1 What Are the Key Concepts?

1.1 Variables Related to Bilingual Language Proficiency

A growing body of research addresses factors that impact first language (L1) and second language (L2) acquisition in sequential bilingual speakers.[1] Wide-ranging questions have emerged from the fields of neuroscience, cognitive and developmental psychology, education, and linguistics, examining key issues and concepts (from each discipline's particular perspective) such as: the neural networks that underlie bilingual language skills; differences in cognitive processes and executive functioning demonstrated by early and late bilinguals; the effects of bilingualism on phonological, morphosyntactic, and lexical-semantic aspects of language; and educational models that further or disadvantage bilingual language functioning for literacy acquisition. Though each discipline frames and tests its questions differently, the puzzle that researchers are attempting to put together generally centers on this piece: What makes bilingual speakers proficient, or not, in each of their languages? Knowledge in this area grows with each study, but findings from different researchers and disciplines at times appear contradictory.

Perhaps the most studied factor in the bilingual language acquisition process is the impact of age of acquisition (AOA) of speakers' languages, a question of special interest when bilingual speakers sequentially acquire an L2 after mastering an L1. Many authors examining levels of bilingual language skill attainment have provided evidence that this factor is a primary predictor for determining "native-like" acquisition of languages (Eubank & Gregg, 1999; Johnson & Newport, 1989; Lahmann, Steinkrauss, & Schmid, 2016; Schmid, 2014; Stevens, 1999; van Boxtel, Bongaerts, & Coppen, 2003; Wartenberger, Heckeren, Abutalabi, Cappa, Villringer, & Perani, 2003; Weber-Fox & Neville, 1996, 1999). According to these studies, younger language learners have an advantage over older learners in terms of the ultimate proficiency level obtained in a given language. This notion, the critical period hypothesis (CPH), is a key, and controversial, consideration in this research: reportedly the existence of critical or sensitive periods for language acquisition (and other areas of cognitive development) implies that there are maturational constraints on skill attainment for languages acquired outside these developmental periods (see Rothman, 2008, for a review; also see Hartshorne, Tenenbaum, & Pinker, 2018, for a recent study in support). However, because native-like attainment

[1] We would like to note that although the topic of simultaneous bilingual language acquisition is related to this subject, we do not specifically address it in this Element. Furthermore, while another growing area of inquiry looks at the effects of the L2 on the L1, this is beyond our scope due to space restrictions.

of L2 skills has been documented in some later L2 learners, other explanations for varied outcomes in L2 ability have been considered (Lahmann et al., 2016). These have included sociological factors, such as educational level and length of residence, and psychological factors, such as motivation. In addition, there is strong evidence for individual variation in L2 learning aptitude, as illustrated in the study conducted by Rimfeld, Dale, and Plomin (2015) involving 6,263 pairs of bilingual twins. The authors posited that such individual differences are genetic in nature.

An alternative view, espoused by Hernandez and Li (2007), has centered on early learning being based on sensorimotor processes, which are readily available to children. Later learning, on the other hand, involves more cognitive processing, which includes areas of the brain involved in higher-level cognition, such as the prefrontal cortex (see Hernandez, Hoffman, & Kotz, 2007; Waldron & Hernandez, 2013, for further discussion). Neuroscience has asked questions and identified effects regarding the neural representations and correlates of bilingual speakers' languages, specifically addressing differences within the brain that appear to be related to early versus later language acquisition (see Vaughn & Hernandez, 2018, for a recent example). The sensorimotor hypothesis has been further developed into a framework, Neurocomputational Emergentism, which conceptualizes development as a series of waves in which brain areas involved in relatively simple cognitive functions become interconnected with each other to take on more complex functions (Hernandez et al., 2019a). Cognitive neuroscientists have evaluated the demands of bilingual language processing and found advantages and disadvantages for bilinguals depending on the task (Schmid & Köpke, 2018a).

Linguists have studied the effects that extent and frequency of L2 use have on the degree of proficiency obtained in that language (Bongaerts, 1999; Flege, Yeni-Komshian, & Liu, 1999; White & Genesee, 1996; Yeni-Komshian, Flege, & Liu, 2000). A later line of inquiry concerns the impact of L1 proficiency on L2 learning. Findings from these studies indicate that a high degree of L1 proficiency positively impacts some aspects of L2 acquisition (Eubank & Gregg, 1999; Flege, Yeni-Komshian, & Liu, 1999; Jiang & Kuehn, 2001). Meanwhile, research on language attrition (or loss of structural aspects of a language) indicates that decreased usage of either language can lead to decreased skills in that language (Bylund, 2009, 2018; Köpke, 2004; Montrul, 1999, 2005). In a review of the literature in this area, Köpke (2004) observed that attrition can occur even when L1 is used to some extent on a daily basis, leading to further questions about whether contact with L2 is also a cause of language attrition. Recent studies in the area provide evidence for a language contact hypothesis (e.g., Kartushina, Frauenfelder, & Golestani, 2016).

Studies attempting to predict or describe relative levels of linguistic skill in bilinguals' languages often display difficulty in defining and measuring language proficiency. Researchers have evaluated language proficiency subjectively and defined it as the ability to converse in a language, as rated by self or others (Cutler, Mehler, Norris, & Segui, 1989). Other researchers have defined proficiency as grammatical ability, or the capacity to perceive and comprehend different units of language, or the level of naming vocabulary (Johnson & Newport, 1989; Oyama, 1976; Perani et al., 1998; Weber-Fox & Neville, 1996). Inconsistency in the definition of proficiency has limited the generalization of findings.

A more recent strand of investigation has noted that different systems of language may be differentially impacted by the varying factors known to have a relationship to language acquisition (e.g., AOA, extent of language use, mode of learning). For example, bilingual speakers who learn English at a younger age will likely demonstrate a more native-like accent in English (Köpke, 2004; Wartenberger et al., 2003) and show more native-like response patterns to speech sounds (Archila-Suerte, Zevin, Bunta, & Hernandez, 2012). Conversely, persons from this group (in this case, Spanish-English bilinguals with early exposure to English) may demonstrate errors in L1 verb formation because their level of use and exposure to Spanish has decreased (Anderson, 1999). The notion that different language domains could interact differently with the variables of interest (e.g., AOA) may limit the usefulness of some results in terms of their ability to provide clear evidence for a factor's general impact on language or proficiency (see Lahmann et al., 2016, for a discussion).

Cummins (1981) proposed a model of language proficiency that differentiates between basic conversational communication skills (those encompassed by grammar, syntax, and pronunciation) and the ability to comprehend and use language for higher-level functioning and reasoning. He postulated that language proficiency is actually a dichotomy of skills, with a distinction being made between basic interpersonal communication skills (BICS) and cognitive/academic language proficiency (CALP). As Cummins (1983) explains it, BICS can be conceived of as the ability to participate in "context-embedded," face-to-face communication such as personal conversations. Conversely, cognitive/academic language proficiency requires the ability to manipulate, use, and understand language in decontextualized settings such as academics. As such, CALP is strongly related to literacy skills (Woodcock & Munoz-Sandoval, 2001); however, CALP emerges from BICS. Utilizing this definition of language proficiency, researchers have developed standardized formal measures of CALP that assess skill level in decontextualized language tasks such as completion of verbal analogies (Woodcock & Munoz-Sandoval, 2001).

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Interestingly, the BICS/CALP distinction lines up nicely with the sensorimotor/cognitive argument put forth by Hernandez and Li (2007).

As can be seen from this brief introduction, current research on the topic of bilingual language development and L2 acquisition supports the notion that there are no simple relationships between the AOA and proficiency in that language, or between language use and language proficiency, or between L1 proficiency and L2 proficiency. The difficulty in measuring or describing these relationships is at least partially due to the fact that there is no simple definition of language proficiency. Another factor that makes investigation of these topics challenging is that other variables such as length of residence or level of education may have as much or more impact on language aspects as the more widely studied variables (DeKeyser, Alfi-Shabtay, & Ravid, 2010) and yet may not be accounted for in the majority of studies. Finally, work looking at genetics found cortical and subcortical dopamine, which is known to play a role in cognitive flexibility, also impacts AOA in the ability to maintain a balanced language proficiency profile in both languages (Vaughn & Hernandez, 2018).

In Sections 2 and 3 of this Element, we provide a focused overview of research considering variables deemed to impact bilingual language acquisition (AOA, language use, and L1 proficiency) and highlight research outcomes from a variety of disciplines, including neuroscience, cognitive psychology, linguistics, and education. With this overview as a backdrop, Section 4 will explore a new avenue of research through an exploratory study which examines the language acquisition of adult Spanish-English bilinguals across a range of domains in their two languages. The study takes into account the primary variables that are known to impact L2 acquisition (AOA and frequency of use) and assesses their impact on bilingual language outcomes likely affected in both languages. The study also incorporates consideration of L1 skills into the L2 proficiency equation (L2 accent and cognitive/academic proficiency). Rather than examining L1 or L2 proficiency independent of the characteristics of the other language, we examine similar aspects of bilingual speakers' two languages and consider the interdependent nature of both languages in light of these variables. In Section 5, we offer a discussion of the study's results and their implications for L2 acquisition, bilingualism, and pedagogy. Our discussion acknowledges that the highly interactive nature of the languages of bilingual speakers is in line with a holistic view of the dynamic, interdependent nature of bilingualism as described by usage-based theories (e.g., Tomasello, 2000) and dynamic systems theories (e.g., de Bot, Lowie, & Verspoor, 2007) and by the conceptualization of bilingual language from a dynamic interactive processing perspective (Hernandez, 2013; Hernandez et al., 2019a; Hernandez, Li, & MacWhinney, 2005; Kohnert, 2004; Kohnert, 2013). The impact of language histories and typologies, a newer area of focus in the exploration of bilingual language acquisition, will also be discussed in connection with the study's findings. Section 6 concludes this Element in which we argue for moving away from a deficiency view of bilingual language skills.

2 What Are the Main Branches of Research?

2.1 Not Two Monolinguals in One Brain

An overview of bilingual research begins logically with a discussion of what is currently understood about the structure and functioning of the bilingual brain. In a seminal article, Grosjean (1989) warned neurolinguists against a monolingual view of bilingualism, affirming that "the bilingual is not two monolinguals in one person!" (p. 3). Grosjean observed in this writing that bilinguals have a "unique and specific *linguistic* [emphasis added] configuration" (p. 3). Ongoing research since has served to extend the concept of the unique configuration of bilinguals to include neurocognitive functioning, as well as encompassing the linguistic and communicative abilities originally considered. For example, in the book *The Bilingual Brain*, Hernandez (2013) states that "two languages live inside one brain almost as two species live in an ecosystem. For the most part they peacefully coexist and often share resources. But they also compete for resources especially when under stress, as occurs when there is brain damage" (p. 12). It is inarguable, then, that bilingual speakers must utilize finite cognitive resources to serve the purposes of storing and communicating information in two (or more) language codes. The question then is: To what extent do languages share geography and resources in the bilingual brain, and to what extent do they compete for available resources?[2]

Francis (2012) described the belief that a complex interdependence of some kind exists between L1 and L2 linguistic knowledge and skills, denoting this interdependence as a set of "cognitive-general competencies" (p. 60). The two language codes emerging from these competencies share cognitive mechanisms, which Baker (2006) has specified as an "integrated source of thought" (p. 170). The elements that comprise this integrated base theoretically include an understanding of how language works, as well as specific linguistic knowledge of the acquired language codes (the extent of the linguistic knowledge depends on the amount of input that the bilingual speaker has had access to in each language). Stemming from this integrated base, knowledge and skills

[2] At this point, we affirm that much of the research described within this manuscript applies to multilingual speakers as well as bilingual speakers, but multilingual speakers are another population meriting specific attention.

should transfer in some degree from one language to another, one mechanism to another, and there is evidence that this does occur (Schmid & Köpke, 2018a).

In contrast to the sharing of resources, competition for resources within the bilingual brain must also be considered (Hernandez, 2013). This issue appears to be more of an overt reality in sequential bilinguals (those acquiring an L2 after developing fundamental competency in a first), and it is true that with the onset of L2 use, the amount of L1 utilized must decrease, which can lead to attrition of L1 skills. Schmid and Köpke (2018a) pointed out that L1 now "begins to exist in a state of co-activation with a competing language system" (p. 644), which can result in decreased efficiency, accuracy, and speed of overall language processing. Another outcome of the competition for resources, these authors point out, is that variations in L1 code conventions may be induced by contact with the other language.

2.2 Neural Correlates of Bilingualism

As we consider the behavioral phenomena attributed to bilingualism, what are the neural correlates that underlie bilingual language functioning? A key consideration is whether or not the language neural network differs for the function of processing two languages versus one language. In an early treatment of this subject, Abutalebi and Green (2007) summarize the evidence for the convergence of the neural representations for L1 and L2. Wong, Yin, and O'Brien (2016), in a thorough discussion of the topic, describe the evidence for a "universal language network" (involving the perisylvian language areas of Broca's area (BA44) in the inferior frontal lobe, Wernicke's area (BA22) in the superior posterior temporal lobe, and the connecting arcuate fasciculus). As detailed by Wong et al., speech production also involves the caudate nucleus, the superior frontal gyrus, and the superior longitudinal fascicle, while reading recruits the fusiform gyrus and the angular gyrus. The authors noted that evidence supports similar brain activations in bilingual speakers for L1 and L2 in the domains of reading, listening, and speech production. However, as the article further explained, the likelihood that the general or "universal" language network is similar across and between languages (in a bilingual speaker) does not preclude substantial differences in the way different subnetworks function for language processes.

One significant way in which monolinguals and bilinguals are believed to differ is in the structure of the caudate nucleus, where bilingual gray matter volume is higher (Zou, Ding, Abutalebi, Shu, & Peng, 2012). Wong et al. attributed this difference to the specialized executive function of controlling and switching between languages, utilized only by those speaking more than one language. Stocco, Yamasaki, Natalenko, and Prat (2012) also detailed the role of subcortical structures (specifically the striatum of the basal ganglia circuit) in controlling language switching in bilinguals. That unique function also likely contributes to differences in connectivity between bilinguals and monolinguals in the frontoparietal network (bilinguals having stronger connectivity), which is involved in cognitive control (see also Grady, Luk, Craik, & Bialystok, 2015). Increased brain volume and connectivity appear to be bilingual characteristics as well for phonological, lexical-semantic, and syntactic aspects of language processing.

An important caveat is highlighted at this point: Differences between monolinguals and bilinguals regarding brain structure and function (activation) appear to be modulated by the variables of AOA and degree of language proficiency. Recent studies have found that simultaneous bilinguals perform better than early and late sequential bilingual speakers (and monolinguals) on tests of verbal and nonverbal working memory (WM; Delcenserie & Genesee, 2017). In considering why this might be the case, insight is provided from Wong et al. (2016), who summarized the results of various findings by noting that "generally, the earlier a language is learned and the higher proficiency is attained in L2, the more grey matter intensity and white matter integrity are observed" (p. 13). The challenge then is to disentangle the effects of AOA from those of proficiency.

In a functional magnetic resonance imaging (fMRI) study among Mandarin-English bilinguals, Nichols and Joanisse (2016) found that AOA uniquely predicted the degree to which the "universal language network" was involved in L2 processing for a picture-matching task that controlled for language proficiency levels. They identified evidence of increased bilateral activation of these regions for subjects with later AOAs and noted additional recruitment of right hemisphere areas for this group in L2 versus L1 conditions of the study, specifically in the right parahippocampal gyrus. This effect was identified in later bilinguals with high degrees of proficiency (but not early bilinguals). The authors explained this finding by observing that the right parahippocampal gyrus might be recruited for additional support of semantic retrieval of L2, as semantic retrieval is a function of the left parahippocampal gyrus. They utilized this evidence to support some separation of functional and structural networks in bilinguals, noting that the results of this study indicate more effortful speech processing as AOA increases. This aligns with the findings by Archila-Suerte, Zevin, and Hernandez (2015), who found evidence of an age effect in processing L2 speech sounds. These authors noted greater activation of the right middle frontal gyrus for early bilinguals, while later bilinguals of all proficiency levels showed greater activation in the left inferior frontal lobe. Liu and Cao (2016), in a meta-analysis of imaging studies addressing bilingual activation patterns, also found more divergent activation patterns for late versus early bilinguals, noting more activation in language "coordination areas" (left superior frontal gyrus) (p. 71) in later bilingual groups. In general it appears that early acquisition of two languages results in increased activation of the "universal language network," or the perisylvian language region – Broca's and Wernicke's area – along with the anterior and posterior segments connecting those regions (Catani, Jones, & Ffytche, 2005). Nichols and Joanisse (2016), in summarizing their findings, postulated that AOA modulates "widespread, whole-brain white matter connections" (p. 23). Functioning over a lifetime as a highly proficient bilingual, therefore, has a significant impact on brain architecture and processing abilities (Grant, Dennis, & Li, 2014).

Proficiency level is a confounding variable in studies of age effects on the bilingual brain. Presumably, an individual who has spoken a language longer (one who began speaking the language at an earlier age) will have as an outcome a higher degree of ultimate attainment, or proficiency, and it may be the case that neural convergence in the classic or "universal" language networks only happens when a high level of proficiency is attained (Wong et al., 2016). Furthermore, it appears that there is a "bilingual anterior-to-posterior and subcortical shift (BAPSS)" (Grundy, Anderson, & Bialystok, 2017) as proficiency increases. That is to say that while less proficient bilinguals with poorer language performance rely primarily on the frontal regions for top-down language processing, highly proficient bilinguals recruit more from posterior and subcortical structures, which are engaged for automatic/motor/sensory and perceptual tasks.

The focus of many studies is to attempt to distinguish between age effects and proficiency effects, and these may be easier to tease apart through functional results versus brain imaging. Outcomes of functional studies regarding proficiency effects have presented a mixed view of its impact according to the area of linguistic processing under examination. Taking a big-picture perspective on this issue, Wong et al. (2016) summarize previous work by noting that "while phonology and syntactic knowledge are generally more sensitive to age effects (earlier AoA = less activation), lexical semantics, on the other hand, is more affected by proficiency levels (higher proficiency = more L1-like activation, generally)" (p. 13). This assertion fits in nicely with Hernandez and Li's (2007) sensorimotor hypothesis.

2.3 Cognitive Functioning, Bilingualism, and Linguistic Interdependence

Can information from neuroscience provide underpinning for Cummin's (1981) model of a "common underlying proficiency" (CUP), or linguistic interdependence? Baker (2006) has apparently adopted that perspective by relabeling CUP as a central operating system, indicating that integrated cognitive functioning makes possible the representation of meaning in two (or more) language systems. One class of evidence that would tend to provide support for Cummin's model is that coming from studies in cross-linguistic transfer. Simply defined, cross-linguistic transfer is "the incorporation of elements of one language into another" (Dominguez, 2013, p. 169.) Schmid and Köpke (2018a) asserted that cross-linguistic influence is bidirectional; they note that when another language is brought into an existing language system, the L1 invariably shapes, constrains, and influences the language acquisition process. Over time, though, and subject to external factors such as language use, language aptitude, and motivation, the L2 produces effects (known as "effects of the L2 on the first," or EotSlotF) which have clear impact on the L1. In sequential bilinguals, the following are possible outcomes of L1 impact: L2-induced changes in L1 grammar; "borrowing" of elements from the L2 lexicon when using L1; "convergence," or the use of a new system which is neither L1 nor L2; "restructuring" of L1 based on L2; and "attrition" (decrease or loss of the ability to generate utterances in L1) (Dominguez, p. 169).

The functional aspects of cross-linguistic influence, when viewed as language competition, are sometimes described as a "bilingual disadvantage"; Schmid and Köpke (2018a) summarized studies describing an advantage for monolinguals over bilinguals in the latency of lexical retrieval. On the other hand, current research appears to point toward stronger executive functioning among bilinguals, probably due to noted differences in connectivity and in the frontoparietal network (Wong et al., 2016). An earlier meta-analysis of 63 studies addressing the connection between cognitive functions and bilingualism found evidence that increased attentional control, WM, metalinguistic awareness, and abstract and symbolic representation skills are associated with bilingual versus monolingual status (Adesope et al., 2010). It must be noted, however, that a later meta-analysis (Donnelly et al., 2015) of 73 comparisons looking specifically at the cognitive capacity to resolve incongruencies in conflict resolution tasks did *not* find conclusive evidence for a clear bilingual advantage (due primarily to methodological issues in the studies included). Therefore, the question of a bilingual advantage in cognition is an open one.

Despite evidence from some studies for a likely bilingual advantage in cognition, a number of authors view transfer effects from L1 to L2 as generally negative, and the terminology that surrounds the concept of language transfer tends to paint a picture of language erosion, particularly in reference to L2 effects on L1. However, the field of bilingual education tends toward another view – that of positive transfer. From this perspective, L1 is seen as a facilitating structure; an "established and organized system of meaning that can be applied to new learning situations . . . In other words, an individual can use concepts that are already well developed in their primary language to facilitate learning and problem-solving in their L2" (Bylund, 2011, p. 6). This Vygotskian perspective, as Bylund continued to explain, focuses on the intersection between thought and language, recognizing that the capacity to transfer information from L1 is a principal resource for the L2 acquirer. Accordingly, this is available to the learner because significant interdependence exists between the L1 and L2 knowledge and skills. However, this idea, original to Cummin's model, appears to be addressing the transfer of well-developed concepts, described by Vygotsky as "verbal thought," rather than superficial aspects of L1 and L2 language codes, which may differ significantly in external characteristics.

There is discussion in the literature regarding how transfer of external language characteristics indeed occurs between L1 and L2. Francis (2012) suggested that recognition of language elements such as word forms that are or appear to be cognates and awareness of similarities and differences between L1 and L2 word-order patterns, phonological patterns, and morphological forms could be considered as direct transfers from one language code to the other. Francis denoted this interaction as a "mutual influence" (p. 60) and noted further that "such interlinguistic transfers do not have to result in target language forms or native-speaker-like accuracy in production to be useful for the L2 learner."

One language modality which has been utilized to exemplify the "central operating system" function of the bilingual brain is that of reading/literacy. Ganan, Hauser, and Thomas (2015) studied the correlation between Spanish fluency and English reading abilities in a sample of sequential-bilingual second and third graders in bilingual classrooms and found that Spanish oral language fluency was a moderate predictor of English reading comprehension abilities. Outcomes differentiated between students with high proficiency in Spanish versus those with lower proficiency. Proficient speakers were five times more likely to meet criterion on the test of English reading comprehension. For our purposes here, this may be understood considering that when students' L1 skills receive support in academic settings that lead to high levels of L1 proficiency, their information-processing abilities advance farther and faster. Instruction in the L1 along with opportunities to hear and use the L2, as opposed to L2-only instruction, permits the development of "academic language skills," including metacognitive and metalinguistic abilities needed for literacy development. Otherwise, as Francis (2012) points out, if content instruction is provided