CHAPTER

3 The Bilingual Brain: Language, Culture, and Identity

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Abstract

This chapter reviews studies of the bilingual brain from a variety of disciplines, employing multiple theoretical approaches and methodologies. For example, developmental psychologists and speech and hearing scientists focus on the development of the bilingual brain in infants and children using cognitive tasks, brain measurements, and observational techniques. Linguists and educational psychologists study the impact of bilingualism on language development and in the society at large with in-depth interviews, longitudinal-observational studies, and parental reports. Social psychologists and cultural scientists investigate the effects of switching languages on thoughts and feelings utilizing self-reports, observational techniques, priming, and laboratory studies. The goal of this chapter is to provide an in-depth analysis of the fascinating world of the bilingual brain, from infancy to adulthood.

Key Words: bilingualism, biculturals, cultural identity, language development, speech perception, executive control, personality, emotion, LENA

Young Henry Lee stopped talking to his parents when he was twelve years old. Not because of some silly childhood tantrum, but because they asked him to. That was how it felt anyway. They asked—no, told—him to stop speaking their native Chinese. It was 1942, and they were desperate for him to learn English.

"No more. Only speak your American." The words came out in Chinglish.

"I don't understand" Henry said in English.

"Hah?" his father asked.

Since Henry couldn't ask in Cantonese and his parents barely understood English, he dropped the matter, grabbed his lunch and book bag and headed down the stairs and out into the salty fishy air of Seattle's Chinatown.

Excerpt from the book Hotel on the Corner of Bitter and Sweet (pp-12–13)

Although the United States has been historically populated by immigrants from all over the world, parents taught their children to speak only English as soon as they arrived in the United States. Parents believed one must speak English to be an American, and that English is the gateway to becoming a part of American society (Fillmore, 2000). However, this trend has changed in recent years. As parents who are raising two bilingual children in the United States, we see that the advantages of bilingualism are beginning to be recognized by the larger society. For example, many of our friends and neighbors mention that they wished their children could become bilingual; and bilingual day care,

immersion schools, and bilingual nannies are very popular among monolingual parents. Not only is this trend apparent in everyday life, there has been increasing scientific interest in understanding the bilingual brain.

In this chapter, we discuss three characteristics of bilingualism: age of second language acquisition, competence in first and second languages, and cultural identity. We first review research on infant bilingualism. This research provides information about the bilingual brain early in development as well as implications for raising a bilingual child. Then, we concentrate on research that has attempted to understand the effects of language mode on perception, personality and emotion in bilinguals. Specifically we discuss the role of culture and cultural identity in the relationship between thoughts and feelings in bilinguals as they alternate between their two languages. This is particularly relevant to the goals of this handbook demonstrating the close coupling of language, culture, and cultural identity, which together influence thought and emotion. Please note that the experience of bilingualism can be different across cultures, and in this chapter we focus on bilingualism from an American perspective. However, we also consider international research, which provides information about the bilingual brain and insight into raising a bilingual child.

Bilingualism and Biculturalism

Bilingualism is the ability of an individual to speak two languages. This broad definition is difficult to operationalize, and researchers have specified a variety of definitions. For example Hamers and Blanc (1989) identify different dimensions of bilingualism, including competence, cognitive organization, age of acquisition, the usage of the second language in the community, social status of the two languages and group membership. In this chapter we ask the question: How does an individual become bilingual? We attempt to answer this question by considering three characteristics of second language acquisition: Age of acquisition, language competence, and cultural identity. Some bilinguals learn two languages simultaneously from birth and are described as simultaneous bilinguals (Genesee, Paradis, & Grago, 2004). For example, our children have been exposed to both English and Spanish from birth: They listen to English from their nanny and Spanish from their parents. In this case Spanish would be considered the children's mother tongue because that is the family language. The mother tongue is the first language and, in the case of our children, English is considered their second language. Simultaneous bilinguals are the focus of many developmental studies since they provide an opportunity to study the effects of exposure to two languages on the representation of language in the brain. Defining simultaneous bilingualism has been a challenge for researchers, which we will discuss later in this chapter.

Second language learners are bilinguals who learn a second language after the mother tongue has been established. We are second language learners. We learned English as a second language in a bilingual school in Mexico after our first language was very well established, around 5 years of age. Although second language learners can become bilinguals at any point in development, there is some consensus that second language learners are those who learn the second language after 3 years of age (Genesee et al., 2004).

Language competency also has various definitions. McNamara (1967), for example, proposes that a bilingual possesses a minimal competence in one of four language skills (i.e., listening comprehension, speaking, reading, and writing) and in a language other than the mother tongue. Simultaneous bilinguals and second language learners may or may not be fully competent in each of their languages. Many bilinguals can speak two languages fluently but have difficulty writing in their second language. For some researchers, the most important characteristic of bilingualism is language competency regardless of age of acquisition. For example, many bilingual studies discussed in this chapter required reading proficiency in both languages from bilingual participants. Other studies required bilingual participants to be competent speaking two languages, focusing on social interactions in which spoken language confidence was required.

Cultural identity is a third characteristic of bilingualism. Bilingualism can also be associated with multiculturalism (LaFromboise, Coleman, & Gerton, 1993). Many simultaneous bilinguals learn two languages while also learning about the cultures associated with the languages. These two cultures may be internalized as part of their identity. Individuals who have been exposed to, and have internalized, two cultures are referred to as bicultural (Benet-Martínez, Leu, Lee, & Morris, 2002, Chapter 13 in this volume). For example, we expect our children to be bilingual (Spanish-English), and also bicultural (Mexican-American). However, not all bilinguals necessarily internalize two cultures.

For instance, in Europe many individuals become second language learners of English and are highly proficient in that language, yet they do not necessarily identify consciously with an English dominant culture. Therefore, they are considered monocultural. Here in the United States, however, many bilinguals are bicultural, and each language is associated with a culture. This is the case in the excerpt *Hotel on the Corner of Bitter and Sweet.* Young Henry Lee is bicultural: English is associated with the American culture, Cantonese with the Chinese culture. Relative ability to speak two languages can be related to the degree that bilinguals "perceive their mainstream and ethnic cultural identities as compatible and integrated vs. oppositional and difficult to integrate" (Benet-Martínez, Leu, Li, & Morris, 2002, p. 9). Bilinguals who have high bicultural identity integration (BII; i.e., they are able to integrate their two cultures and see them as compatible, Benet-Martínez & Haritatos, 2005) are more likely to use the languages of their two cultures in their everyday lives. In contrast, bilinguals who have low BII (i.e., they see their two cultures in opposition and in conflict, Benet-Martínez & Haritatos, 2005) are less likely to maintain the languages of both cultures. In many instances, the integration of two languages and two cultures is related to the degree that the mother tongue is associated with low or high social status. In the United States, English would be the high status language and it is associated with socioeconomic power, whereas Spanish would be the low status language and it is associated with less or no socioeconomic power (Genesee et al., 2004). Thus, language fluency in bilinguals is associated with assimilation of their two cultures, and the social status of first and second languages.

This linkage between culture and language is crucial to investigations of the bilingual/bicultural brain from the perspective of social and psychological phenomena including studies of language as a cultural identity capable of affecting personality and emotion. For example, Hong and colleagues (Hong, Morris, Chiu, & Benet-Martínez, 2000, see also chapter 2 in this volume) showed that biculturals are able to switch their perceptions in response to cultural cues: Chinese-American biculturals display more internal attributions when primed with American icons (e.g., American flag, Superman), and more external attributions when primed with Chinese icons (e.g., Chinese dragon, Great Wall). In this study culture and identity interacted affecting the attributions of bicultural individuals. In many of the studies that will be addressed in this chapter, the bilingual brain is investigated from the perspective of language as a cultural identity. How language influences personality switch in bilinguals and how that switch matches personality differences across cultures. Or how emotions change when using two languages and how those emotions are an expression of their two internalized cultures.

Conclusion. The characteristics of bilingualism just outlined are relevant to the research reported in this chapter (Table 3.1). Bilinguals may learn their two languages concurrently from birth (simultaneous bilinguals), or later in their life (second language learners). They vary in proficiency in each of their languages and may be considered monocultural or bicultural.

Table 3.1 Bilinguals and biculturals: Characteristics and terms used in this chapter.

Characteristics	Types of Bilinguals	Terms Used in this Chapter
Age of Acquisition Genesee et al. (2004)	Both languages were acquired simultaneously from birth.	Simultaneous bilinguals
	Second language is acquired after the first language (or mother tongue) is established.	Second language learners
Competence McNamara (1967)	Individuals who possess a minimal competence in one of four language skills and in a language other than the mother tongue.	Bilinguals who are competent in writing in both languages Bilinguals who are competent in speaking both languages
Cultural Identity Benet-Martínez and Haritatos (2005)	Individuals who identify themselves with one culture and speak two languages.	Monocultural bilinguals
	Individuals who identify themselves to two cultures and speak two languages.	Bicultural bilinguals

Bilingualism in Infancy: Language Development and Cognitive Advantages

In many countries, bilingualism is the norm. For instance, in 2006 the European commission reported that more than 50% of individuals living in the European Union are able to hold a conversation in a second language, and close to 30% are able to use a third language. In contrast, according to the U.S. census 80% of the U.S. population speaks only English at home. Although there has been a steady increase in the number of individuals that speak a second language at home in the past three decades, the United States is a generally monolingual culture. This is surprising since the United States population is largely multicultural. For instance, a recent report from the United States census shows that 50.4% of the population under one year of age were minorities as of July 1, 2011 (Bernstein, 2012). What accounts for this combination of monolingualism and multiculturalism?

One reason, discussed earlier, is the relatively lower status of a non-English mother tongue, which may cause families and institutions to suppress the lower status language (Genesee et al., 2004; Hamers & Blanc, 1989). However, the most salient reason may be the prevalent misconception that learning two languages will cause speech and cognitive delay (King & Fogle, 2006). For example, until recently switching back and forth between their two languages in simultaneous bilinguals, sometimes called *code-switching*, was interpreted as a sign of confusion (Werker & Byers-Heinlein, 2008). Parents, therefore, instructed their children to speak only the dominant language, even when communication was disrupted within the family, as was the case with young Henry Lee. Although simultaneous bilinguals effortlessly acquire two or more languages early in life, some parents and educators still view bilingualism as an impediment in language development. Petitto and colleagues called this phenomenon "the bilingual paradox" (Petitto, 2009; Petitto, Katerelos, Levi, Gauna, Tetreault, & Ferraro, 2001). This idea of "language contamination" (i.e., exposure to another language before the first language is fully established) is reflected in contemporary educational practice (Crawford, 1999). For instance, in the United States, many children start formal instruction in another language in high school, after they have already established their first language (Petitto, 2009). Because opportunities to learn second languages in schools are limited for young children in the United States, it is more difficult for parents of bilingual children to support their cultural traditions by maintaining and expanding their children's proficiency in the mother tongue. As a result, most children become English dominant or English monolingual when they start their school years (Fillmore, 2000).

In this section, we discuss research that has emerged in recent years questioning the notion that bilinguals experience difficulties due to early exposure to two languages. Specifically, we review investigations that compared monolingual and bilingual infants and children at different stages in their language development—from the perception of speech sounds to the production of words. Do bilinguals perceive speech sounds differently than monolinguals? Is vocabulary growth faster in monolinguals than bilinguals? Although the answers to these questions are not simple and straightforward, they have provided insight into similarities and differences in monolingual and bilingual speech and language development. Furthermore, we also review research that showed some cognitive advantages for simultaneous bilinguals and second-language learners.

Speech production in monolingual and bilingual children

The idea that learning two languages will affect developmental milestones of speech and language in the bilingual child is a misconception that persists among parents and educators (De Houwer, 1990). Empirical studies carried out in recent years examined the effects of learning two languages on language development in the bilingual child. The results from these studies have shown that monolinguals and bilinguals do not differ in the achievement of developmental milestones in a variety of areas, from babbling (Oller, Eilers, Urbano & Cobo-Lewis, 1997) to word production (e.g., Holowka, Brosseau-Lapré, & Petitto, 2002; Pearson, Fernández & Oller, 1993; Petitto et al., 2001).

Oller and colleagues (1997) carried out a longitudinal study of the effects of early bilingual experience on early babbling, known to be related to later speech development (e.g., Oller, Eilers, Neal, & Schwartz, 1999). Monolinguals and simultaneous bilinguals were recruited at four months and followed until they were one-and-half years old. Monolinguals and bilinguals did not differ in canonical babbling (or production of well-formed syllables). Other studies have reached similar conclusions when comparing vocabulary in monolingual and simultaneous bilingual children.

Researchers often use the MacArthur-Bates Communicative Development Inventory (CDI)

(Fenson et al., 2007) to assess language development. This survey has been proven to be reliable and valid for children between the ages of 8–36 months. Parents report the number of words the child produces based on the vocabulary checklist section of the CDI. The CDI also measures other communication skills in different sections such as First Communicative Gestures and Sentence Complexity. The CDI has been translated to other languages and current research has shown that if both languages are included when comparing the vocabulary to monolingual norms, then bilinguals show the same developmental pattern as monolinguals. For example, vocabulary size in Spanish-English bilinguals' is comparable to monolinguals when words in both Spanish and English are combined to assess total vocabulary (e.g., Pearson et al.,1993). More recent studies show that the first-word milestone and first-50-word milestone are commensurate to the monolingual norms in simultaneous bilinguals if first and second language vocabularies are combined (Holowka et al., 2002; Petitto et al., 2001).

We also replicate the preceding findings in CDI data we collected as part of an ongoing large-scale study at the Institute for Learning & Brain Sciences (e.g., García-Sierra, Ramírez-Esparza, & Kuhl, 2010; Ramírez-Esparza, García-Sierra, & Kuhl, 2010; ~~2012~~). Specifically, we collected CDI Words and Sentences surveys from English monolingual infants (N = 26) and Spanish-English bilingual infants (N = 21), at five different points: when the participants were 18, 21, 24, 27, and 30 months old. The monolingual families filled out the English version of the CDI, and the bilingual families filled out both the English and Spanish versions of the CDI. The number of words produced was based on the vocabulary checklist section of the CDI in English and in Spanish.

The results showed that monolinguals produced significantly more words in English than the bilinguals across the five ages measured (see Figure 3.1, Graph A), but if words produced in English and in Spanish are summed for the bilinguals, then both groups show similar patterns of language development (see Figure 3.1, Graph B). These results are consistent with previous work demonstrating that linguistic milestones are comparable in monolinguals and bilinguals when both languages are included (Holowka et al., 2002; Pearson et al., 1995, Petitto et al, 2001). Please note that there are multiple approaches to creating combined language measures in bilinguals. The data reported in Figure 3.1 summed the words produced in English and Spanish. Other investigators have employed word quantification from video-recorded interactions among parents and their infants (e.g., Holowka et al., 2002; Petitto et al., 2001). Another approach utilizes translations equivalents—words in each language that refer to the same concept (e.g, *water* in English and *agua* in Spanish). The average percentage of translation equivalents at the first-50-word milestone in bilingual infants is approximately 30% (Pearson et al., 1995; Petitto et al., 2001). Researchers argue that the fact that

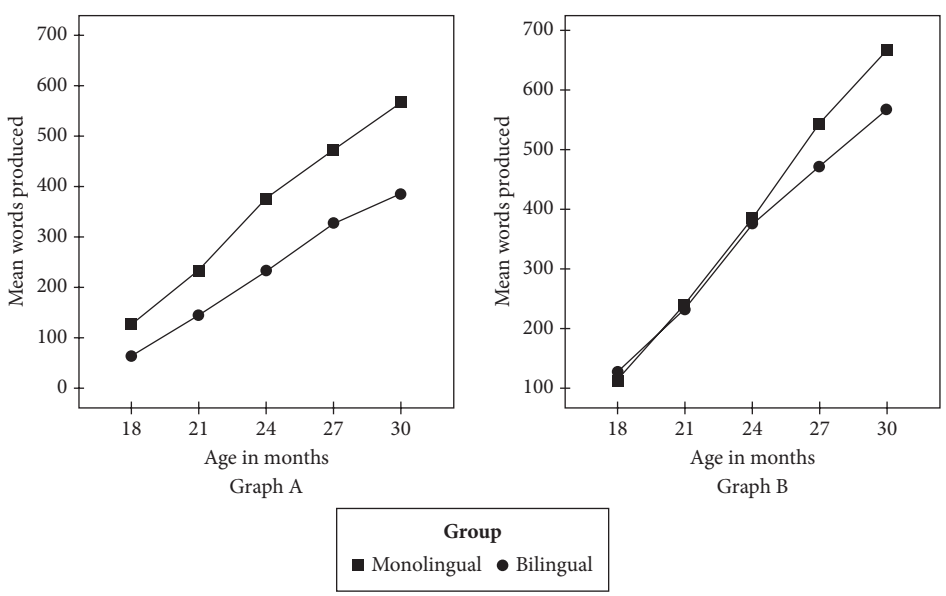


Figure 3.1 Word count for monolingual and bilingual infants across time.

bilinguals are able to use different words for the same concept demonstrates that bilinguals are able to separate their two language systems and do not confuse them (Holowka et al., 2002; Pearson et al., 1995, Petitto et al, 2001). The research on word production in bilingual children has been pivotal in the ongoing slow improvement of negative attitudes toward bilingualism in early childhood; however, there are still some concerns about bilingualism in children with disabilities in speech and language. It has been argued that children with language impairments are not capable of learning two languages. However, Paradis, Crago, Genesee, and Rice (2003) find that monolingual and bilingual children with language impairments do not differ in their acquisition of language morphology at 7 years of age. This suggests that children with language disabilities who are learning two languages may not be disadvantaged in comparison to those with similar language disabilities who are exposed to only one language.

Conclusion. Studies of speech production in bilingual infants and children demonstrate that they are similar to their monolingual counterparts in the achievement of developmental milestones. Language acquisition, however, begins with speech perception long before the production of the first word. Thus, there is strong interest in speech perception of preverbal simultaneous bilinguals, especially the representation of speech sounds in bilingual infants and its relationship to later word production. We focus on the studies in this area that employ electrophysiological methods; however, there is a substantial body of work using behavioral methods (see Werker & Byers-Heinlein, 2008 for review).

Speech perception and speech production in monolingual and bilingual infants

Research has shown that exposure to a particular language reduces infants' abilities to discriminate speech sounds foreign to that language. Infants around 6-months of age are able to discern differences among the phonetic units used in the worlds' languages (Eimas, Siqueland, Jusczyk, & Vigorito, 1971). For example, American and Japanese infants are equally good at discriminating the acoustic properties that distinguish the sound "ra" from "la" when they are 6 months, but Japanese infants lose this ability as they grow older because "la" is not part of their native language. Researchers interpret this as evidence of neural commitment during the first year of life, with infants showing increasing sensitivity to native speech sounds and decreasing sensitivity to non-native speech sounds (Best & McRoberts, 2003; Kuhl, Stevens, Hayashi, Deguchi, Kiritani, & Iverson 2006; Werker & Tees, 1984; for reviews see Kuhl et al., 2008 and Werker & Curtin, 2005). Neural commitment depends on language exposure: The more infants are exposed to their native language, the faster they will lose their ability to perceive non-native sounds. This view leads to the prediction that infants whose early discrimination abilities are better for native as opposed to non-native contrasts will initially show more rapid language development than infants who continue to show sensitivity to contrasts that do not occur in the native language. Researchers first tested this hypothesis using a behavioral method, the well-established conditioned head-turn procedure, in which the infant is conditioned to turn his head in response to a change in speech sounds (see Kuhl, 1985; Werker, Polka, & Pegg, 1997). Infants who show commitment to their native language at 6 months produce more words when they are two years of age (Kuhl, et al., 2008; Tsao, Liu, & Kuhl, 2004).

The association between neural commitment and word production was confirmed in follow-up studies in which event-related brain potentials (ERPs) were used (Kuhl et al., 2008; Rivera-Gaxiola, Klarman, García-Sierra, & Kuhl, 2005). Event-related brain potentials provide some advantages over behavioral methods; it controls for potential contribution of cognitive factors, such as attention, to experimental results. Discriminatory abilities in ERPs are measured by means of phonetic changes in the form of the mismatch negativity (MMN) in both infants and adults (e.g., Näätänen et al., 1997; Cheour et al., 1998; Rivera-Gaxiola, Silva-Pereyra, & Kuhl, 2005; Rivera-Gaxiola et al., 2007). The MMN is elicited by presenting a repetitive sound that establishes an auditory memory trace for that sound. Then, a new sound that differs from the memory trace (in frequency, localization, duration, intensity, etc.) is presented. The degree of deviance between the memory trace and the new sound is reflected by the ERP amplitude, so that the MMN response increases as the acoustic differences between standard (memory trace) and deviant increase (Tiitinen, May, Reinikainen, & Näätänen, 1994).

The ERP studies showed that the ability to discriminate native speech sounds in infancy was related to later word production. Interestingly the ability to discriminate *non-native* speech sounds was related *negatively* to later word production (Kuhl et al., 2008; Rivera-Gaxiola, Klarman et al., 2005).

That is, if infants are still uncommitted and "open," as evidenced by better non-native speech sound discrimination, then language advancement is slower. This pattern of perceptual change raises questions regarding the development of speech perception in infants who are exposed to two languages. Do bilinguals follow the same pattern as the monolinguals?

García-Sierra et al. (2011) carried out an electrophysiological study of neural commitment to both native languages in simultaneous bilingual infants and compared them to a monolingual group. They recruited Spanish-English bilingual families from the San Antonio, TX area and assessed bilingualism using a questionnaire administered during in-home interviews. The questionnaire included questions about the amount of exposure to English and Spanish the infant received from the nuclear family, extended family and other adults living in the home. Infants' brain responses were assessed using electrophysiology while they listened to native and non-native speech sounds. Discriminatory abilities were assessed by means of the MMN (mismatch negativity). The results revealed that bilingual infants do not show the same pattern of commitment to the speech sounds of their native languages (i.e., Spanish and English) seen in monolinguals (Rivera-Gaxiola, Silva Pereyra et al., 2005; Rivera-Gaxiola, Klarman et al., 2005). This suggests that bilinguals remain more "open"—that is, less neurally committed—compared to monolingual infants at the same time in development. This investigation also replicated the relationship between neural commitment and later word production. That is, bilingual infants who showed more commitment to English speech sounds produced more words in English as toddlers. Likewise, infants who showed more commitment to Spanish speech sounds produced more words in Spanish as toddlers. One interesting finding of this investigation was the relationship between language exposure and neural commitment. Infants who had high exposure to English were better able to discriminate native English sounds, whereas infants who had high exposure to Spanish were better able to discriminate native Spanish sounds.

In a recently published study, Petitto and colleagues (~~Petitto et al.,~~ 2012) also found that bilingual and monolingual infants show a different developmental pattern in a neuroimaging study. Petitto et al. recruited monolingual and bilingual infants from different age groups: younger (i.e., approximately 4 months of age) and older (i.e., approximately 12 months of age). Bilingual infants were defined by rigorous assessment and validation of parental language input. Parents completed an on-line screening questionnaire, an extensive bilingual background questionnaire and were also assessed by experimenters in the lab. All participants listened to either native or non-native speech sounds, whereas their neural activity was assessed using functional near-infrared spectroscopy (fNIRS). The fNIRS is similar to its well-known cousin, functional magnetic resonance imaging (fMRI), but with some key advantages. The fNIRS is portable and virtually silent; it is also more comfortable for participant families—the infant can sit on their parent's lap as their brain activity is being measured. The results of this investigation showed that there was robust neural activation in the left superior temporal gyrus across language group and age, which Petitto and colleagues describe as the area attuned to the basic units of language. On the other hand, the left inferior frontal cortex (which includes Broca's area) showed a difference for age and group. Specifically there was an increase in neural activation in the left inferior frontal cortex in the older, compared to younger, monolingual and bilingual infants. Furthermore, for the older bilingual infants, this area of the brain showed activation for both native and non-native speech sounds, whereas the monolingual infants showed robust activation only for the native speech sound, and not for the non-native speech sound. This latter finding provides evidence that bilingual infants remain uncommitted to their native speech sounds and open to language input for a longer period of time than monolingual infants.

We propose here that in order to better understand the bilingual brain in simultaneous bilinguals, other variables must be taken into account, such as socioeconomic status and the amount and characteristics of language input to infants. For example, in a recent study we found a relationship between language input to infants in everyday natural social interactions and language development (Ramírez-Esparza et al., ~~2012~~). Our results show that increased exposure to "~~motherese~~" (i.e., higher pitch, slower tempo, and exaggerated intonation contours, Grieser & Kuhl, 1988) and increased interaction in a one-on-one context (i.e., infant is alone with the parent) in infancy results in larger productive vocabulary when children are toddlers. On the other hand, increased exposure to adult-directed speech (i.e., normal, everyday voice) and increased interaction in a group environment (i.e., the infant and the parent are with other people) results in a smaller productive vocabulary.

Previous work by García-Sierra et al. (2011) described earlier is, to our knowledge, one of the few studies that has attempted to understand the bilingual brain in infancy by combining contextual variables (e.g., language exposure at home) with brain measures. However, in order to investigate speech perception and speech production in bilinguals, it is important to assess language exposure in a systematic way in order to capture broader contextual variables (Werker & Byers-Heinlein, 2008). In our lab, we implemented LENA technology (LENA foundation, Boulder Colorado) to assess language exposure in monolingual and Spanish-English bilingual families. The LENA system includes a digital language processor (DLP) that can store up to 16 hours of digitally recorded sound. The DLP weighs 3 ounces and can be snapped into a chest pocket in children's clothing, allowing the recorder to be "out of sight, out of mind." The audio recordings are downloaded to a computer and analyzed by LENA software to characterize the acoustic environment over time, allowing efficient identification of segments with language activity, which are then coded for social behaviors. We can quantify the numbers of words that the infants heard in both English and Spanish, yielding a more accurate assessment of language exposure as well as other social variables (Ramírez-Esparza et al., 2010, ~~2012~~). The goal is to understand the bilingual brain in infants by combining language input, brain measurement of speech perception, and later word production (Box 3.1). This will permit investigation of the relationship between language exposure and neural commitment to non-native speech sounds in bilingual infants. The overall approach will allow comparison of speech and language development in monolingual and bilingual infants, identifying similarities and differences.

Conclusion. In this section we discussed attempts to understand the bilingual brain by investigating the perception of speech sounds in preverbal infants. These studies suggest that the bilingual brain remains more open (not neurally committed) for a longer period of time than the monolingual brain. Importantly, the terms *open* and *uncommitted* do not suggest that bilinguals show delayed language development; rather they indicate that bilingual and monolingual infants differ in the pattern of early commitment to the sounds of their native language(s). In this section, we also propose that by using advanced technologies, such as LENA, we can capture more information about the bilingual environment, which will shed some light about the bilingual brain.

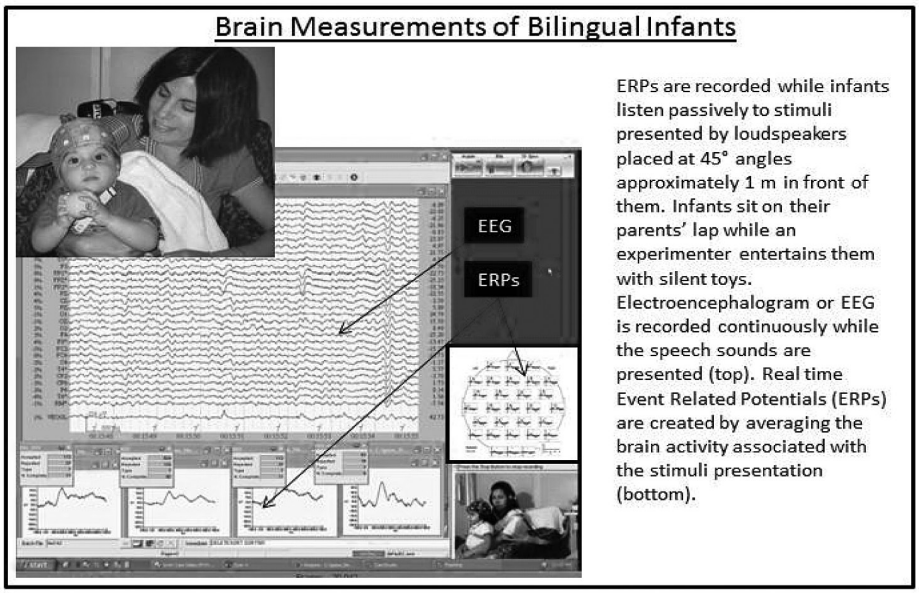
Advantages of bilingualism: Executive Control

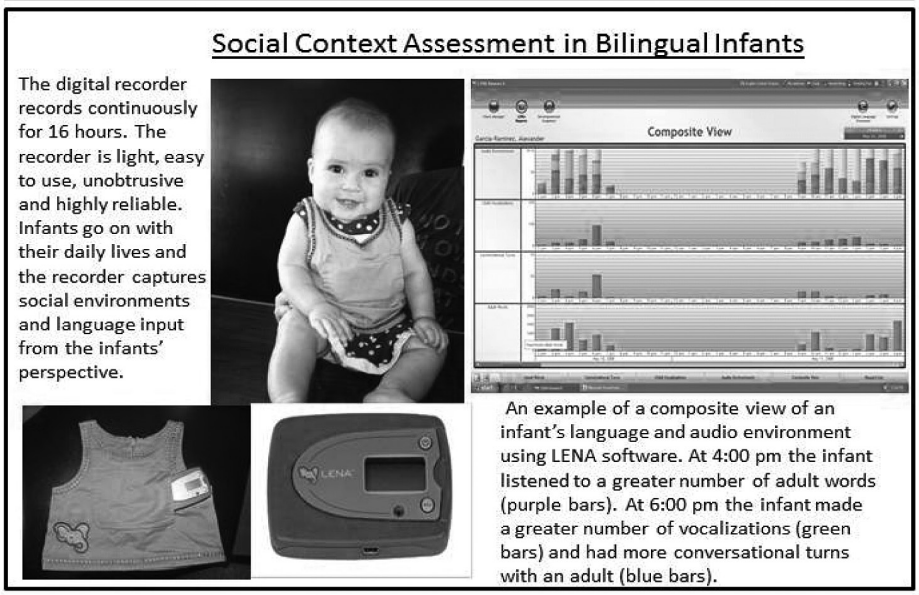
Although research has shown that bilinguals do not have an advantage or disadvantage in language development compared to monolinguals, studies over the last four decades have shown cognitive advantages in bilinguals. Specifically, studies since the early 1960s have reported that bilinguals have increased mental flexibility compared to monolinguals (e.g., Peal & Lambert, 1962). Bialystok and colleagues called this cognitive advantage *executive control* and they define it as "the set of cognitive skills based on limited cognitive resources for such functions as inhibition, switching attention and working memory" (Bialystok, Craik, & Luk, 2012, p. 241).

In a classic study, Bialystok (1999) finds that bilingual children show an advantage in solving problems that require construction of complex representations of rules. She recruited Mandarin/Cantonese-English bilingual preschoolers who were as competent in English as a group of monolinguals who also participated in the study. The task consisted of sorting cards into two different containers according to different criteria using a target stimulus. For instance, one container would have the target stimulus of a red circle, and another container the target stimulus of a blue square. The children are given a set of cards with red circles or blue squares and they are asked to sort the cards according to color (e.g., to sort all the red cards in the container with the red stimulus or all the blue cards in the container with the blue stimulus). After completing this task children are asked to sort according to shape (e.g., to sort all the circles in the container with the stimulus circle or all the squares in the container with the stimulus square). The sorting tasks are counterbalanced so that half of the participants sort according to shape first, and half of the participants sort according to color first. The challenge of the task is to follow the second instruction. Typically it is extremely difficult for children to sort the cards according to the second criterion; they use the first criterion to sort the cards even after the instructions have been changed. The results of this study showed that bilinguals performed better on this task than the monolinguals.

In another classic study, Bialystok (1988) finds that bilinguals outperform monolinguals in an arbitrariness of language task. Children of approximately 7 years of age were tested on their ability to understand the arbitrary connection between linguistic form and reference in the world. The task consisted of telling the children "suppose

Box 3.1 Understanding the Bilingual Brain: Assessing Infants' Language Development Using Multiple Techniques





you were making up names for things, could you then call the sun 'the moon' and the moon 'the sun' (p. 562). The children were persuaded that this was possible and then they were told, "Now suppose that happened and everybody decided to call the sun 'the moon' and the moon 'the sun'" (p. 562). Then the participants were given points if they correctly gave the answer "sun" when they were asked: What would you call the thing in the sky when you go to bed at night? And the answer "dark" when they were asked what would the sky look like when you are going to bed? Bilinguals outperformed monolinguals in this activity. Bilingual children are constantly alternating between their two languages systems that label the same conceptual system, providing a cognitive advantage when they interchange labels to name the same concept (Bialystok, 1988).

A recently published study Barac and Bialystok (2012) demonstrated that the advantages of bilingualism in executive control were not related to other variables that may themselves influence

performance. For example, it has been suggested that Asian children may have an advantage on tests of executive control (Sabbagh, Xu, Carlson, Moses, & Lee, 2006). The authors recruited bilingual 6-year-olds (English plus Chinese, Spanish, or French) and compared them with an English-speaking monolingual group. The comparison of the Chinese-English bilingual group with the other bilingual groups allowed testing the idea that cultural background could have an effect on performance. Likewise all groups were matched for socioeconomic status to control for the possibility that this variable influenced executive control. The results showed that all bilingual groups performed better at a color-shape switching task than the monolinguals. Furthermore, there were no differences among the bilingual groups.

Most studies of executive control have studied children; however, Sebastián-Gallés and colleagues (Sebastián-Gallés, Albareda-Castellot, Weikum, & Werker, 2012) recently published a study demonstrating cognitive advantages in bilinguals over monolinguals as early as 8 months of age. The authors assessed the capacity of Spanish-Catalan bilinguals and Catalan monolinguals to discriminate French and English by watching silent video-clips of speakers' faces. The results showed that bilinguals are able to discriminate change in language much better than monolinguals. Moreover, Spanish-Catalan bilinguals and French-English bilinguals (a sample assessed in a previous study by Weikum et al., 2007) are equally good at the discrimination task. The authors interpreted the fact that Spanish-Catalan bilinguals are good at discriminating non-native languages as evidence of a perceptual attentiveness advantage of bilinguals over monolinguals. They also concluded that their results show that bilingual infants are not at risk for confusing their two languages, and are better prepared than monolinguals to discriminate two unknown languages.

Conclusion. In this section we discussed the advantages of speaking two languages. We provided examples of studies that have shown that bilinguals have the ability to resolve tasks that require them to manage attention, to understand concepts such as the difference between form and meaning, and to resolve problems requiring attention to the task while ignoring misleading information. Indeed, the advantages of executive control among bilinguals are now well established in the literature. Adesope and colleagues, for example, show medium to large effect sizes in a recent meta-analysis (Adesope, Lavin, Thompson, & Ungerleider, 2010). Why is bilingualism related to executive control? Bialystok et al. (2012) reviewed studies using various methodologies (e.g., EEG, fMRI, magnetoencephalography or MEG) to understand the neural correlates that may help explain the relationship between bilingualism and cognitive control. They conclude that "lifelong experience in managing attention to two languages reorganizes specific brain networks, creating a more effective basis for executive control and sustaining better cognitive performance throughout the life span (p. 241)." Research investigating the effects of bilingualism on the onset of dementia and other age-related diseases is consistent with this interpretation of the neural correlates of bilingualism. Bialystok, Craik, and Morris (2007) collected data from monolingual and bilingual people with dementia. The results were staggering: Symptoms started to appear in the bilingual people 4 years later than their monolingual peers. These findings were replicated on a sample of people with Alzheimer's disease—bilinguals had a 5-year delay in the onset of symptoms (Craik, Bialystok, & Morris, 2010).

Although early research on executive control in bilinguals was published three decades ago, media interest has just begun. Bialystok was interviewed by Catherine de Lange, a reporter for the *New Scientist,* in May of 2012 and said "For 30 years I've been sitting in my little dark room doing my thing and suddenly in the last five years it's like the doors have swung open." Indeed de Lange's report titled *One brain*, *two minds: The Surprising Impact of Speaking Another Language* was featured in the cover of the *New Scientist* magazine (de Lange, 2012). In the same month, the cover story in the *Observer* was *Speaking Your Mind: Bilingual Language*, *Culture*, *and Emotion* (Fields, 2012). As Americans are learning about the benefits of bilingualism they are beginning to show an interest in raising their children bilingually. If raising bilingual children becomes a laudable family goal in the United States, it is possible that opportunities for early instruction in a second language will become more available in schools and negative stigmas about non-English languages will change in the near future.

Bilingualism in adulthood: Language context and the bilingual brain

Although there is evidence that fluent bilinguals show activation of both languages and some interaction between their languages at all times, there are contexts that activate one language more than the other. Grosjean (2001) proposes that bilinguals function along a continuum that reflects the state of

activation of a given language at a given point in time during their everyday activities. At one end of the continuum, bilinguals are in monolingual mode and at the other end of the continuum, bilinguals are in bilingual mode. In the monolingual mode, bilinguals use one language while deactivating the other language to the greatest extent possible. In the bilingual mode, bilinguals choose a base language and activate the other language as needed. However, and importantly, Grosjean hypothesizes that bilinguals are governed by a "base language" that controls language processing at any given time. Therefore, in Grosjean's view, bilinguals must be immersed in a specific language to establish the "base language." In this section, we discuss studies of language-mode activation in bilinguals by immersing them in the language of interest, investigating the influence of language mode on speech perception, as well as more advanced constructs such as personality and emotions.

Speech Perception Switch in Bilinguals

Studies assessing bilingualism and speech perception seek to understand whether bilinguals have two language systems or a single language system. Perceptions of speech sounds are used to investigate this complex idea because they are typically perceived categorically (Liberman, Harris, Kinney, & Lane, 1961). The acoustic information in speech sounds is perceptually grouped into phonetic categories. For example, Abramson and Lisker (1967) demonstrated that the interval between the release of the articulation and the onset of voicing (voice onset time or VOT) differentiates /b-p/, /d-t/, and /g-k/. They also showed that speakers of different languages categorize these speech sounds differently. Accordingly, Abramson and Lisker (1967) synthesized a total of 37 speech sounds, varying in physically equal VOT steps, and presented the speech sounds to monolingual speakers of different languages. The results showed that listeners grouped the speech sounds into no more than three phoneme categories. Interestingly, the listeners' native language influenced category boundaries. These findings suggested two things: First, the ability to discriminate a set of stimuli varying along one dimension is limited to the ability to identify them as different sounds (Liberman et al., 1961). Second, native language influences the way speech sounds are categorized in individuals. Later research has supported the finding that native language deeply influences the way speech sounds are perceived (Best, McRoberts, & Sithole, 1988; Kuhl, Williams, Lacerda, Stevens, & Lindblom, 1992). If native language influences the perception of speech sounds, then how do bilinguals with two language systems perceive speech sounds?

Research assessing bilingualism and speech perception began in the seventies studying the effects of language context on perception across a continuum of speech sounds in bilinguals. Researchers hypothesized that the perceptual boundary dividing a voiced-voiceless continuum would be consistent with the language a bilingual subject was using at the moment. That is, researchers asked if bilinguals show a double phonetic representation. Caramazza, Yeni-Komshian, Zurif, and Carbone (1973) asked bilingual speakers of French and English to identify the same set of speech sounds in two conditions. In one experimental session, English was emphasized by having a brief conversation in English before the experiment, whereas, in the second session, the conversation occurred in French. Monolinguals, on the other hand, were only exposed to English conversations before the identification task. The results showed no differences in bilinguals' perceptual boundaries across language contexts; however, bilinguals' phonetic boundaries were at intermediate VOT values compared to those of monolingual speakers of English and French. Williams (1977) showed a similar result; that is, bilinguals differed from the monolinguals, but their phonetic boundaries did not change across language contexts.

However, follow-up studies suggested that the double phonetic boundary might emerge if bilinguals are focused on the language of interest throughout the entire experiment. In order to accomplish this focus, researchers used precursor sentences in the language of interest (e.g., *Which sound do you hear?* see Elman, Diehl, & Buchwald, 1977). Indeed, phonetic boundaries do shift depending on the language context established by precursor sentences (Flege & Eefting, 1987; García-Sierra, Diehl, & Champlin, 2009; Hazan & Boulakia, 1993). However, Bohn and Flege (1993) found that language context shifted the voicing boundary in a similar way for both bilinguals and monolinguals. These results suggested that the shift in the voicing boundary might be the consequence of biases caused by precursor sentences.

In order to control for biases that may be caused by precursor sentences, researchers investigated bilingual's access to their language systems using ERPs. Specifically García-Sierra and colleagues examined whether the relationship between language mode and speech perception observed in behavioral tests persisted during ERP testing, when bilinguals do

not attend to the speech sounds (García-Sierra, Ramírez-Esparza, Silva-Pereyra, Siard, & Champlin, 2012). Speech perception was assessed in the form of the mismatch negativity or MMN. The results showed that the MMN changed as a function of the language context. For example, when bilinguals were reading Spanish, the new sound was perceived as belonging to a different category (i.e., there was an MMN response); but when bilinguals were reading English, the same new sound was *not* perceived as belonging to a different category (i.e., there was no MMN response). These results provide evidence that the basic sounds of a language can be processed differently by the bilinguals depending on language mode.

Peltola and colleagues (Peltola, Tamminen, Toivonen, Kujala, & Näätänen, 2012) also tested the idea that the perception of speech sounds in bilinguals depends on the language context. However, in this investigation, different types of bilinguals were assessed: Simultaneous bilinguals and second language learners. The authors hypothesized that simultaneous bilinguals have a single system and, therefore, their perception of sounds would not be influenced by the language context, whereas second language learners would be more strongly influenced by the context, and their perception of speech sounds would change accordingly. They collected ERPs from Finnish-Swedish simultaneous bilinguals and Finnish second language learners of Swedish while they listened to a standard and a deviant speech sound in an oddball paradigm (i.e., the standard is presented repetitively and the deviant is presented infrequently). The speech sounds were members of the same category in Swedish, but members of different categories in Finnish. As in García-Sierra and colleagues' study (2012), an MMN indicated the two sounds were perceived as belonging to *different* categories (in this case in the Finnish language context, because the two sounds are in different categories in Finnish); in contrast, the MMN would be absent if the two sounds were perceived as belonging to the *same* category (in this case in the Swedish language context because the two sounds are in the same category in Swedish). The results confirmed the authors' hypotheses: the MMN was stronger in the the second language learners of Swedish in the Finnish language context.

Conclusion. Researchers in the area of speech perception and bilingualism are attempting to understand how bilinguals access their language systems. The basic idea is that bilinguals alternate between their languages, depending on the language mode. The original and later studies that tested this idea using behavioral techniques showed contradictory findings. However, recent studies, using electrophysiological measures, show that bilinguals do, indeed, alternate between their languages according to the language mode. That is, bilinguals' brain responses are more like a Spanish-speaker when they are inmersed in a Spanish language context and more like an English-speaker when they are inmersed in a English language context (García-Sierra et al., 2012). However, Peltola and colleagues (2012) provide an intriguing theory, that simultaneous bilinguals have merged their two language systems so that they no longer switch between language modes. It is as if they are always in bilingual mode (Grosjean, 2001). Research in this area is just beginning, and more important questions remain. For example, what is the effect of immersing *monolinguals* in two language modes? Do their brain responses also switch? Recall that, in a behavioral study, monolinguals also showed a switch associated with language context (Bohn & Flege, 1993). Therefore, more studies establishing language modes in monolinguals are also important in the understanding of the bilingual brain.

Personality Switch in Bilinguals

When we moved from Mexico to Austin, TX to start our PhD programs, we had the opportunity to interact for the first time with people who were simultaneous Spanish-English bilinguals. It was striking to observe students shift between their languages with ease. It was even more interesting to observe how their behaviors changed when they were speaking English or Spanish. I asked simultaneous bilinguals if they felt differently when they spoke English and when they spoke Spanish. Virtually all said that they felt their personality changed as they switched between languages. Dewaele and Pavlenko (2001–2003) asked this question in a systematic way. They conducted an online study in which 1039 informants responded the question "Do you feel like a different person sometimes when you use your different languages?" Of those questioned, 65% gave affirmative answers. Likewise, Ozanska-Ponikwia (2012) provided some interesting examples from writers who describe being a different person while using different languages:

> Green (1993) and Tzvetan Todorov (1994) show that the same story takes a very different shape when writing in two languages. Green (1993, [p]. 62) writes that there was so little resemblance between the texts describing the same thing in English and French that

> it might be doubted that the same person wrote those two pieces of work. (p. 218)

Although the experience of feeling like a different person when switching languages is commonly reported in bilinguals, this idea has been empirically tested only in the last decade. In fact, when I began studying this topic, I found only two studies that specifically addressed the question: Do bilinguals change personality when they alternate languages? Ervin (1964) examined whether French-English bilinguals showed different personalities when responding to the Thematic Apperception Test (TAT) in English versus French. Her results showed that bilinguals use different themes when responding to the TAT, depending on language. For example, bilinguals use more verbal aggression toward peers in French stories than in English stories. She suggested that was a reflection of French educational practices, which emphasize the use of oral argument in defense of insults from others. Hull (1996) evaluated personality changes in Spanish-English bilinguals responding to the California Psychological Inventory (CPI). The results demonstrated a relationship between personality switch and language use. For example, bilinguals' scores in the *Good Impression* factor were higher in Spanish than in English. Hull speculated that this is due to greater concern about interpersonal harmony and pleasing others in the Spanish-speaking culture, as in other collectivist cultures (Marín & Marín, 1991). Although these two studies provided results indicating that bilinguals do change personality with different language modes, they also suffered from a number of limitations. First, as Hull himself points out, the CPI has been criticized as lacking a factorial foundation (see Domino, 1985; Eysenk, 1985; Goldberg, 1972). In addition, no clear comparative evidence is provided regarding CPI and TAT differences in monolinguals (i.e., French-speaking monolinguals response to the TAT in French or English-speaking monolinguals response to the TAT in English). Finally, the findings have not been replicated in multiple samples.

In a series of investigations, Ramírez-Esparza and colleagues (Ramírez-Esparza, Gosling, Benet-Martínez, Potter, & Pennebaker, 2006) attempted to address these limitations by testing personality change in several samples of bilinguals and by including personality differences among English speaking and Spanish speaking monolinguals. The authors asked the questions: Do bilinguals change personality depending on the language they are using at the moment? Are any observed personality differences consistent with personality differences associated with their two languages and cultures? Spanish-English bilinguals of Mexican descent were asked to participate in two language sessions. In the Spanish session, the participants were interviewed in Spanish and then completed the Big Five Inventory in Spanish (Benet-Martínez & John, 1998). The same procedure was repeated in the English session and the participants responded to the Big Five Inventory in English (John & Srivastava, 1999). Ramírez-Esparza et al. (2006) found that responses on the personality questionnaire depended on the language mode. Specifically, bilinguals were more extraverted, agreeable, and conscientious in English than in Spanish and these differences were consistent with the personality displayed in each culture. That is, Americans also scored higher in extraversion, agreeableness and conscientiousness than the Mexicans. These findings were robust since replicated across three different samples of bilinguals. The results from this study were in agreement with the Cultural Frame Switching effect (Hong, Chiu, & Kung, 1997; Hong et al., 2000, chapter 2 in this volume), where bicultural individuals shift values and attributions in the presence of culture-relevant stimuli. By using the language of the questionnaire as a cultural prime, it was possible to switch bilinguals' own standing in a trait. However, it is important to note that the correlations between the Spanish and English versions of the questionnaire are very strong (mean $r = 0.80$, also see Benet-Martínez & John, 1998). This suggests that individuals tend to retain their rank ordering within a group but the group as a whole shifts. Thus, an extrovert does not suddenly become an introvert as she switches languages; instead a bilingual becomes more extraverted when she speaks English rather than Spanish but retains her rank ordering within each of the groups.

Ramírez-Esparza et al. (2006) demonstrated that personality changes, depending on the language mode; however, the personality differences between Americans and Mexicans were inconsistent with well-known stereotypes about these cultures. Mexicans are polite and kind; they show respect toward others, avoid conflict, emphasize positive behaviors and deemphasize negative behaviors. Cultural scientists have used the cultural script *Simpatía* to label this kind of social interaction among Mexicans and Latinos (Díaz-Loving & Draguns, 1999; Holloway, Waldrip, & Ickes, 2009; Triandis, Marín, Lisansky, & Betancourt, 1984). However, on self-reports, Mexicans and bilinguals

(when responding to the questionnaire in Spanish) saw themselves as less agreeable than Americans and bilinguals (when responding to the questionnaire in English). What could account for this paradoxical finding?

Ramírez-Esparza, Gosling, & Pennebaker (2008) observed *behavior* in bilinguals when they switch languages in order to resolve the paradox. Spanish-English bilinguals of Mexican descent were recruited to participate in two language sessions, in one session they provided answers to a personality questionnaire in Spanish and participated in a social interview task in Spanish. During a second session, the same tasks were completed in English. In order to control for the possibility that bilingual interviewers might themselves change their behavior as they spoke different languages, a "videotaped interview" was created in which a fluent Spanish-English bilingual was videotaped giving instructions and outlining the questions in both English and Spanish. The recorded bilingual interviewer had a neutral face and position when doing the interviews in both English and Spanish. This "videotaped interview" was presented to the bilinguals while they were in a room alone, and they responded to the questions while looking into a video camera.

Judges rated the participants' behavioral agreeableness by observing the videotaped interview with the volume off. Five judges coded the videotaped interview when the participants were speaking in Spanish and a different group of five judges coded the same participants speaking in English. The results replicated previous findings on self-reports: bilinguals saw themselves as less agreeable when responding to the questionnaire in Spanish than when responding to the questionnaire in English. However, bilinguals' behavior was rated as more agreeable during the interview in Spanish than during the interview in English. Ramírez-Esparza and colleagues proposed that an underlying characteristic of the cultural script *Simpatía* is modesty. In other words response to self-reports interacts with cultural values in bilinguals. When bilinguals read a question in Spanish, the modesty cultural value is activated and they show modesty by diminishing their standing on this trait. This set of findings suggests that language and culture interact in bilinguals—cultural values are activated along with language mode.

Two more recent studies test personality change in bilinguals by taking into consideration cultural norms. Chen and Bond (2010) recruited 76 female Chinese-English bilinguals to participate in a social interaction task. To avoid for possible gender effects these participants were interviewed by 4 males, 2 Caucasians, and 2 Hong Kong Chinese. Using interviewers with different ethnic background allowed observation of the interplay between cultural norms and behavioral personality. The participants provided self-reports of personality in both languages with a 2- or 3-week delay between reports (counterbalanced). They were then interviewed in English and in Chinese by one Chinese interviewer, and in English and in Chinese by a one Caucasian interviewer (each interview lasted 10 minutes). Observers rated the participants' personality in terms of extroversion and openness. The results showed some interesting interactions between behavioral personality and the interviewer's ethnic background. Specifically, participants were rated as significantly more extroverted, and open to experience when talking with Caucasian interviewers than when talking with Chinese interviewers, independent of language. When talking with a Chinese interviewer, they were perceived as more extroverted and open to experience in English than in Chinese. Interestingly, there were not significant differences on self-rated personality across languages for these dimensions. The personality differences across languages and interviewers were in accordance to expected cultural differences. For example, native English speakers whose cultural norms are from more individualistic cultures are expected to behave as more extroverted and open to experience than Chinese speakers whose cultural norms are from more collectivistic cultures.

Chen and Bond's study is noteworthy because it provides evidence that personality switch in bilinguals is dependent not only on language, but also on cultural norms. However, this study has a limitation that is difficult to address. Since the interviewers were also bilingual, it is possible that their personality switched with interview language, which in turn influenced the personality of the bilingual participants. Likewise the Caucasian interviewer may have acted more extroverted and open to experience than the Chinese interviewer, influencing the participants' personality. Thus, it is especially difficult to separate the effects of culture and language in this study, since both variables have potential effects in both the interviewers and the participants. Ramírez-Esparza et al. (2008) controlled for these effects by engaging the bilingual participants in a social interaction task using a prerecorded interview. This approach made it possible to observe the effects of language rather than cultural norms.

Although researchers attempt to control for cultural and language effects in investigations of personality switching, there is no doubt that these two variables are interrelated.

The effects of culture on personality can be observed by using cultural primes other than immersion in a language mode. Mok and Morris (2009) investigated changes in self-perceived personality as a function of cultural primes in biculturals. The authors also observed the effects of bicultural identity. In a previous study, Benet-Martinez and colleagues (Benet-Martínez et al., 2002, see chapter 13 in this volume) provided evidence that the degree of integration of two cultural identities within the individual (BII) moderates the effects of attributional bias. For example, attributions in Asian-Americans with an integrated identity (high BII) change in the expected direction after being exposed to a cultural prime: They make external attributions in response to American primes and internal attributions in response to Chinese primes. In contrast, biculturals with conflicting identities (low BII) show the opposite pattern: They make internal attributions in response to American primes and external attributions in response to Chinese primes. Mok and Morris tested the role of cultural identity in the context of personality in two studies.

In Study 1, Asian American students completed self-reports on the Need for Uniqueness after they were randomly assigned to view four book covers from American or East Asian culture. In Study 2 Asian-American students completed self-reports on extroversion after a more subtle priming manipulation: Participants were asked to play the role of a manager in North America or East Asia. Students in the American condition saw employees with Western names, whereas participants in the Asian condition saw employees with Asian names. In both studies, the participants were measured in terms of their bicultural identity. The results showed that highly integrated Asian Americans perceived themselves as more uniqueness seeking and extroverted following the American prime than the Chinese prime. In contrast, the opposite pattern was found in individuals with low integration: that is, the participants perceived themselves as *less* uniqueness seeking and extroverted following the American prime than the Chinese prime. In other words, those participants with strong and integrated cultural identities changed their personality in response to American primes to be more congruent to the stereotyped "American personality"—they saw themselves as more unique and extroverted. However, those participants who felt a disassociation between their two cultural identities changed their personality in opposition to the "American personality." The authors concluded "Thus, integrated biculturals can follow the lead of cultural cues without feeling that they are leaving part of themselves behind. Conversely, conflicted biculturals are more likely to experience a cultural cue as threatening to their *other* cultural identity, spurring a need to retreat, or affirm that other identity to restore equilibrium in the bicultural identities" (p. 888).

Conclusion. In general, research suggests that bilinguals switch personality when they switch languages in a way that is consistent with the cultures associated with each language. However the relationship is not simple. When bilinguals are immersed in a language, cultural values associated with that language are activated which influences response to self-reports (Ramírez-Esparza et al., 2008). Studies of personality shift in bilinguals that combine self-reports and measurements of social behaviors also indicate that bilinguals do change personality when they switch languages (Chen & Bond, 2010; Ramírez-Esparza et al., 2008). Furthermore, personality shift is also associated with cultural identity and can be observed by activating culture using subtle primes other than language in biculturals (Mok & Morris, 2009). These studies reveal the association between personality, cultural norms, and language, as well as the difficulty in separating language and culture. Overall personality in bilinguals is dependent on both language and culture.

How can we separate the role of language and culture in bilinguals? One possible approach is to ask bilinguals to describe their personality in Spanish and in English, and identify the most salient themes in each of their languages. Ramirez-Esparza and colleagues (Ramírez-Esparza, Chung, Sierra-Otero, & Pennebaker, 2012) demonstrated that Mexicans and Americans differ in the themes they use when describing their personality. For example, Mexicans use words about being nice and agreeable (i.e, *affectionate*, *responsible*, *help*, *honest*, *sensible*), whereas Americans use words related to being outgoing and sociable (i.e., *outgoing*, *shy*, *open*, *meet*, *laugh*, *friendly*). If bilinguals living in the United States are similar to Mexicans when describing their personality in Spanish, and are similar to Americans when describing their personality in English, we can infer that personality in bilinguals is more language dependent: Even if the bilinguals are living in the United States, just by switching languages they switch their personality. On the other

hand, if bilinguals are similar to Americans when describing their personality in both languages, we can infer that personality in bilinguals is more culture dependent: The American cultural context influences the way they describe their personality in both languages. Such studies could be informative in this regard (see Ross, Xun, & Wilson, 2002 for a relevant study), and much work remains to be done in this area.

Emotion Switch in Bilinguals

Another area of research that has been increasingly popular in the past years is emotional response to language in bilinguals. For example, most bilinguals indicate that they experience more emotional weight in response to the phrase "I love you" in their first language (Dewaele, 2008). Cursing or taboo words generally produce more emotional intensity in the first language (Dewaele, 2004). This area of research, however, is also limited by the methodological issues discussed in the previous section, and other weaknesses such as the definition of emotional experience. Caldwell-Harris and colleagues at Boston University employ an interesting definition of emotional weight: skin conductance (for a review see Harris, Gleason, & Ayçiçegi, 2006). This approach overcomes the methodological concerns related to self-report in bilinguals: The method is not subject to translation concerns and response-style biases. Furthermore, it has been well established that emotionally charged words, such as taboo words, produce higher skin conductance than neutral words in monolingual participants (e.g., Mathews, Richards, & Eysenck, 1989). The association of skin conductance and emotion makes it a good tool for studying language mode in bilingual participants, allowing the evaluation of relationships between language and emotion.

Caldwell-Harris and colleagues recorded skin conductance activity in bilinguals associated with taboo words, reprimands, aversive words, positive words, and neutral words in their first and second language (Caldwell-Harris & Ayçiçegi-Dinn, 2009; Harris, 2004; Harris, Ayçiçegi & Gleason, 2003). In one of the earliest studies, Turkish learners of English showed higher electrodermal activity in the first language than the second language, but only to childhood reprimands (e.g., "Don't do that!" or "Shame on you" or "Go to your room") (Harris et al., 2003). The authors argued that these findings were congruent with the idea that bilinguals can categorize autobiographical memories as occurring in their first or their second languages. The phrases in Turkish were associated with memories from their childhood, whereas the phrases in English were not associated with any childhood memories.

In a follow-up study Harris (2004) recruited Spanish-English bilinguals who acquired both languages in early childhood and compared them to Spanish-English bilinguals who learned English later in their life. Interestingly, only the late learners of English showed significant skin conductance differences to reprimand phrases. That is, the reprimand phrases in Spanish elicited significantly higher skin conductance than reprimand phrases in English in late learners of English—differences were not significant in the early learners of English. These finding suggest that reprimands do not necessarily have more emotional weight in one language or the other. The early English learners almost certainly grew up listening to reprimands in both languages, and, therefore, autobiographical memory was not associated with a specific language.

In a series of follow-up studies, the authors investigated the linkage between memory and emotions (Ayçiçegi & Harris, 2004; Ayçiçegi-Dinn & Caldwell-Harris, 2009). They used a standard emotion-memory measure, in which emotionally charged words are better remembered than neutral words, that has been successfully tested in monolinguals. In the first study, they recruited Turkish-English bilinguals who arrived in the United States after age 17 to test emotion-memory effects in first and second languages (Ayçiçegi & Harris, 2004). The task consisted of reading words on a computer screen, including childhood reprimands, taboo words, negative words, positive words and neutral words in both English and Turkish. Each word was rated for emotional intensity and a surprise recall task was performed at the end. The authors expected bilinguals to remember more words in Turkish because reading the word in their first language would have more emotional effect. The results were in the opposite direction! Participants' percentage recall was higher in their second language than in their first language, especially for reprimand and taboo words. Furthermore, their findings were not consistent with the results of their earlier studies using skin conductance (Harris et al., 2003).

The authors attempted to disambiguate these conflicting findings in a more recently published study (Ayçiçegi-Dinn & Caldwell-Harris, 2009). Specifically they made two methodological changes to the 2004 study. First, bilingual participants living in Turkey were recruited. The authors hypothesized

that residing in an English-speaking context affected emotional recall. Second, they performed different incidental memory tasks: The authors argued that perhaps the English words were more amusing or novel and, therefore, the English words were processed more deeply. The incidental memory tasks now varied on the degree of emotional processing. For example a shallow task such as counting the number of letters that are contained in a closed circle was compared to tasks with deeper emotional processing such as translating a word into the other language or associating as many words as possible with a target word. The bilinguals living in Turkey remembered significantly more reprimand words in English than in Turkish. Other word categories did not show significant differences across languages and/or did not show a consistent pattern across tasks. The authors concluded that the memory-emotion effect for reprimand words cannot be attributed to the language context of the current environment in bilinguals, nor can they be attributed to the depth of emotional processing. What could account for these paradoxical findings? A group of researchers in Spain suggested that the differences could be the result of methodological issues and the type of bilinguals (Ferre et al., 2010).

Ferre and colleagues (2010) tested the emotional-memory effects of positive, negative, and neutral words in Spanish-Catalan bilinguals who acquired their second language (i.e., Catalan) early in their lives and Spanish-English bilinguals who acquired their second language (i.e., English) later in their lives. They implemented a new selection of words based on a well-validated inventory that categorizes English words according to emotional dimensions, which has been translated into Spanish. In this study, one group of bilinguals performed the emotion-memory task in Spanish and another group of bilinguals performed the task in Catalan. Both groups recalled emotion category words better than neutral words. However when the task was completed across languages in early bilinguals (i.e., Spanish-Catalan bilinguals) and late bilinguals (Spanish-English bilinguals), there were no differences in recall of word categories for the first and second language. Thus, there were no relationships between remembering emotionally charged words and language in either early or late bilinguals. Unfortunately, childhood reprimands were not included in the inventory, limiting the use of this study in the interpretation of earlier work.

Do bilinguals switch emotion with language? Well, yes and no, it all depends on measurement. In Dewaele's studies, hundreds of bilinguals responded to his online questionnaire, and most reported that emotionally charged words produce an stronger emotional impact in their first language, however this difference disappears in bilinguals who acquired two languages early in life (Dewaele 2004; 2008). The studies of Caldwell-Harris and colleagues using skin conductance are consistent with this finding: bilinguals who acquire their second language later in life show higher skin conductance for some emotionally charged words (i.e., childhood reprimand phrases) (Harris et al., 2003). This difference in electrodermal activity disappears in late bilinguals (Harris, 2004), and no consistent differences are found in other emotionally charged word categories (Harris et al., 2003; Harris, 2004). Furthermore, other methodologies, like the emotion-memory task, produce differences in the unexpected direction: bilinguals have better recall of reprimand phrases in their second language than in their first language (Ayçiçegi & Harris, 2004; Ayçiçegi-Dinn & Caldwell-Harris, 2009), and no clear differences are found for the other word categories (Ayçiçegi & Harris, 2004; Ayçiçegi-Dinn & Caldwell-Harris, 2009; Ferre et al., 2010) even in simultaneous bilinguals (Ferre et al., 2010).

Here we argue that in order to capture real emotional differences across languages in bilinguals, it is important to immerse the person in the language of interest, allowing the bilingual to "switch on" a language by "turning off" the other language (Grosjean, 2001). In other words, in order to activate the emotions associated with a language it is important that the participant is in a monolingual mode for that language; feeling and thinking in one language so that memories associated with that language will be more accessible along with associated emotional response. We know of two studies that took this approach in different ways. Marian and Kaushanskaya (2004) recruited Russian-English bilinguals who immigrated to the United States when they were about 14 years old to participate in a recorded interview. The interviews were divided in two parts: The first part was done in Russian and the second part in English (counterbalanced). The interview was done with the cue word technique to access autobiographical memories by using key words (e.g., summer, neighbors, cat). The key words were used once and different words were used in each language. After all memories were recorded, participants had to indicate in which language the memory occurred (i.e., in Russian, English or both). Finally raters coded

all narratives as a function of emotion defined by two variables: Emotional intensity (i.e., from no emotion to extremely high intensity), and by the valence of the emotion (i.e., from narratives that expressed completely negative affect to narratives that expressed completely positive affect). The results showed that autobiographical memories were scored higher in emotional intensity when the language in which the memory occurred and the language used in the interview matched than when they did not match. Furthermore, memories that occurred in the Russian language were rated as less positive that memories that occurred in English. The authors explained the results in terms of cultural differences associated with each language. For example, individualistic cultures such as the United States tend to be more positive in their emotions than collectivist cultures such as Russia.

Perunovic and colleagues (Perunovic, Heller, & Rafaeli, 2007) tested emotion switch in East-Asian Canadian biculturals living in Canada using a diary approach. The participants completed a self-report emotional experience questionnaire (PANAS, Watson, Clark & Tellegen, 1988) 3 times a day over 10 days. The questionnaire asked the participants to rate the extent to which each item described mood in the specific moment (items include positive emotions, such as excited, strong, and negative emotions such as, upset, strong, guilty). Then the participants answered questions about cultural identification and language use. For example, they were asked "during the past 2 hr, which specific cultural group did you most identify with?" (p. 609), and "during the past 2 hr think of the person or group you spent most of the time with. What language did you speak most of that time" (p. 609). The authors hypothesized that when the participants were immersed in a Western context, they would respond the PANAS as westerners do, whereas, when the participants were immersed in an Asian context, they would respond the questionnaire as the Asians do. Previous studies have shown that East Asians are more dialectical in their emotional experience than westerns (Bagozzi, Wong, & Yi, 1999). This means that East Asians are able to experience both positive and negative emotions in any given moment, which suggests that the correlation between positive and negative affect should be less negative, or even positive, whereas Westerners tend to experience either positive emotions or negative emotions, which results in negative correlations between positive and negative affect. The results supported the hypotheses; when the biculturals were immersed in a Western context a negative correlation between positive and negative affect was found, but when they were immersed in an Asian context the correlation disappeared.

Conclusion. In this section we reviewed literature about the association between language and emotion. The literature is complex, employing a variety of research questions and methodologies including large-scale online single-question studies, physiological measures, memory tasks, and social-interaction tasks. The involvement of memory increases the complexity. Since there are strong associations between emotions and memory, it follows that emotions associated with language are most likely linked to autobiographical memories. We believe that the methodological approach used by Marian and Kaushanskaya (2004) is the most productive approach. By using an extensive interview task it is possible to immerse bilinguals in the language of interest and affect their emotions in different ways. If the participants are thinking in Russian and they are remembering aspects of their lives that occurred in a Russian-speaking context, then the autobiographical memory has more emotional intensity. This finding is consistent with the idea that bilinguals change their emotions across languages and that emotions are experienced more strongly in the first language. A pivotal follow-up study would use the approach of Marian and Kaushanskaya to evaluate simultaneous bilinguals. For example, do bilinguals who grew up in the United States listening to both languages simultaneously also change their emotions as function of language? It is possible that the differences will disappear, but it is also possible that memories will be associated with a context (e.g., Spanish with the family context, and English with the school context) and a similar pattern of differences will emerge. On the other hand, Perunovic and colleagues (2007) observed language immersion using a diary technique. This approach allowed assessment of the cultural contexts that bicultural individuals encounter in their everyday life. Although this study is not related to memory, it does provide support for the idea that bilinguals do change their emotions depending on the language.

General Conclusion

Being born in an English-speaking culture is advantageous in many ways. As the editorial in the *New Scientist* write in their piece *Oh, to Be Bilingual:* "There are many reasons to be grateful for being part of the 'Angloshpere'. English is the world's lingua franca, the language of science, technology,

business, diplomacy and popular culture" (May 2012, p. 3). For these reasons and others, English is a door to opportunities. Since our children are growing up in an English-dominant culture, why would we want to raise them bilingually? As we reviewed in this chapter, being bilingual has powerful advantages in cognitive function across various domains such as attention, working memory, and multitasking. This is the kind of "brain work" that may protect them from age-related cognitive problems (such as dementia and Alzheimer). Furthermore, research shows that our children will reach language milestones at the same rate as the monolinguals. Although misconceptions about bilingualism are still prevalent in the United States, bilingualism has been increasingly valued in recent years. As more parents want to raise bilingual children, bilingual education will become more available in the United States school system. These changes in attitudes toward bilingualism will help our children to embrace their mother tongue even if it is associated with a low-status culture.

The bilingual brain is indeed fascinating and research focused on the mechanisms associated with the way bilinguals function in the world is just beginning. Here we reviewed studies that have attempted to understand integration of two languages in bilinguals using the basic units of language. We also reviewed studies of the bilingual brain from the perspective of more complex psychological phenomena such as personality and emotion. A reporter once asked me: "Do you think bilinguals have greater emotional/behavioral flexibility and, therefore, they have better ability to adapt to different social situations?" I had to acknowledge that I did not know of any research that could answer this question, but I wanted to say yes. I like to imagine that bilingualism will be a tool that will help our children walk strong in this increasingly multicultural-multilingual world. As the editorial from the *New Scientist* ends "In a fiercely competitive world, being born into an Anglophone culture is not quite the blessing it may first appear."

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