Bilingual Memory Storage: Compound-Coordinate and Derivatives

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Introduction

A recurring theoretical issue in the study of bilingualism concerns the manner in which speakers of one or more languages might store their languages in memory. Figure 1 shows a plausible semantic network organization for the Spanish-English interlingual homograph *red*. Interlingual homographs are words across languages that are similar in form, but different in meaning (Degani and Tokowicz 2010). Thus, for a Spanish-English bilingual, the reading of the word *red* would activate: (a) its English-related meanings (*orange*, *green*, *fire*), (b) its Spanish direct translation (*rojo*) and associations (*rojo-doctor, hospital)*, (c) its additional meanings in Spanish related to *red-pelo* (*net-hair*)*, red-pez* (*net-fish*)*, red*-internet (not included in Fig. 1), associations (*pelo-cabeza, pez-agua),* and direct translations (*pez-fish, agua-water*). How is this general network or series of subnetworks organized in bilingual memory? Although the issue of whether bilingual memory is organized in one or two memory systems has been debated over the past 50 years (e.g., Heredia 2008; Heredia and Brown 2013), current bilingual models postulate separate but interconnected systems (e.g., Jared et al. 2013; Kroll et al. 2010; but see Brysbaert and Duyck 2010).

In this chapter: (1) we critically review the plausibility of a bilingual compound-coordinate semantic representational system in memory, in which depending on how the two languages are learned, bilinguals attribute the same or different meanings to words or expressions in their two languages (Macnamara 1967), and when appropriate suggest additional lines of research, as well as the current status, extensions, and contributions of this model to our current view of bilingual memory; and (2) the model and its extensions are further evaluated in terms of the mechanisms

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R. R. Heredia, J. Altarriba (eds.), *Foundations of Bilingual Memory,*
DOI 10.1007/978-1-4614-9218-4_2,

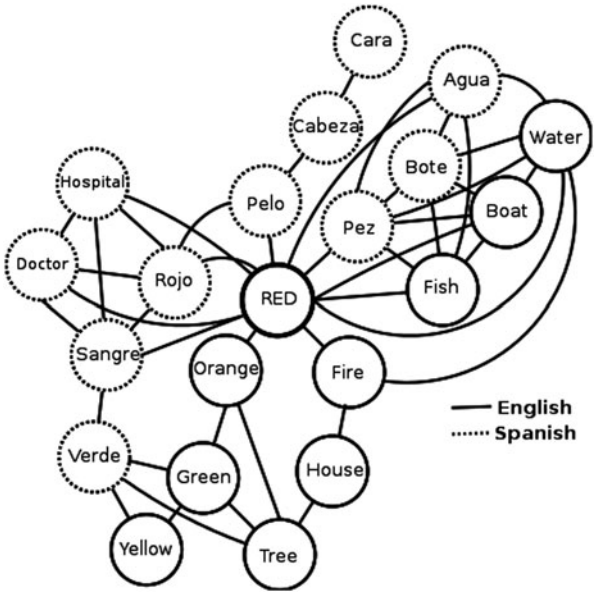

Fig. 1 A semantic network model for the interlingual homograph *red*, related to color in English (*red-orange,* in solid circles), its direct Spanish translation (e.g., *red-rojo,* in broken circles), and other Spanish meanings related to *red-pez* (*net-fish*), and *red-pelo* (*net-hair*)

posed during the learning (i.e., encoding) of both languages, and how the learning process influences how bilinguals store and retrieve their two languages. We begin by discussing the original bilingual structures proposed by Weinreich (1953) and early crucial modifications making these models empirically testable. We then review evidence for these models and argue for the possibility that the compound-coordinate view of bilingualism accounts for language-dependent effects in episodic memory, or memory for time and place, particularly, autobiographical memory. Throughout this chapter, we underscore the contributions of the compound-coordinate (and subordinate) bilingual types to research in bilingualism and to current models of bilingual memory that assume language-specific lexicons (i.e., mental dictionaries) underlying one conceptual system (Potter et al. 1984), or one conceptual-experiential information store (Paradis 1980).

Bilingual Storage Structures

Weinreich's (1953) proposed bilingual storage system distinguished between levels of representation and types of memory organization. At the representational level, information is organized in terms of meaning (i.e., the conceptual or signified level, represented by squares in Fig. 2), or word-form (i.e., the lexical or signifier level, represented by circles in Fig. 2) representation. Thus, for a *compound bilingual*, information at the meaning or conceptual level is fused or shared and information at the lexical or word level is independent (see Fig. 2a). For a Spanish-English *compound bilingual*, whose first language (L1) is Spanish and second language (L2) is

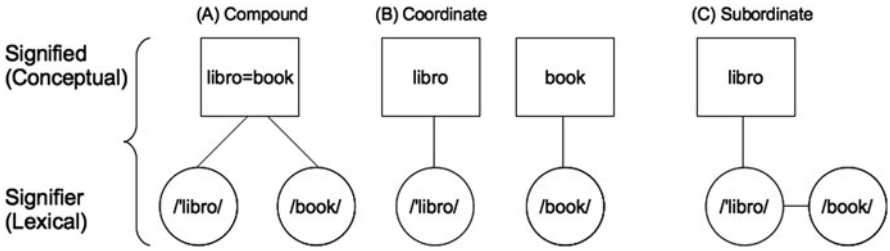

Fig. 2 Three bilingual storage representations. (Adapted from Woutersen et al. 1994. Copyright 1994 by Cambridge University Press)

English, two different lexical items or verbal labels represent the concept of *libro* and *book*, but the underlying meaning would be the same across the two languages. Figure 2b describes a *coordinate bilingual* structure. This bilingual configuration is often referred to as *pure bilingualism* where the bilinguals' two languages are separate and independent, both at the conceptual and lexical levels (but see Fig. 1). This bilingual configuration suggests that the definitions of *libro* and *book*, for example, represent meanings that may be unique to each language (cf. de Groot 1993) Thus, the meaning of the Spanish word *libro* and its translation (*book*) are different, and both meanings are associated with information that is language-specific.

A subordinate system (Fig. 2c) on the other hand, views the bilingual as containing one meaning-based representational system, in which the to-be-learned language or L2 is simply a translation of the L1 word. This architecture suggests that during early stages of L2 learning, bilinguals link or associate every L2 word with the L1 translation equivalent and access to the meaning-based representational system must necessarily go through the L1 (cf. Potter et al. 1984). It is important to note that the human cognitive system is dynamic, continuously reorganizing, and restructuring (McLaughlin 1990) to process the information more efficiently. Similarly, bilingual memory representation is dynamic. A subordinate bilingual memory structure through practice (McLaughlin 1990; Shiffrin and Schneider 1977) may develop into a compound bilingual structure (Weinreich 1953; see also Woutersen et al. 1994). Moreover, bilingual concepts may have instances of compound, (e.g., *concrete words*: *Father vs. Padre,* and *cognates* or words similar in form and meaning across languages: *Hospital* in English *vs. Hospital* in Spanish) or coordinate representations (e.g., abstract: *Love* vs. *Amor*, and interlingual homographs: *Red* as in color in English vs. *Red* as in net in Spanish; e.g., de Groot 1992; Heredia and Brown 2013; Woutersen et al. 1994).

Acquisition (Learning) Context and Language Organization

What are the bases for Weinreich's (1953) bilingual memory representations? Weinreich's original formulation, further elaborated by Ervin and Osgood (1954), is one of the few bilingual theoretical approaches to propose the conditions leading to a

compound or coordinate bilingual structure. Accordingly, the acquisition or learning context is a crucial determinant of bilingual language organization. In this case, acquisitional context refers to the environmental (e.g., home vs. school), and cultural (how different the two cultures are) settings, as well as to whether the L1 was learned in one country and the L2 in a different country. The more different the acquisitional context, the more likely it is for the bilingual's two languages to be stored independently (see e.g., Macnamara 1967).

Thus, a compound system is developed in a situation in which both languages are essentially learned in the same context (i.e., a bilingual home). In this memorial configuration, two different signifiers or word labels code the same underlying meaning. Thus, it would be likely for a child learning Spanish and English to arrive at the conclusion that *amor* and *love* are interchangeable and that it would be semantically plausible to describe one's *love* for the family dog the same way in both languages (e.g., *I love Fiona, my [female] dog vs. Yo amo a Fiona, mi perra*). The difference is while *love* is semantically unconstrained in English, where *everything can be loved*, *amor* in Spanish is semantically constrained to animate objects and specifically to human beings (see e.g., Heredia and Brown 2013). Alternatively, learning a new language through the *indirect method* (Weinreich 1953; cf. Potter et al. 1984; Kroll and Sholl 1992; Kroll and Stewart 1994), in which every L2 word to be learned is associated or translated into its L1 or the base language, will likely develop this type of system. Although it would be possible to develop a subordinate structure, at least during the early stages of bilingualism (cf. Potter et al. 1984), this structure would eventually lead to a compound memorial structure.

In contrast, learning an L2 in a cultural context significantly different than where the L1 is learned would result in a coordinate bilingual, memory organization (Gekoski 1980). Thus, a coordinate bilingual would develop a memory representation in which meanings or concepts are independently linked to distinct verbal labels and meaning representations (see Fig. 2b). A bilingual learning Spanish in Mexico and English in Texas would likely appreciate why McDonalds, a fast food restaurant, uses *I'm loving it* as its slogan in English to describe its customer's reactions to their food, but *Me encanta* (*I like it* or *makes me happy*), in Spanish. Note that being raised in a household where only one language is spoken and the L2 is learned at a school setting would not assure a bilingual coordinate representation; it would depend on the cultural-linguistic proximity of the two languages under consideration. As another example, consider the difference between *librería* (*a book store*) in Spanish and *library* in English. If learned in Mexico, the semantic representation of *librería* might contain information about all things associated with a place or store where school materials (e.g., *maps*, *pencils*, *books*, *notebooks*) are sold. On the other hand, learning the word, library, in a traditionally English-based school setting would involve encoding information about things associated with school libraries (e.g., *reading*, *librarian*, *library card*). Although similar at the orthographic level, the underlying meanings of these false cognates are different. However, the Spanish word *biblioteca* is likely to trigger similar associations—but not identical—to library, since it is its direct translation. Notice that it would also be possible that during the learning of a word or concept, other personal and highly

impacting information that is event- and time-specific might be encoded as part of the meaning (of the memory trace) of the newly acquired concept. Retrieval of that particular word, later on, would trigger the personal or autobiographical information associated with the word or concept; as Gabriel García Márquez' Colonel Aureliano Buendía recollects the first time he learned about *ice*:

> MANY YEARS LATER as he faced the firing squad, Colonel Aureliano Buendía was to remember that distant afternoon when his father took him to discover ice. . . . "It's the largest diamond in the world." "No," the gypsy countered. "It's ice.". . . . "Five reales more to touch it," . . . . José Arcadio Buendía paid them and put his hand on the ice and held it there for several minutes as his heart filled with fear and jubilation at the contact with mystery. . . . Aureliano . . . took a step forward and put his hand on it, withdrawing it immediately. "It's boiling," he exclaimed, startled. (García Márquez 1967/1971, pp. 8–29)

Because of Aureliano Buendía's emotionally charged experience during the learning process, retrieval of the word *ice* included the personal aspects associated with the original acquisition of the word. The possibility that autobiographical information is additionally encoded during the acquisition of some concepts explains the intuitions that bilingual speakers report as they remember a word (e.g., *when I think about church I think about the anti-Communist resistance in Poland—going to church and the priest talking about it*).

Empirical Evidence

In one of the most recent studies to empirically test the compound-coordinate bilingual memory distinction, Basi et al. (1997) explored the *bilingual generation effect* and memory retrieval in compound and coordinate bilinguals. Briefly, the bilingual generation effect refers to the finding that learner-generated words (e.g., read word *house* and generate its Spanish translation *casa*) are recalled better than read words (e.g., read the word *house* and read its Spanish translation *casa*). Previous studies (e.g., Slamecka and Katsaiti 1987) reported no such bilingual generation effect. Spanish-English bilinguals studied English words (*house*) where, depending on the experimental condition, they either generated a Spanish translation (*casa*), the generate condition, or simply copied the Spanish translation given by the experimenter, the read-read condition. For the read-generate condition, participants were given the English word along with the first letter of the Spanish translation (e.g., *house_C*). Basi et al. predicted that coordinate bilinguals would show a larger generation effect because two different concepts would be evoked when generating translation equivalents. No generation effect was predicted from the compound bilinguals because only one concept, identical for the translation equivalents, would be evoked. Coordinate bilinguals, in this experiment, were those bilinguals reporting learning the L2 after 10 years of age and after moving to the USA from a predominantly Spanish-speaking country. Compound bilinguals learned their two languages before they were 10 years of age.

Basi et al.'s (1997) results showed no statistically significant differences between the two bilingual types in the read-read condition. However, contrary to the predictions, compound bilinguals recalled significantly more generated items than coordinate bilinguals. Thus, compound bilinguals showed a larger generation effect than coordinate bilinguals. In general, the compound-coordinate distinction has been plagued by inconsistencies, with some studies supporting the distinction (e.g., Lambert et al. 1958; Jakobovitz and Lambert 1961), and others failing to support it (e.g., Dillon et al. 1973; Gekoski 1980; Gekoski et al. 1982; Kolers 1963; Lambert et al. 1958).

Other studies involving mental health-related issues provide some interesting insights into a possible coordinate bilingual structure in which the bilingual's two languages are further separated at higher levels of cognition. Del Castillo (1970) reports a series of case studies in which:

> Patients of foreign extraction, mainly Spanish-speaking... [who] appear obviously psychotic during the interview with the psychiatrist held in their mother tongue but seem much less so, and even not show any overt psychotic symptoms at all, if the interview is conducted in English. (p. 243)

Such is the case of J. S., a 30-year-old Puerto Rican patient charged with murder, who was reported to be coherent, calm, and sane during his sanity hearing when interrogated in English, his L1. However, when he was spoken to in Spanish, he showed signs of severe mental disorganization, unsystematized delusional symptoms, and pathological levels of anxiety, in general (Del Castillo 1970, p. 243). In another case study, R. A., a 28-year-old Cuban patient charged with murder was diagnosed as psychotic suffering from terrifying imagery experiences by a Spanish-speaking physician, but totally coherent, factual, and free from overt psychotic manifestations when diagnosed by an English-speaking psychiatrist. Although care should be taken in interpreting these results owing to the unknown and unspecified procedures used during the psychiatric evaluations, De Zuleta, Gene-Cos, and Grachev (2001) using more controlled experimental conditions, arrived at similar conclusions. De Zuleta et al. described a case study of Mr. D., a 48-year-old Polish man suffering from a personality disorder and schizophrenia. His primary language was Polish and he learned English at 8 years of age. During a bilingual diagnostic interview, Mr. D. appeared to be more lucid and emotionally available when speaking in Polish, his first language. Other studies investigating the effects of language context and personality traits find that depending on the sociolinguistic environment, bilingual speakers are able to access the perceived cultural norms of the group more often associated with that particular language (Chen and Bond 2010; see also Ramírez-Esparza et al. 2006). For example, Chen and Bond found that in a series of interviews, Chinese-English bilinguals were perceived as more extraverted, open, and assertive when speaking English than Chinese, in conversations with Chinese interviewers. Similarly, when interviewed by an English-speaking Caucasian, Chinese-English bilinguals were perceived as even more extroverted, open, and assertive than when conversing with a Chinese interviewer (p. 1525). This pattern of results suggested that the language, English in this case, and the Caucasian interviewer served as cues

or primes to activate traits corresponding to the prototypical trait profiles associated with western personalities.

Overall, the evidence for the compound-coordinate distinction is mixed. Although limited, case studies from the mental health-related literature and more recent findings from the episodic (e.g., Jared et al. 2013, see also Pavio this volume), autobiographical memory (e.g., Javier et al. 1993; Guttfreund 1990; Marian and Fausey 2006; Marian and Kaushanskaya 2004, 2008; Marian and Neisser 2000; Schrauf and Hoffman 2007; Schrauf and Rubin 1998, 2000) and emotion literatures (e.g., Anooshian and Hertel 1994; Aragno and Schlachet 1996; Burck 2004; Harris et al. 2003; Schwanberg 2010; see also, Ramos-Sánchez 2007; but see Caldwell-Harris, Tong, Lung, & Poo, 2010, for some inconsistent findings between subjective measurements and skin conductance responses to emotional phrases for compound bilinguals) suggest that during the learning processes, some information is stored in a *content-addressable* language-specific memory store that can be accessed at a later date with the language (of encoding) as a retrieval and contextual cue (Marian & Fausey, 2006; Marian & Kaushanskaya, 2007; Matsumoto & Stanny, 2006). For example, Marian and Kaushanskaya (2007) showed that coordinate Chinese bilinguals learning English as their L2, at approximately 12 years of age, were more likely to access information encoded in Chinese when interviewed in Chinese. Similarly, they were more likely to access information encoded in English when interviewed in English. Thus, when asked in Chinese to *name a statue of someone standing with a raised arm looking into the distance*, they responded with the *Statue of Mao*, and when asked in English, they were more likely to name the *Statue of Liberty* (see also Jared et al. 2013; Marian and Fausey 2006; Pavio, this volume, for an alternative theoretical explanation involving the Dual-Coding Model). Inspection of the L2 age of acquisition (AoA) for these reviewed studies reveals that, by and large, most bilinguals were coordinate, learning the L2 after 10 years of age, with the exception of Caldwell-Harris et al. (2010) and Marian and Kaushanskaya (2007), whose bilingual participants were both compound and coordinate. Because of the lack of a compound bilingual group as a comparison, the results are at best suggestive of the separation of languages or bilingual language-dependent memory representations. Clearly, future studies would benefit from including different types of bilinguals.

Empirical Issues

Although other bilingual theoretical distinctions have been proposed that emphasize age and order of L2 relative to L1 acquisition (e.g., *early vs. late bilingualism*), the compound-coordinate bilingual view is both a model of a possible bilingual memory representation and a language learning model that, depending on *how* the bilingual's two languages are learned, would determine *how* the languages are stored. Although this model's main focus is on the acquisition and memory representation of word meanings (semantics), it may very well be extended to include other aspects

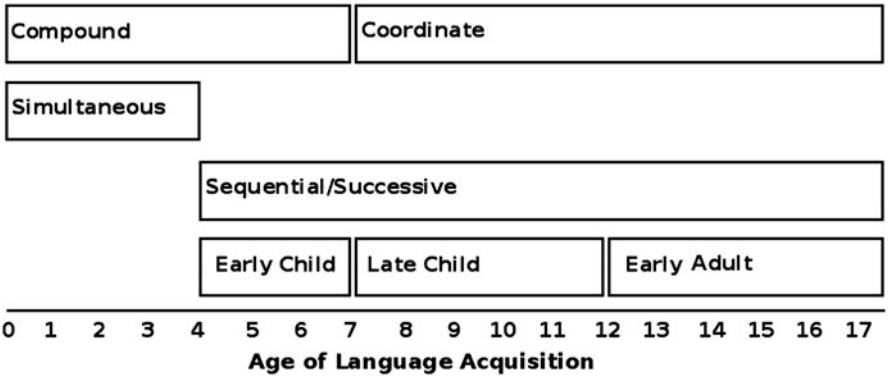

Fig. 3 Age of language acquisition in years as a function of bilingual type

of language such as grammar (i.e., language-specific syntactic structures) and the learning of figurative language expressions, for example. However, clear and consistent empirical evidence for the compound-coordinate bilingual distinction is lacking. There are three possible reasons as to why past research has failed to support the compound-coordinate distinction.

First, the compound-coordinate distinction assumes an age-related time window that determines if the meaning representation of a concept would become compounded (fused) or coordinated (separate). Inspection of the bilingual compound-coordinate literature shows a wide range of age of language acquisition for the bilingual participants. For example, Guttfreund's (1990) compound-coordinate cutoff distinction was made at 5 years of age. Bilinguals learning their 2 languages before the age of 5 years, in a similar setting, were classified as compound, and coordinate if the L2 was learned after 5 years of age, provided that it was learned in separate environmental settings. Additional compound-coordinate age of acquisition (AoA) cutoffs used in the literature include 6 (e.g., Dillon et al. 1973; Lambert and Rwalingss 1969; Segalowitz and Lambert 1969), 10 (Basi et al 1997), and 15 years of age (Gekoski 1980). Other published studies failed to provide specific information about bilinguals' AoA (e.g., Gekoski 1980; Jakobovitz and Lambert 1961; Woutersen et al. 1994) resorting to providing verbal descriptions of the bilingual participants. Even when the compound-coordinate AoA criteria are provided, there is no clear empirical or theoretical rationale.

Figure 3 summarizes cutoff criteria for the different types of bilingual classifications (cf. Montrul 2008). Figure 3 is based on typical language development milestones that children go through as their phonological, semantic, syntactic/morphological, and pragmatic linguistic systems mature. Roughly, by 7 years of age, typically, children are skilled language users, able to utilize language appropriately in various social situations, such as home and school (Bryant 2013). That is, children at this age have, for the most part, acquired communicative competence and are able to reason logically (e.g., Bohannon and Bonvillian 2013). Thus, learning a

second language before the age of 7 would result in compound bilingualism. Learning a second language after the age of 7 would result in coordinate bilingualism. Specific linguistic experiences learned at home or at school ought to be compartmentalized in each particular store, accordingly.

Second, past compound-coordinate bilingual studies (e.g., Gekoski et al. 1982) have failed to distinguish between words possessing fused or separate meaning representations across languages (e.g., de Groot 1992; Heredia and Brown 2013). Pavlenko (2008) provides three ways in which concepts/meanings across languages can be classified: (1) Concepts across languages are similar or identical, such as the concrete word in Spanish *padre* in its different interpretations (e.g., man in relation to his offspring, priest, or evangelical) and its direct translation in English *father*; (2) Concepts between languages are different and have no direct translation, such as Spanish *comadre* that roughly translates into English as *the godmother of one's child*. It would certainly be awkward during everyday conversations to continuously refer to one's *comadre* as *my daughter's godmother.* It would be more communicatively efficient to simply incorporate the Spanish word into the English sentence (i.e., code-switch) as in *my comadre* (see e.g., Heredia and Altarriba 2001). Incidentally, it is interesting to note that marriage-alliance-related concepts (i.e., in-laws) are concrete and straightforward in Spanish (*yerno*, *nuera*, *suegra*, and *cuñado*.); whereas in English these concepts are compound words (e.g., *son-, daughter-, mother-*, and *brother-in-law*, respectively); and (3) Concepts across languages partially overlap. *Amor* and its English translation *love* were earlier described as coordinate or different across the two languages due to specific language constraints (i.e., constrained to human relationships in Spanish, and no semantic constraints in English). However, under Pavlenko's (2008) concept comparability scheme, these two concepts would be classified as partially overlapping, where the core meanings or prototypes of the two concepts overlap, and are differentiated at the periphery or through the links between the category in question and other categories (p. 152). For example, when asked to provide associations to the word *love* in English, native English speakers are likely to favor metaphoric and symbolic associations such as *heart*, *red*, and *roses*. On the other hand, Spanish native speakers show preferences for sensory and referential associations. This goes to show that the concepts of *love* and *amor* are only partially overlapping across the two languages. Other word-related characteristics that have been overlooked in the compound-coordinate bilingual distinction include AoA or whether a word is learned early or late in life (e.g., Assink et al. 2003; Bowers and Kennison 2011; Hernández and Li 2007; Izura and Ellis 2004; Izura et al. 2011; see also Li, this volume). For instance, Bowers and Kennison (2011) had Spanish-English bilinguals translate early acquisition words with an AoA of approximately 2.0 years and late acquisition words of 4.0 years for both Spanish and English words. Bilinguals in this experiment were given a word in Spanish and asked to generate its English translation (e.g., see *zapato* generate *shoe*). The same procedure was used for the English experimental condition. The results revealed AoA effects; bilinguals were about 53 ms slower to translate from Spanish to English than from English to Spanish but only for the early AoA words. Overall, late AoA words took longer to translate than early AoA words. Other variables, such as the number of translations

a particular word may have in the other language, have also been shown to affect translation latencies (e.g., Kroll and Tokowitz 2001; Tokowitz et al. 2002). Clearly, these variables among others (e.g., word frequency, concreteness, participant's language proficiency, and language dominance) must be experimentally controlled or varied in order to arrive at a better understanding of a compound-coordinate bilingual structure.

Third, whether newly learned linguistic information is stored in a language-dependent or a fused system, a distinction between semantic (i.e., general knowledge) and autobiographical memory (i.e., information about specific events and experiences that are unique to one's self) should be considered. That Barack Hussein Obama is the forty-fourth (and the first black) president of the USA is an example of general semantic knowledge or semantic memory. Remembering specific details about the election night (e.g., emotions, *where was I*, *what was I doing*) is part of one's autobiographical memory. As shown by Marian and Kaushanskaya (2007) and Jared et al. (2013), *culture-loaded* or culture-specific concepts (e.g., *The Statue of Liberty* vs. *The Statue of Mao*) are likely to be encoded in a language-specific manner, due to their emotional impact and the perceived significance to one's patriotic foundations. Thus, it seems that episodic/autobiographical memory is more likely to encode and retrieve language-dependent information, given the proper experimental conditions (i.e., a match between encoding and retrieval of linguistic cues). Although it remains to be seen, the learning of the concept of i*ce* as *frozen water* may not be encoded in a language-specific manner. The personal experience, as described by García Márquez' Colonel Aureliano Buendía, of having seen and touched it for the first time, would be measurable with the appropriate memory tasks measuring autobiographical memory such as diaries and the memory probe/cue method (Baddeley 2009; Pavlenko 2008), where participants are provided with a probe or a cue (e.g., *ice*) and asked to think about personal memories related to the cue word (Schrauf and Hoffman 2007). More recently, however, Caldwell-Harris et al. (2010) have been able to combine traditional self-reports (e.g., ratings scales) and psychophysiological techniques that involve the recording of skin conductance responses (SCRs). Accordingly, SCR measures environment threat or relevance, or internal effort/arousal, the assumption being that human language (e.g., words, phrases) is intrinsically associated with prior threatening experiences that have led to fear and anxiety. These threatening experiences are capable of engaging the fight or flight system, which, in turn, increases adrenaline flow into the blood stream and leads to the sweating that increases the transient conductivity of the skin (p. 335). For instance, taboo phrases such as *she's a b*tch* are capable of eliciting measureable SCRs due to their direct association with previous threats and punishment, and over time, the phrase itself elicits fear or a measurable response. Reprimands, on the other hand, are viewed as possibly reexperiencing autobiographical memories involving fear of punishment, and as a consequence elicit SCRs. At issue was whether highly emotional language would produce lower SCRs in the L2 and higher SCRs in the L1, because of the long-standing belief that the bilingual's L1 is closer and more emotional, whereas the L2 is more emotionally detached. Caldwell-Harris and colleagues had Chinese-English bilinguals, whose age of exposure to English ranged from 0 to 15 years, listen to a

http://www.springer.com/978-1-4614-9217-7

Foundations of Bilingual Memory
Heredia, R.R.; Altarriba, J. (Eds.)
2014, XIV, 297 p., Hardcover
ISBN: 978-1-4614-9217-7