 'Cognitive control and lexical access in younger and older bilinguals,' *Journal of Experimental Psychology: Learning, Memory, and Cognition* 34: 859–73. doi:10.1037/0278-7393.34.4.859.

Birdsong, D. 2005. 'Interpreting age effects in second language acquisition' in J. F. Kroll and A. M. B. De Groot (eds): *Handbook of Bilingualism: Psycholinguistic Approaches*. Oxford University Press, pp. 109–27.

Birdsong, D. 2006. 'Dominance, proficiency, and second language grammatical processing,' *Applied Psycholinguistics* 27: 46–9.

Birdsong, D. To appear. 'Dominance in bilingualism: Foundations of measurement, with insights from the study of handedness' in C. Silva-Corvalán and J. Treffers-Daller (eds): *Language Dominance in Bilingualism: Issues of Measurement and Operationalization*. Cambridge University Press.

Birdsong, D., L. M. Gertken, and **M. Amengual.** 2012. *Bilingual Language Profile: An Easy-to-Use Instrument to Assess Bilingualism*. COERLL, University of Texas at Austin, available at https://sites.la.utexas.edu/bilingual/.

Bylund, E 2009. 'Maturational constraints and first language attrition,' *Language Learning* 59: 687–715.

Bylund, E., N. Abrahamsson, and **K. Hyltenstam.** 2012. 'Does first language maintenance hamper nativelikeness in a second language?,' *Studies in Second Language Acquisition* 34: 215–41.

Caldas, S. and **S. Caron-Caldas.** 2000. 'The influence of family, school, and community on bilingual preference: Results from a Louisiana/Québec case study,' *Applied Psycholinguistics* 21: 365–81.

Caldas, S. and **S. Caron-Caldas.** 2002. 'A sociolinguistic analysis of the language preferences of adolescent bilinguals: Shifting allegiances and developing identities,' *Applied Linguistics* 23: 490–514.

Cook, V. (ed.). 2003. *Effects of the Second Language on the First*. Multilingual Matters.

DeBot, K. 2007. 'Dynamic systems theory, lifespan development and language attrition' in B. Köpke, M. S. Schmid, M. Keijzer, and S. Dostert (eds): *Language Attrition: Theoretical Perspectives*. John Benjamins, pp. 53–68.

Gertken, L. M. 2013. 'Priming of relative clause attachment during comprehension in French as a first and second language,' Doctoral dissertation, University of Texas at Austin.

Gollan, T., C. Fennema-Notestine, R. Montoya, and **T. L. Jernigan.** 2007. 'The bilingual effect on Boston Naming Test performance,' *Journal of the International Neuropsychological Society* 13: 197–208.

Gollan, T., R. I. Montoya, C. Cera, and **T. C. Sandoval.** 2008. 'More use almost always means a smaller frequency effect: Aging, bilingualism, and the weaker links hypothesis,' *Journal of Memory and Language* 58: 787–814. doi:10.1016/j.jml.2007.07.001.

Gollan, T. H., G. Weissberger, E. Runnqvist, R. I. Montoya, and **C. M. Cera.** 2012. 'Self-ratings of spoken language dominance: A multi-lingual naming test (MINT) and preliminary norms for young and aging Spanish-English bilinguals,' *Bilingualism: Language and Cognition* 15: 594–615.

Goral, M 2004. 'First-language decline in healthy aging: Implications for attrition in bilingualism,' *Journal of Neurolinguistics* 17: 31–52.

Granena, G. and **M. H. Long.** 2013. 'Age of onset, length of residence, language aptitude, and ultimate L2 attainment in three linguistic domains,' *Second Language Research* 29: 311–43.

Grosjean, F. 1989. 'Neurolinguists, beware! The bilingual is not two monolinguals in one person,' *Brain and Language* 36: 3–15.

Grosjean, F. 2010. *Bilingual: Life and Reality*. Harvard University Press.

Harris, C. L., J. B. Gleason, and **A. Aycicegi.** 2006. 'When is a first language more emotional? Psychophysiological evidence from bilingual speakers' in A. Pavlenko (ed.): *Bilingual Minds: Emotional Experience, Expression, and Representation*. Multilingual Matters, pp. 232–56.

Jacobson, J. M., N. P. Nielsen, L. Minthon, S. Warkentin, and **E. H. Wiig.** 2004. 'Multiple rapid automatic naming measures of cognition: Normal performance and effects of aging,' *Perceptual Motor Skills* 98/3: 739–53.

Kaplan, E., H. Goodglass, and **S. Weintraub.** 1983. *Boston Naming Test.* 2nd edn. Lea & Febiger.

Kohnert, K. J., A. E. Hernandez, and **E. Bates.** 1998. 'Bilingual performance on the Boston Naming Test: Preliminary norms in Spanish and English,' *Brain and Language* 65: 422–40.

Köpke, B. and **M. S. Schmid.** 2004. 'Language attrition: The next phase' in M.S. Schmid, B. Köpke, M. Keijzer, and L. Weilemar (eds): *First Language Attrition: Interdisciplinary Perspectives on Methodological Issues*. John Benjamins, pp. 1–43.

Lazarev, V. and **L. Pravikova.** 2005. 'The North Caucasus bilingualism and language identity' in J. Cohen, K. T. McAlister, K. Rolstad, and J. MacSwan (eds): *ISB4: Proceedings of the 4th International Symposium on Bilingualism*. Cascadilla Press, pp. 1309–27.

Mohamed Zied, K., P. Allain, K. Pinon, V. Havet-Thomassin, G. Aubin, A. Roy, and **D. Le Gall.** 2004. 'Bilingualism and adult differences in inhibitory mechanisms: Evidence from a bilingual Stroop task,' *Brain and Cognition* 54: 254–6.

Montrul, S. To appear. 'Dominance and proficiency in early and late bilingualism' in C. Silva-Corvalán and J. Treffers-Daller (eds): *Language Dominance in Bilingualism: Issues of Measurement and Operationalization*. Cambridge University Press.

Muñoz, C. and **D. Singleton.** 2011. 'A critical review of age-related research on L2 ultimate attainment,' *Language Teaching* 44/1: 1–35.

Nelson, L. R. and **L. D. Zaichkowsky.** 1979. 'A case for using multiple regression instead of ANOVA in educational research,' *Journal of Experimental Education* 47: 324–30.

Nicholas, M., C. Barth, L. K. Obler, R. Au, and **M. L. Albert.** 1997. 'Naming in normal aging and dementia of the Alzheimer's type' in H. Goodglass and A. Wingfield (eds): *Anomia: Neuroanatomical and Cognitive Correlates*. Academic Press, pp. 166–88.

Olsson, A. and **K. P. H. Sullivan.** 2005. 'Provoking dominance shift in a bilingual Swedish-American English 4-year-old child' in J. Cohen, K. T. McAlister, K. Rolstad, and J. MacSwan (eds): *ISB4: Proceedings of the 4th International Symposium on Bilingualism*. Cascadilla Press, pp. 1750–64.

Ortega, L. 2009. *Understanding Second Language Acquisition*. Hodder.

Pallier, C. 2007. 'Critical periods in language acquisition and language attrition' in B. Köpke *et al*. (eds): *Language Attrition: Theoretical Perspectives*. John Benjamins, pp. 155–68.

Pallier, C., S. Dehaene, J. B. Poline, D. LeBihan, A. M. Argenti, E. Dupoux, and **J. Mehler..** 2003. 'Brain imaging of language plasticity in adopted adults: Can a second language replace the first?,' *Cerebral Cortex* 13: 155–61

Pelc, L. A. 2001. 'L1 lexical, morphological and morphosyntactic attrition in Greek-English bilinguals,' Doctoral dissertation, City University of New York.

Ramscar, M., P. Hendrix, C. Shaoul, P. Milin, and **H. Baayen.** 2014. 'The myth of cognitive decline: Non-linear dynamics of lifelong learning,' *Topics in Cognitive Science* 6/1: 5–42. doi: 10.1111/tops.12078. Epub 2014 Jan 13.

Snodgrass, J. G. and **M. Vanderwart.** 1980. 'A standardized set of 260 pictures: Norms for name agreement, image agreement, familiarity, and visual complexity,' *Journal of Experimental Psychology: Human Learning and Verbal Behavior* 23: 67–83.

Stine-Morrow, E. A. L. and **M. C. Shake.** 2009. 'Language in aged persons' in C. V. Mobbs and P. R. Hof (eds): *Handbook of the Neuroscience of Aging*. Elsevier/Academic Press, pp. 287–92.

Tombaugh, T. N. and **A. M. Hubley.** 1997. 'The 60-item Boston Naming Test: Norms for cognitively intact adults aged 25 to 88 years,' *Journal of Clinical Experimental Neuropsychology* 19/6: 922–32.

Treffers-Daller, J. and T. Korybski. To appear. 'Using lexical diversity measures to operationalize language dominance in bilinguals' in C.

Silva-Corvalán and J. Treffers-Daller (eds): *Language Dominance in Bilingualism: Issues of Measurement and Operationalization.* Cambridge University Press.

Vanhove, J. 2013. 'The critical period hypothesis in second language acquisition: A statistical critique and a reanalysis,' *PLoS One* 8/7: e69172. doi:10.137/journal.pone.0069172.

Wiig, E. H., N. P. Nielsen, L. Minthon, and **S. Warkentin.** 2002. *AQT: Assessment of Parietal Function*. PsychCorp.

Zahodne., L. B., P. W. Schofield, M. T. Farrell, Y. Stern, and **J. J. Manly.** 2014. 'Bilingualism does not alter cognitive decline or dementia risk among Spanish-speaking immigrants,' *Neuropsychology* 28/2: 238–46. doi: 10.1037/neu000014.

Zec, R. F., N. R. Burkett, S. J. Markwell, and **D. L. Larsen.** 2007. 'Normative data stratified for age, education, and gender on the Boston Naming Test,' *The Clinical Neuropsychologist* 21: 599–619.

NOTES ON CONTRIBUTOR

David Birdsong is a Professor of French Linguistics and current chair of the Department of French and Italian at The University of Texas at Austin. He has published in such journals as *Language*, *Journal of Memory & Language*, *Language Learning*, *Studies in Second Language Acquisition*, and *International Review of Applied Linguistics*. He has also contributed to *The New Handbook of Second Language Acquisition*, *Handbook of Bilingualism: Psycholinguistic Approaches*, *The Handbook of Applied Linguistics*, and *The Handbook of Educational Linguistics*. *Address for correspondence*: David Birdsong, Department of French and Italian, University of Texas at Austin, Austin, TX 78712, USA. <*birdsong@austin.utexas.edu*>