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Chapter 7

Successive Language Acquisition

Ping Li

Unlike the situation with simultaneous language acquisition, which is defined by some scholars as "exposure to both languages from birth or within the first year" (see Chapter 6), successive acquisition of two languages can occur across the lifespan, in adolescence, in adulthood, as well as childhood. However, given that bilingual language learning is a complex continuum, the distinction between simultaneous versus successive language acquisition is necessarily arbitrary, as pointed out earlier. Nevertheless, this discussion does provide a convenient way to talk about different types of bilingual experiences and to examine different theoretical questions associated with different learning situations.

Because the study of simultaneous bilingual acquisition focuses on childhood, the theoretical issues there tend to be similar or closely related to the issues addressed in the domain of first or child language acquisition. Researchers are often reluctant to call the bilingual child's two languages "first language" (L1) versus "second language" (L2), given the nature of simultaneous acquisition. In contrast, the theoretical questions in the study of successive language acquisition are more closely related to those addressed in the domain of second language acquisition. Here, there is a relatively clear distinction between the learner's first language and second language. In most cases, the first language is the native language, the dominant, more frequently used, and stronger language, whereas the second language is the nonnative language, the less dominant, less frequently used, and weaker language. In addition, the age at which the second language is acquired varies greatly from individual to individual, and this variation and its impact on the speed and outcome of language acquisition has been a matter of intense theoretical debate for the last several decades. In this chapter, we will examine this "age of acquisition" effect and its theoretical implications.

This chapter is organized into three sections. In Section 7.1, we provide a review of the contentious critical period hypothesis and the different theoretical perspectives. In Section 7.2, we examine speech learning in infants, children, and adults,

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along with a brief discussion of the variables that could influence success in speech learning. In Section 7.3, we examine how the two languages influence one another in the mental representation of the bilingual learner during successive language acquisition, and how cross-language influences might surface not only in the direction from L1 to L2, but also from L2 to L1.

7.1 Age Effects in Second Language Acquisition

In an increasingly globalized world, knowing two or more languages confers distinct social, economic, and even cognitive benefits (see Chapter 9). Researchers and laymen alike are interested in second language acquisition for a variety of intellectual and pragmatic reasons. But anyone who has experience learning a second language will probably be struck by the apparent child-adult difference: while most children appear to be at ease acquiring multiple languages simultaneously or learning additional languages successively, adult learners appear to have significant difficulties, sometimes even with rudimentary aspects of new languages, after years of struggle. Such age-related differences in L2 learning have motivated researchers to look for explanations, and led to decades of intense debates on the cognitive and neural mechanisms of second language acquisition.

7.1.1 The critical period hypothesis

Perhaps no other domain in second language acquisition has generated so much public attention, debate, and controversy as the critical period hypothesis (CPH). Indeed, understanding of the critical period for language learning has been listed among the top 125 big science questions for the next quarter century in the 125th anniversary issue of *Science* (vol. 309, July 1, 2005). According to the original formulation of the CPH by Lenneberg (1967), the automatic acquisition of a language in the natural setting (e.g., from mere exposure to a given language) takes place only during a critical period (age 2 to puberty), after which language learning proceeds more slowly, and ultimately proves less successful (Lenneberg, 1967: see Long, 1990 for a review). Lenneberg linked this critical time window to constraints in brain development, and the endpoint of that period coincides with puberty, at which time, it was believed, brain lateralization is complete, that is, the language function is settled in the left hemisphere (for over 90% of people). This formulation and explanation of why children are better language learners than adults attracted a great deal of interest for its simplicity and conformity to intuition based on folk wisdom, and the idea that there is a fixed biological timetable for language development also accorded well with nativist views of language such as those championed by Noam Chomsky (1988).

While early work did not question this view of the CPH, few studies were actually devoted to experimentally testing the biological basis of the critical period in humans. Progress was made, however, in understanding the critical period of learning and maturation in other species, particularly in songbirds, perhaps because it was possible to isolate animals from their natural environment for extended periods, something that is naturally unethical and illegal with humans. In one study (Marler, 1970), researchers put baby white-crowned sparrows in acoustic isolation for a given period of time, and then exposed the birds to the normal songs their species. The amount of time in isolation for these birds varied from a few days to a few weeks to a few months. The longer the birds were in isolation, the worse their songs were when they grew up, compared to the song patterns of the normal white-crowned sparrows. The findings were clear: songbirds that did not get early exposure to their native tongue (bird songs) were unable to sing "natively." These data suggest that age of acquisition, at least in learning bird songs, is the determining factor for success in reaching a native level of vocal production.

7.1.2 Experimental studies of the critical period in successive language acquisition

While the CPH based on biological explanations seemed at first a highly viable account, in the 1980s researchers started to question this line of thinking by comparing children's and adults' linguistic performance with regard to both learning speed and ultimate attainment in the context of second language acquisition. In a series of comprehension and production tasks (e.g., auditory discrimination of sounds, translation), Snow and Hoefnagel-Höhle (1978) studied native English speakers who spent a year in the Netherlands learning Dutch, and showed that older children (12–15 years of age) had a faster rate of learning than the younger groups of children (3–5, 6–7, 8–10 years of age). This study, although limited in its scope (e.g., testing over a short period of time), countered the argument that older language learners are worse than younger learners. Further counter evidence to the biological account of the critical period is that lateralization appears to occur early in children, definitely much earlier than puberty, a time stipulated by Lenneberg for the end of the critical period. Many researchers felt uncomfortable with the use of "critical" for critical period, and instead adopted the term "sensitive period." The use of "sensitive" suggests more of a window of opportunity rather than a time period beyond which language acquisition becomes impossible (see Long, 1990 for discussion). More recently, researchers have adopted the term "age of acquisition" (AoA) to refer more generally to age-related differences in language acquisition, including effects of critical or sensitive periods.[1]

[1] The term AoA has been used in three distinct ways in the literature to refer to different age effects: the age at which a lexical item is acquired by monolingual speakers, the age at which L2 learning begins, and the age at which skills are acquired in nonlinguistic domains (see Hernandez & Li, 2007 for a review). Further complicating the picture is the use of AoA along with other terms to refer to overlapping concepts with slightly different focus, including critical period, sensitive period, age-related difference, age of onset (AoO), and age of arrival (AoA).

In 1989 Johnson and Newport published a study that later became highly influential. In that study, 46 successive language learners were tested on their knowledge of L2 grammar. They were native speakers of Chinese or Korean who learned English as a second language at various points in life. Johnson and Newport used "age of arrival" in the US as a measure of when the participants were first exposed to English, which varied from age 3 to age 39. They also used "length of residence" in the US to measure the participants' amount of English experience, which varied from 3 to 26 years by the time of the study. Participants were asked to listen to English sentences and make grammaticality judgments (i.e., judge whether a sentence was grammatical or not). Half of the sentences contained morphosyntactic errors such as lack of plural marking (e.g., *the farmer bought two pig at the market*) or wrong past tense (e.g., *a bat flewed into our attic last night*), and half were grammatical sentences. The sentence judgment scores were used as an index of a participant's performance in English, compared with judgment scores for the same set of sentences by native speakers of English. Findings from this study indicated that participants' age of arrival was a key factor in determining performance, when compared with other variables such as length of residence, motivation, and cultural identification. For learners who arrived in the US early (before age 16), performance in sentence judgments decreased linearly as age of arrival increased, whereas for those who arrived in the US late (after age 16), performance in sentence judgments was generally poor, but highly variable, and unrelated to age of arrival.

Johnson and Newport's study provided experimental grounds for the CPH, but also showed that the original CPH needed to be modified, in at least two respects. First, their data indicated that, contrary to common belief, the "critical period" has no sharp boundary before which performance is uniformly good and after which performance is uniformly bad. There is a linear decline before the critical period, such that the earlier the L2 is learned, the better the learner will perform in the L2. Second, there are large individual variations after the cutoff point (age 16), such that some learners do very well while others do poorly. One individual, even at the age of arrival of 23, could perform as well as native speakers. Such individual differences may be attributed to a number of cognitive, motivational, and social-cultural factors (including level of education, as demonstrated by Hakuta, Bialystok, & Wiley, 2003).

While Johnson and Newport's study contributed significantly to the understanding of the critical period for language acquisition, some subsequent studies were inconsistent with the general claim about the contrasting patterns for the early versus the late learner groups. Birdsong & Molis (2001), for example, attempted to replicate Johnson and Newport's study with Spanish learners, and found that early and late learners similarly showed negative correlations between L2 performance and age of acquisition. Other researchers found more complex, nonlinear patterns of development associated with age of acquisition. Liu, Bates, and Li (1992) tested Chinese learners of English who arrived in the US at varying ages,

as in Johnson and Newport's study. They examined L2 learners' processing strategies in thematic role assignment in sentences (i.e., determining who does what to whom) rather than their knowledge of morphosyntax. Liu *et al.*'s data indicated that the late learners tended to show forward transfer, that is, they used L1 processing strategies for L2 comprehension, whereas early learners, depending on the age of L2 acquisition, showed either backward transfer (using L2 strategies for L1 comprehension) or differentiation (distinct patterns for L1 versus L2). Interestingly, in contrast to Johnson and Newport's findings, their data showed no linear decline even within the critical period, indicating that there is no single critical point for successful language learning, and that a positive outcome can rise and fall at different developmental points. Such data constitute further evidence against the existence of a simple, clearly bounded, and monotonically developing, critical period.

7.1.3 The cognitive and neural bases of the critical period

Johnson and Newport's (1989) contribution lay not only in their experimental evidence for a refined view of the critical period, but also in the theoretical proposal the authors advanced. The biological account as proposed by Lenneberg attributes the critical period to brain maturation, specifically brain lateralization, whereas Johnson and Newport relied on the interplay between learning mechanisms and other cognitive capacities in explaining age of acquisition effects. They suggested the "less is more" hypothesis: the less well developed cognitive capacity in children actually confers learning advantages: young learners tend to be engaged in piecemeal, gradual, and implicit learning whereas adults, because of formal operational abilities, tend to use explicit analytic procedures in dealing with complex aspects of language. When faced with complex linguistic stimuli, children perform only a limited number of componential analyses of the possible form-meaning mappings because they do not have the capacity (e.g., a large working memory) to compute the complete set of data or perform complex form-to-meaning (sounds-to-semantic relations) mappings. Such componential analysis turns out to be advantageous to children as they are not overwhelmed from the beginning. This "less is more" hypothesis coincides with patterns from computational modeling (Elman, 1993), according to which connectionist networks (see Chapter 10) are able to learn complex grammar only if the network first receives simple sentences and then moves on to complex ones, or alternatively, if the network is provided with limited memory windows early on so that initial componential analysis is efficient and successful.

The "less is more" hypothesis has remained largely a hypothesis for the past 20 years, as there is scant experimental evidence (other than from connectionist modeling) for the negative relationship between cognitive resources and L2 acquisition. An alternative view is to look at the critical period effects in relation to the competition between the two languages, more specifically to the "entrenchment" created by the varying degrees of consolidation of L1 at different points of learning (Hernandez, Li, & MacWhinney, 2005). As knowledge and skills of L1 become more established, its representational structure becomes increasingly resistant to change ("entrenched") in the face of new input, or new data. Connectionist simulations in which L2 was introduced at different time points relative to L1 learning (Zhao & Li, 2010) have shown that these entrenchment effects are observed in both phonological and lexical representation systems, in that at later stages of acquisition, a parasitic L2 representation develops, resting upon the L1 representation (for discussion of connectionist models in L2, see Chapter 10, Section 10.3). This is because when structural consolidation in L1 has reached a point of entrenchment, organization of the L2 will have to tap into existing representational resources as well as its structure. Entrenchment is accompanied by changes in neural plasticity, particularly in sensorimotor integration, such that highly flexible neural systems for developing fine-grained articulatory motor actions and for sequences processing are no longer available, while these skills are critical for early phonological processing and grammatical acquisition. Once the neural system settles into stable states for learned patterns (rather than for brain lateralization), radical changes become difficult even if the new language requires such changes (see Hernandez & Li, 2007 for discussion of the "sensorimotor integration hypothesis"; Figure 10.4 also offers an illustration of the L1 and L2 competition in connectionist models of lexical learning).

A recent theoretical framework articulated by MacWhinney (2012), the Unified Competition Model (UCM), has attempted to account for critical period effects in L2 by reference to a host of neural, cognitive, and social variables formulated as risk factors of L2 learning. Consistent with the above perspective on the dynamic interplay between the competing languages, the UCM model assumes that the underlying learning mechanisms for L1 acquisition and L2 acquisition are not fundamentally different, contrary to what the CPH posits. How do we then account for the different outcomes due to age of acquisition? According to the united model, such differences arise from a set of risk factors: negative transfer from L1, entrenchment as discussed above, parasitism (dependency of L2 on L1 including positive and negative transfer), mismatched connectivity (incorrect connections between processing areas in the brain), and social isolation of the L2 learner. To achieve successful L2 acquisition (or to overcome the critical period effect), the adult successive learner must strive to use the same core mechanisms available to the child (e.g., implicit learning, embodied experience), as well as a set of protective factors: positive (rather than negative) transfer from L1 to L2, social participation or immersion (rather than social isolation), active thinking in the L2, reorganization through resonance (interactive activation for relevant processing sites), and internalization (using L2 for inner speech). Successive learners who are able to maximize the benefits of these protective factors will show better and faster learning than learners who are highly susceptible to the risk factors. A major challenge in future research will be to identify how the various risk factors unfold in development and how they affect different domains of linguistic processing.

7.2 Speech Learning in Successive Language Acquisition

Although MacWhinney's (2012) unified model assumes no fundamental differences in the learning mechanisms underlying first language and second language acquisition, it does take into consideration the very different experiences that children and adults have in acquiring single or multiple languages. In Chapter 6 we saw how language acquisition unfolds in a context in which young children are exposed to both languages simultaneously. In Section 7.1.3 above, we discussed how the representation of L2 might depend on the entrenchment effects due to consolidation of the L1 and its influence on L2. In this section, we examine in some detail the differences between simultaneous and successive language acquisition, and how the competing languages might interact dynamically with one another to impact the representation and acquisition of the bilingual's two languages. We will focus on speech, hence the expression "speech learning," and more precisely on the perception and discrimination of speech sounds in L2 learners.

7.2.1 Speech learning in children and adults

Young children spend at least three quarters of their first year actively listening to environmental sounds, including speech input, before they take on the major task of speaking (they typically produce their first words around their first birthday). Adults rarely have the luxury of concentrating first on the second language phonology for an extended period of time and then moving on to other aspects of language (e.g., lexicon and grammar), and moreover, they already have a first language phonological system in place. Such differences could have profound implications for why the acquisition of a native-like, accent-free, second language phonology is so difficult. Both speech perception and speech production involve fine-grained sensorimotor coordination and integration, from the accurate processing of phonemes, tones, and intonations, to the rapid and precise control of tongue, lips, and larynx movements. Neuroimaging evidence suggests that a frontal-striatal circuit may play a significant role in the relevant sensorimotor processes, and children may have both the time and the neuroplasticity to develop sensorimotor processes necessary for native phonological perception and production (see Hernandez & Li, 2007 for a discussion). By contrast, adults in general lack the neural resources to radically change learned systems (L1 phonology) or to develop new phonological categories in the second language to be sufficiently differentiated from those in the first language (Flege, 1995). Connectionist models (see the discussions in Section 7.1.3 and Chapter 10) provide mechanistic accounts of such age of acquisition effects, in that if the connections in the model are fully committed to the learned structure (i.e., functionally specified in weights), the model will be less open to radical changes in terms of the updating of connection weights, rendering the model an entrenched system that is resistant to adaptation.

In studies of early infant speech perception, researchers have examined how bilingual babies, compared with monolingual babies, are able to handle speech sounds from both languages if they are exposed to both early on (see a discussion in Chapter 6, Section 6.3.1). By contrast, adult learners often fail to acquire a native-like phonological system. It has been found that speech accent is the most difficult aspect to overcome for immigrant L2 learners (e.g., Yeni-Komshian, Flege, & Liu, 2000). Why do adults have so much difficulty in speech learning, as compared with children? Flege (1995) proposed the Speech Learning Model (SLM), according to which L2 learners establish phonetic categories according to the degree to which the phonological system of the target language resembles that of their native language; for example, similar but nonidentical phonemes, such as English vowels /æ/, /ɒ/, and /ʌ/ (as in *hat*, *hot*, and *hut*, respectively), present more difficulties to second language learners than totally different phonemes. In both Spanish and Chinese, these English vowels would be mapped onto a single vowel /a/, and hence L2 learners easily confuse them. Importantly, child learners can create new phonetic categories more easily than adult learners, and these child-adult differences are due to the degree to which the phonetic representations of the L1 vs. that of L2 are stabilized over the lifespan of learning. The SLM's account of speech learning differences with respect to both cross-linguistic overlap and L1-L2 interaction is highly consistent with our discussion in terms of the impact of L1 consolidation on L2 (Hernandez *et al.*, 2005) and the sensorimotor integration hypothesis (Hernandez & Li, 2007), as discussed in Section 7.1.3. An interesting aspect of the SLM, in fact, is the hypothesis that age differences may be linked to changes in perceptual and sensorimotor processes involved in learning, although this hypothesis has never been directly put to the test empirically. Obviously, the articulation of sounds must be a sensorimotor process, and the accuracy of L2 as well as L1 pronunciation must depend on the speaker's motor control and coordination of the articulatory apparatus (tongue, lips, jaw, larynx, etc.).

Another important aspect of the SLM theory is that cross-language similarity creates different effects with respect to the ease of speech learning in a second language. Although the details of the SLM are concerned with speech learning, researchers have found that the degree to which L1 and L2 overlap in phonology, grammar, and the lexicon will all lead to cross-language transfer or interference. A Chinese learner of Spanish will need to form a complex set of grammatical rules (such as gender agreement) which is absent in Chinese, whereas a Spanish learner of Chinese will need to avoid the interference of lexical stress when learning lexical tones. Previous research has shown that native speakers of European languages tend to show a higher level of L2 proficiency in English, all other things being equal, compared with native speakers of Chinese who learn English as the L2 (see Birdsong & Molis, 2001; Jia, 2006). In Chapter 10, we will discuss the neural correlates of cross-language similarity or overlap in bilingual representation and processing. Here it suffices to say that learners whose native language does not make a given phonological distinction will have more difficulty in learning a language that makes that distinction.

A widely studied phonemic distinction is that between /r/ and /l/ in English, a distinction that is not made in Japanese. Japanese learners of English have great difficulty in accurately perceiving or producing the phonemic contrast between English /r/ and /l/: for example, the words /load/ and /road/ would be considered the same by native Japanese speakers. In two experiments Aoyama, Flege, Guion, Akahane-Yamada, and Yamada (2004) tested native Japanese children and adults who resided in the US and had learned English. In Experiment 1, 16 children (mean age = 10) and 16 adults were asked to listen to triads of words that contained the consonants /r/, /l/, and a few other consonants. The participants' task was to indicate if one of the three words differed from the other two. In Experiment 2, the same 32 participants were asked to name pictures whose English names began with the /l/, /r/, or /w/ consonants. Native English speakers then made judgments on the words produced by the learners. In both experiments, the children and adults were tested twice (Time 1 and Time 2), one year apart, in order to assess their improvement in learning. Results from Experiment 1 showed that, compared with native English speakers, both Japanese children and adults performed worse for the /r/-/l/ contrast. In addition, the adult learners improved their performance only slightly from Time 1 to Time 2 of testing, whereas child learners improved significantly within the same period. Results from Experiment 2 indicated similar patterns, in that the child learners improved significantly over the 1-year period, whereas adults showed little improvement. Interestingly, adult learners started out with better performance at Time 1 in both perception and production, but their performance did not improve at Time 2. Furthermore, children's improvement was observed mainly with /r/ rather than /l/, and Aoyama *et al.* interpreted this finding as being consistent with the SLM model discussed above: previous studies have found that the English /r/ is perceptually more dissimilar from the Japanese /r/ than is English /l/ for native Japanese speakers. Since Japanese learners did better with English /r/, this confirmed that more dissimilar phonemes are easier to learn than more similar ones, as suggested by the SLM model.

7.2.2 Age of acquisition effects and individual differences in speech learning

The study of Aoyama *et al.* showed a clear difference between child and adult learners in discriminating non-native phonemes in the second language, and the age of L2 acquisition (L2 AoA) clearly is a very important variable here. The children tested in their study were on average 10 years of age, and with experience, they were able to perform well in the phonemic perception and production tasks, although not to a native level. Archila-Suerte, Zevin, Bunta, and Hernandez (2012) further tested Spanish-English bilinguals' perception of speech sounds in a similarity-judgment task, in which syllables that contrasted in English vowels (e.g., *saf*, *sef*, *sof*, *suf*) were presented to participants in pairs and participants were asked to rate how similar the two syllables were. These syllables were also digitally edited so that many tokens (examples) of the same syllable were created that varied in intonation, timbre, and duration. The bilingual participants were all native speakers of Spanish and learned English as a second language at varying AoA and had varying levels of English proficiency. Unlike the Aoyama *et al.* study that examined only two groups (child vs. adult learners), the Archila-Suerte *et al.* study divided the participants into three groups based on the bilinguals' L2 AoA: early (mean L2 AoA = 3.6), intermediate (mean L2 AoA = 6.9), and late (mean L2 AoA = 14.5). The results indicated that only the early learners performed similarly to native monolingual English speakers, not only in perceiving the different categories associated with different syllables, but also in ignoring the variability (e.g., intonation) of the different tokens of the same syllable.

Archila-Suerte *et al.*'s study was significant in two ways. First, age of L2 acquisition is important in determining whether the learners will end up with native-like performance in speech perception. Their intermediate and late learners did not perform like native speakers. In addition, the early learners who performed as native speakers learned English after age 3, which is inconsistent with the hypothesis that language-specific speech perception occurs already at the end of the first year (see Chapter 6, Section 6.3.1). It appears from these data that there is considerable plasticity for learning in the early childhood years for native-like speech performance. It is important to note that age 3–4 is still very young (mean AoA was 3.6 in Archila-Suerte *et al.*) compared with the critical period originally thought to end around puberty (Lenneberg, 1967) or age 16 (Johnson & Newport, 1989). Thus, the learning of phonology, as compared with that of grammar or lexicon, might impose an earlier time constraint for native-like performance. Second, the learner's language proficiency also plays an important role in determining speech perception. A high level of proficiency in the second language helped the intermediate and late learners to correctly discriminate phonemic boundaries between pairs of syllables. The difference between these learners and the early learners is that the intermediate and late learners could not ignore the acoustic changes (e.g., different intonation, timbre, or duration) that are irrelevant for the target language phonemic categories, often treating different tokens of a syllable with minor changes as belonging to different phonemic categories. Perhaps the late learners, due to their increased attentional and cognitive executive abilities, employ different, more controlled, processing strategies as compared with early child learners, and therefore cannot ignore irrelevant details in speech perception. This conjecture is consistent with the "less is more" hypothesis (see Section 7.1.3) with respect to the performance outcome of speech learning. It would be interesting to see in future research whether such different styles of processing are reflected in the different brain systems used by children and adults.

If the success of L2 speech learning is determined by age of second language acquisition as discussed, can we see individual differences in how well learners with the same L2 AoA perform in speech learning? In other words, do different learners have different perceptual abilities such that these differences also determine how successful L2 speech learning will be? Researchers are increasingly interested in such individual differences: two learners, with the same language background, same length of residence in the target language country, or even starting at the same

age of L2 learning, may end up with very different learning outcomes as well as speed of learning. What factors determine such differences? This question has been traditionally asked by L2 researchers interested in language aptitude, including the study of learner differences in motivation of learning, learning strategies, and cognitive style (see Dörnyei, 2005). Cognitive scientists have also been interested in whether executive control abilities such as working memory and processing speed might predict individual learners' success in a second language (see Miyake & Friedman, 1998). In a recent study, Diaz, Baus, Escera, Costa, and Sebastián-Gallés (2008) specifically addressed the individual difference question by examining Spanish-Catalan bilinguals who learned the Catalan phonetic /e/-/ɛ/ contrast not present in Spanish (Spanish has only /e/). The participants were native Spanish speakers who all started to learn Catalan at age 4, and based on their performance with discriminating the /e/-/ɛ/ sounds, participants were divided into the good performers (GP) versus the poor performers (PP).

Diaz *et al.* were specifically interested in whether the differences between GP learners and PP learners stemmed from general perceptual variability in detecting basic acoustic differences, or whether their differences reflected only speech-specific abilities. The researchers generated nonspeech acoustic contrasts such as tones that vary in duration and frequency, and speech material that contrasted in vowel space (e.g., /o/-/e/). By collecting participants' ERP responses to speech and nonspeech contrasts presented (see discussion of the ERP method in Chapter 10), Diaz *et al.* found that the GP and PP learners did not differ in discriminating the acoustic variations, but did differ in discriminating both native and non-native speech sounds. The authors therefore concluded that poor L2 speech perception performance is correlated with speech-specific discriminatory abilities, not with general perceptual psychoacoustic abilities. More specifically, phonetic abilities in the native language may predict one's success in learning the phonetic contrasts in a second language. However, it remains an open question whether such conclusions would apply to the learning of speech contrasts involving consonants (only vowels were studied by Diaz *et al.*) and suprasegmental features such as lexical tones in Chinese. Evidence from other phonetic training studies has suggested that better acoustic processing abilities are correlated with faster speech learning and such correlations are reflected in neuroanatomical differences between faster or successful versus slower or less successful learners involving the superior temporal gyrus and the parieto-occipital brain areas (e.g., Golestani, Paus, & Zatorre, 2002; Wong, Perrachione, & Parrish, 2007; see Chapter 10 for discussion of neuroscience approaches).

7.3 Dynamic Interaction between First Language and Second Language

Although the Speech Learning Model (Flege, 1995; see discussion in Section 7.2.1) was developed to account for phonological acquisition, the basic premises of the model are relevant to other aspects of successive language acquisition. In particular, the SLM model argues for the importance of cross-language interaction and child-adult differences in perceiving and producing speech sounds in a second language. Building on the original cross-linguistic Competition Model (Bates & MacWhinney, 1987), the Unified Competition Model (MacWhinney, 2012; see discussion in Section 7.1.3) highlights the core principles of competition, cross-language variation, and child-adult differences in the acquisition of both first and second languages. Importantly, the UCM model does not view the underlying learning mechanisms for L1 and L2 acquisition as fundamentally different, but rather attributes the child-adult differences to a set of risk factors (e.g., negative transfer from L1 and entrenchment; see Section 7.1.3). In Chapter 6, syntactic transfer and code-mixing in simultaneous learners were used as evidence of cross-language interaction at a very early age. In the remainder of this chapter, we discuss how cross-language lexical and grammatical interactions occur with successive learners.

7.3.1 Patterns of cross-language lexical interaction and competition

A major task in learning a second language is the acquisition of new lexical items in the target language. This task may appear daunting to an adult successive learner, considering how many words there are in a dictionary, and how fast the child learner acquires the vocabulary in his or her native language.[2] The situation is further complicated by cross-language mismatches in phonology, grammatical use, and semantic nuances. A significant challenge to the L2 learner is then to figure out not only how to correctly produce the words, but also how to use them grammatically in a sentence and appropriately in a speech context. Thus, words of the two languages cannot simply be lined up as translation equivalents. Moreover, even many seemingly equivalent words are not truly equivalent, as illustrated in Figure 7.1.

The English words *chair* and *sofa* can be easily translated into the Chinese words *yizi* and *safa*, respectively. However, Figure 7.1 shows that the two languages are in disagreement as to which word should be used to refer to the object in the middle. In English, padded, upholstered seats for one person receive the same name as hard wooden seats for one person (*chair*), whereas in Chinese they receive the same name as padded, upholstered seats for several people (*safa*) (see the arrows in Figure 7.1). In other words, English assigns more weight to size and Chinese gives more weight to the material of the object in naming. Interestingly, in German the three objects in Figure 7.1 would receive three separate names, *stühl*, *seßel*, and *sofa*, respectively. This situation shows significant differences in how words from different languages may carve up the world differently (see Bowerman & Choi, 2001, for a discussion of such cross-linguistic differences in the use of spatial prepositions and verbs).

[2] An average 6-year-old may have a passive vocabulary of 14,000 words, according to some estimates (e.g., Carey, 1978).

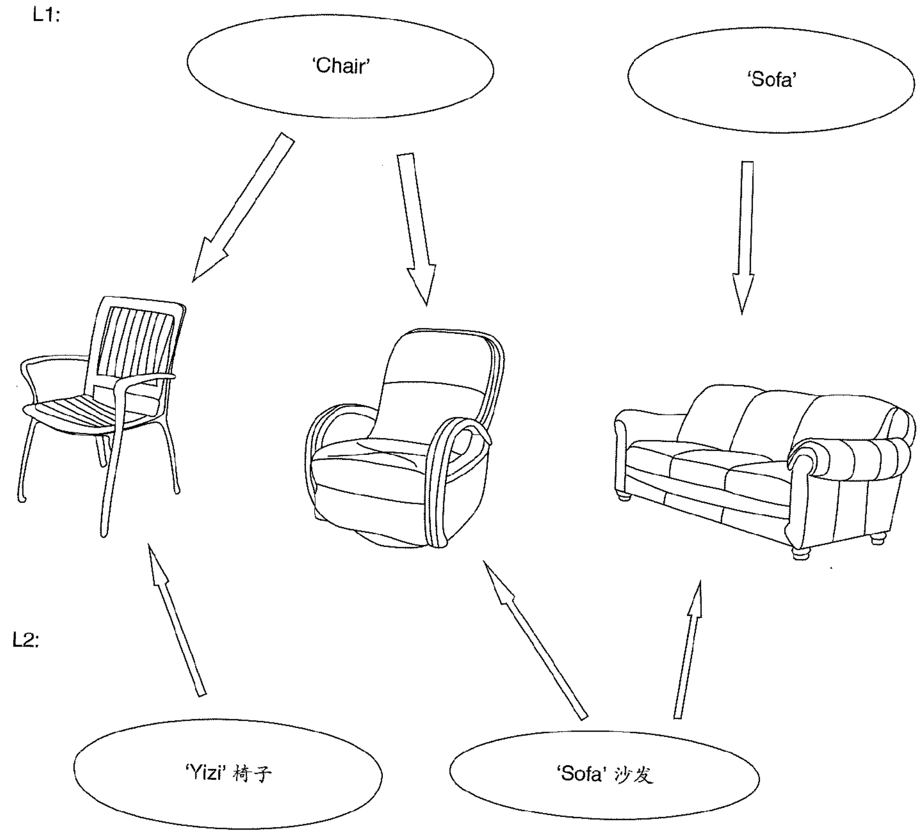

Figure 7.1: Cross-language differences in object naming. In English (designated as L1 here), size or shape of the object is important in calling something a chair or a sofa, whereas in Chinese (designated as L2 here), material of the object (e.g., having soft cushions) is more important. Speakers will name the middle object differently depending on whether the language pays attention to size or to material.

In successive language acquisition, the first possible pattern of cross-language interaction is the influence from L1 to L2. With respect to the situation depicted in Figure 7.1, an English learner of Chinese as L2 would be more likely to call the middle object *yizi*, due to influence of *chair* in L1 English. Similarly, a Chinese learner of English as L2 would be more likely to call a mug or a glass a *cup*, because in Chinese the word *beizi* is used to refer to all objects covered by the three English terms. As in speech learning, the degree to which such L1 to L2 influences occur may depend on the semantic distance between L1 and L2 items. If word meanings are totally different, the negative impact from L1 to L2 could be smaller, as compared with cross-language overlaps such as those described in the English-Chinese examples. This prediction is quite similar to that espoused by the SLM model with regard to the impact of cross-language phonetic similarities on speech learning.

There is some empirical evidence for this prediction: for example, Malt and Sloman (2003) found that L2 English learners showed naming patterns for common household objects that did not match those of native speakers, but some lexical categories (e.g., jars) showed better matches than others (e.g., containers), perhaps due to different degrees of L1 to L2 influence.

Studies of second language acquisition have traditionally focused on how L1 influences or impacts L2, but not on how L2 could influence L1 (but see Grosjean & Py, 1991). More recent evidence suggests that our first language is more permeable than traditionally thought, and that such L2 to L1 influences not only exist in early, simultaneous, bilingual language acquisition (as discussed in Chapter 6), but also in late, successive language learning (e.g., Linck, Kroll, & Sunderman, 2009; Pavlenko & Malt, 2011). That is, the influence of the later learned language could exert significant impact on one's native language, and such influences may be observed first in L1 lexical uses that are deviant from those of monolingual speakers. In extreme cases, significant L2 -> L1 influence may be accompanied by language attrition in the L1 (i.e., loss of productive use of L1) or a shift in the speaker's language dominance from L1 to L2 (i.e., the L2 becomes the dominant language; see also Chapter 1, Section 1.3 and Chapter 6, Section 6.2).

Pavlenko and Malt (2011) provided clear empirical evidence that late L2 learning may influence L1 in the domain of lexical usage. They tested three groups of immigrant Russian-English bilingual speakers who learned English as L2: early bilinguals (mean L2 AoA = 3.6 years), childhood bilinguals (mean L2 AoA = 11.7 years), and late bilinguals (mean L2 AoA = 22.8 years). Like Malt and Sloman (2003), they tested the bilingual as well as the monolingual participants' naming of common household objects, particularly drinking containers like cups, mugs, and glasses that varied in size, height, volume, and material (e.g., glass, paper or ceramic; see Figure 7.2 for examples). They counted how often participants would use different words to name a given object, and the results indicated that first, there were clear cross-language differences in the naming patterns produced by monolingual native speakers of English versus Russian. The three Russian words *chashka*, *kruzhka*, and *stakan* are generally translated into English as *cup*, *mug*, and *glass*, respectively, but the naming data indicated that each language assigns different weights to different meaning features of words. English, for example, distinguishes *cup* from *glass* based on the material that the container is made of, whereas Russian distinguishes *chashka* from *stakan* more on the basis of the size or height of the container. Such differences mean that bilinguals need to learn to focus on the right features in using names for objects. Second, the researchers found, as in Archila-Suerte *et al.* (2012; see discussion in Section 7.2.2), that there was a strong AoA effect in the L2 -> L1 interactions. The early bilinguals showed the strongest L2 influence in their L1, and the late bilinguals the least influence. This makes sense especially in light of the fact that the early bilinguals considered English (L2) to be their dominant language.

Pavlenko and Malt found that the L1 shift toward L2 entailed attrition of some L1 words as well as changes in the usage of others. There has been growing interest in L1 lexical attrition in recent years (see Schmid & Köpke, 2009), but for the most

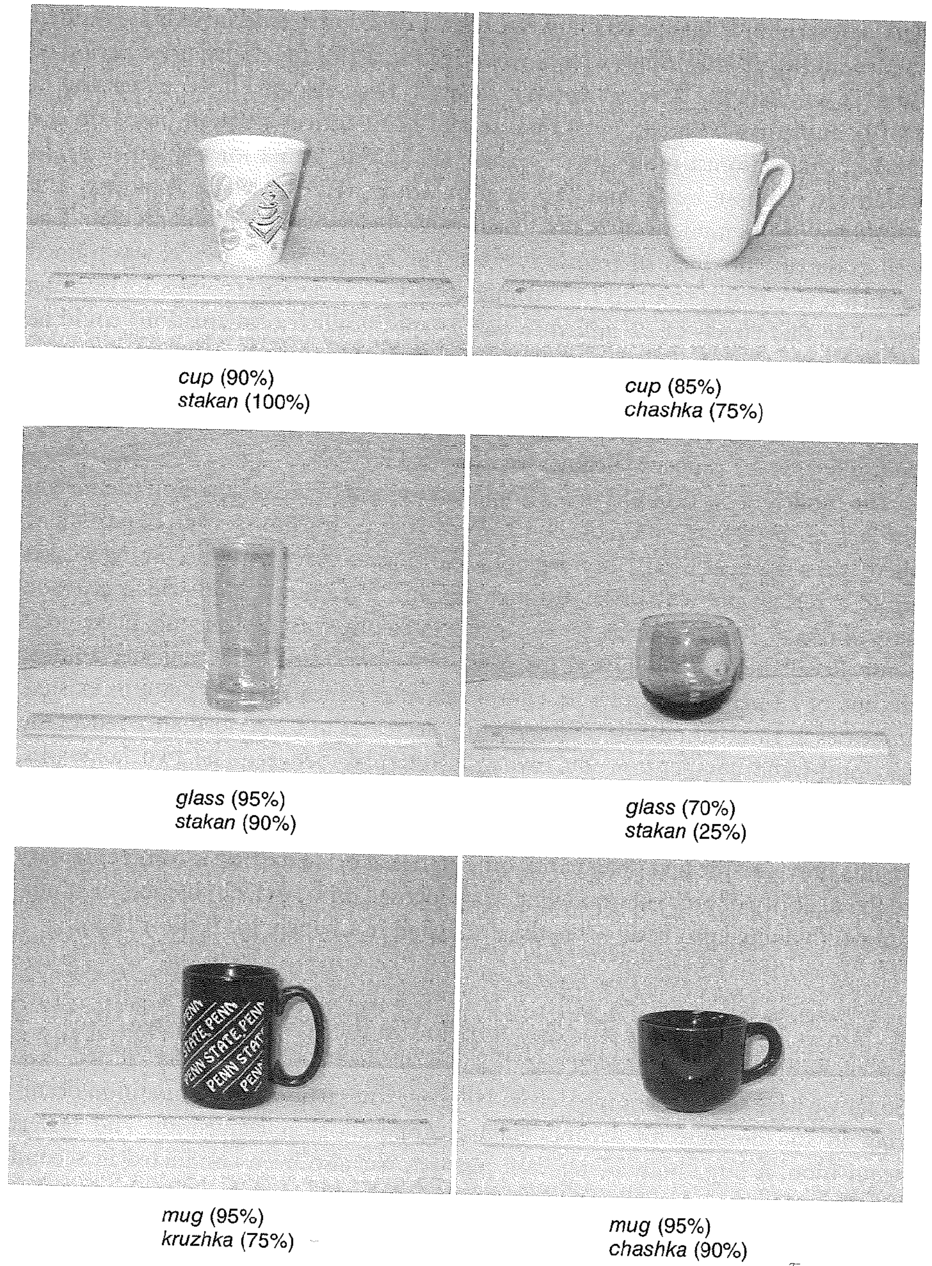

Figure 7.2: Stimulus examples of drinking containers used by Pavlenko and Malt (2011). Below the picture of each object is the dominant name produced by native speakers of English and Russian, respectively, along with the percentage of speakers who produced the name. (Reproduced with author permission.) Copyright © 2010 Cambridge University Press.

part, research on language attrition has been a descriptive enterprise limited often to case studies of individuals who have stopped using L1 for an extended period of time. To simulate the developmental changes in language attrition, Zinszer and Li (2010) implemented a computational model of L1 lexical attrition based on the DevLex connectionist model (see Chapter 10, Section 10.3.2 for a discussion), in which 116 Chinese words and 116 English words were the learning targets. The advantage of the model was that L2 AoA could be systematically manipulated, as well as the age at which L1 training ceases. The Zinszer and Li model was trained in such a way that it stopped L1 learning at varying time points when L2 learning began, so that effects of L2 influence on L1 (specifically lexical attrition) could be observed as a function of L2 AoA. Figure 7.3 illustrates how this can be done in the model by changing the L2 onset time and the L1 attrition time (this is just one scenario in which the model could be manipulated; in other cases, L1 training can continue after L2 exposure begins; see Zhao & Li, 2010).

The modeling results indicated a nonlinear pattern of lexical attrition (defined as the lack of correct activation of the L1 words after L2 learning starts). In particular, there was a stronger L1 attrition when L2 learning occurred early, becoming weaker up to a certain point (halfway through the entire training), after which attrition slowed down. These patterns, when considered along with L2 learning, make great sense. Recall the data in Johnson and Newport's (1989) study that indicated a linear decline of L2 performance up to a given age, after which no clear patterns existed. Increases in L1 attrition and corresponding decreases in L2 performance reflect the wax-and-wane competition and dynamic interplay between the two languages, showing that the earlier the L2 is learned, the less complete the L1 may be (for some bilinguals at least), and the more susceptible the L1 is to attrition. The modeling results provided the first systematic computational evidence that is complementary to the majority of previous modeling work focused on L1 to L2 influences or simultaneous bilingual processing (see the discussion in Chapter 10, Section 10.3).

7.3.2 Grammatical acquisition in the second language

So far we have seen the complex cross-language interaction and competition occurring in the domains of second language phonological acquisition and lexical acquisition. A large body of relevant research has also been conducted in second language grammatical acquisition, including the acquisition of tense and aspect that we illustrate in this section as an example.

In first language development, the ability to talk about time is one of the earliest tasks that children learn. Speakers use tense markers to indicate that a given event that occurred in the past is occurring in the present, or will occur in the future. By contrast, aspect is a grammatical means with which the speaker marks the temporal contour of a situation described, for example, presenting the speaker's view of a situation or an event as ongoing or as completed. Temporal reference can be encoded in a variety of ways in different languages (see Klein, 2009, for a discussion of how

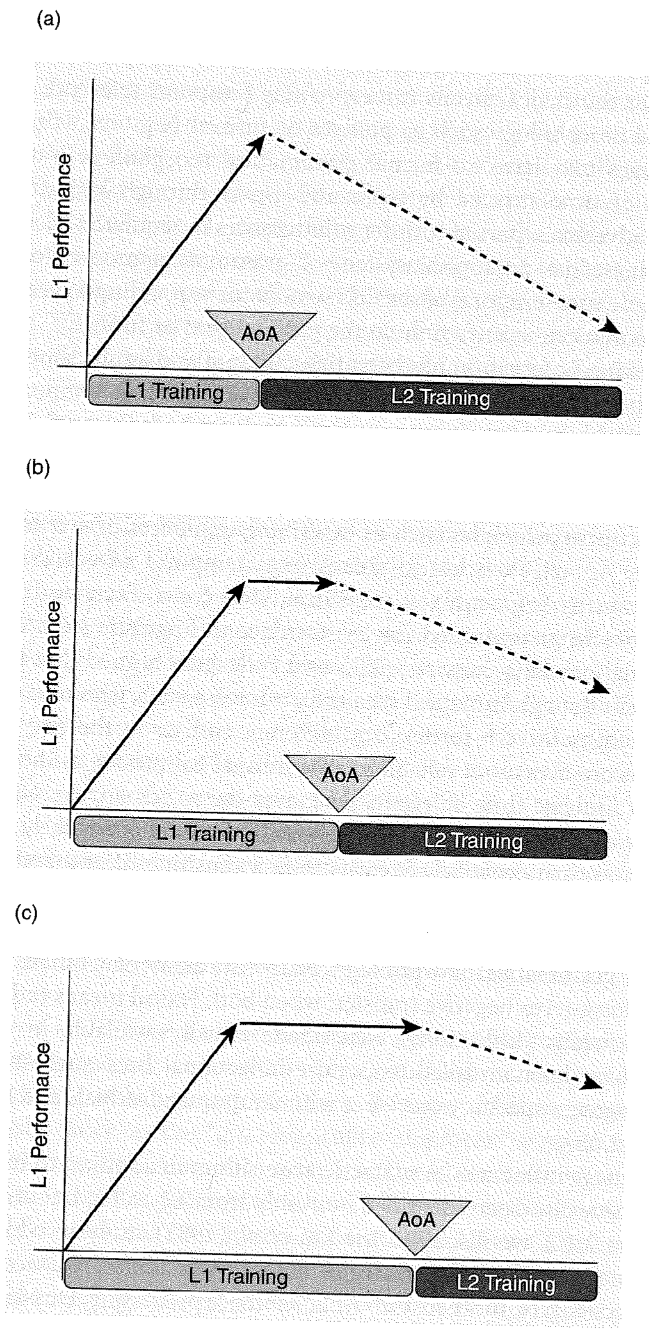

Figure 7.3: Illustration of how L1 lexical attrition is simulated as a function of L2 AoA in a computational model. (a) Early L2 AoA: L1 learning is stopped in the model at an early point in model training, and severe L1 attrition occurs; (b) Intermediate L2 AoA: L1 reached a consolidated level and training is stopped mid-course, with some L1 attrition occurring; and (c) Late L2 AoA: L1 is further entrenched before L2 begins and only limited L1 attribution occurs.

time is encoded in human languages). In most Indo-European languages, tense and aspect are the major means for expressing temporal reference, in the form of inflectional morphology such as prefixes or suffixes (e.g., *-ed*, *-ing* in English). Other languages may have no formal grammatical morphology but can express the concepts of time covered by tense and aspect through lexical or discourse devices (e.g., adverbials, particles, order of utterances in sequence; Klein, 2009). For example, Chinese has no formal system of grammatical morphology for tense. Instead, Chinese uses temporal adverbials (words corresponding to yesterday, today, tomorrow) to mark an event's time in the past, present or future.[3]

One interesting observation has been that children and adults show clear differences in their preferences for different means of encoding temporal reference: monolingual children start to use grammatical markers of tense and aspect as early as 1.5 years, many months before they systematically use lexical means of temporal reference (Weist, 1986), whereas adult L2 learners prefer to use pragmatic means first (e.g., discourse principles such as describing sequences of events in the order in which they occur), then lexical means (e.g., temporal adverbials), and finally grammatical means (e.g., suffixes; see Shirai, 2009 for a discussion). Such L1-L2 differences have been accounted for by reference to linguistic saliency and attentional blocking (see Ellis, in press). Ellis and colleagues argued that lexical means are more salient than grammatical means for adult learners, who often fail to detect the subtle changes in verb forms (e.g., different suffixes at the end of the verb). Lexical means are also more reliable than grammatical means, as the meanings of words clearly indicate time of events whenever the words appear. Given the lexical repertoire adults have for temporal reference, they are more likely to use lexical means, which in turn negatively impacts their acquisition of grammatical markers (i.e., lexical means block grammatical means). Experimental evidence indicates that such blocking effects are most clearly reflected in L2 learners whose native language does not use grammatical morphology. Native speakers of Chinese demonstrate most clearly long-term negative transfer: when both lexical means (adverbials) and grammatical means (inflections) were made equally available in experimental conditions, these learners failed to acquire inflectional cues, suggesting effects of long-term language-specific experience with temporal adverbials and lack of grammatical morphology.

Cross-language influences in syntactic acquisition, in addition to morphological acquisition, have also been identified, not only from L1 to L2, but also from L2 to L1. In Section 7.1.2, we discussed the Liu *et al.* (1992) study in which backward transfer (using L2 processing strategies for L1) was found for second language sentence processing. In another study of L2 sentence processing, Dussias and Sagarra (2007) asked Spanish-English bilinguals to read L1 Spanish sentences that contained relative clauses, such as *El policía arrestó a la hermana del criado que estaba enferma*

[3] Chinese does have a grammatical system of aspect, not through morphological markers, but through bound morphemes of lexical units (e.g., the aspect markers *-le*, *-zhe*, *-guo*; see Li & Bowerman, 1998; Li & Shirai, 2000).

desde hacía tiempo (the police arrested the sister of the servant who had been ill for a while; see Chapter 4, Section 4.4.1 for a more detailed discussion of the study). For the English version of the sentence, native speakers prefer to attach the relative clause to the second NP (*servant*), interpreting the servant as the one who is ill. Native Spanish speakers, when faced with such sentences, prefer to attach the relative clause to the first NP (*sister*), interpreting the sister as the one who is ill. In the specific Spanish example, the sentence was disambiguated by the gender marking on the adjective (i.e., *enferma*), marked with female gender morphology that agrees with the first NP. The participants were monolingual Spanish speakers plus two groups of Spanish-English bilinguals who differed in their L2 (English) immersion experience and in self-rated L2 proficiency. Analyses of the participants' eye movements during the reading of the sentences indicated that the bilinguals with limited immersion experience performed similarly to monolingual Spanish speakers, in that they spent more reading time on the sentences with relative clauses modifying the second NP, whereas the bilinguals with more immersion experience spent more time on sentences with relative clauses modifying the first NP.

Dussias and Sagarra's data point to an important aspect we discussed with cross-language lexical interaction: bilinguals with more immersion experience may change processing strategies in reading their own native language, due to their experience with and proficiency in the second language. In this set of data, the bilinguals with immersion experience may have adopted the second NP interpretation strategy preferred by native speakers of English (their L2). The data further confirm that the L1 syntactic comprehension system is also permeable, as is the lexical representation. Thus, language immersion and proficiency may have similar effects as AoA on bilingual performance: increased proficiency in the L2 grammar may be associated with more L2-native like performance but may also be accompanied by an increased loss of access to L1 processing strategies, just as younger AoA leads to better performance in the L2 and worse performance in the L1 (see Liu *et al.*, 1992 and Jia, 2006 for reviews).

In Chapters 4 and 10, we see how researchers can use electrophysiological (ERP) methods to study second language morphosyntactic processing with learners of different L2 AoA and language proficiency. By using ERP in combination with behavioral tasks (such as the "grammaticality judgment" as used by Johnson & Newport, 1989), researchers are able to tap into the L2 learner's use of grammatical knowledge during on-line processing (i.e., as it happens in real time). Reviewing a number of behavioral and ERP studies, Clahsen and Felser (2006) suggested that child L1 and adult L2 learners employ fundamentally different mechanisms in grammatical processing, in contrast to what has been suggested by the Unified Competition Model (see Section 7.1.3). Specifically, Clahsen and Felser suggested the "shallow structure hypothesis," which states that when adult L2 learners process syntactic structures in the non-native language, they are unable to construct a detailed syntactic representation for comprehension. Such detailed syntactic representations may include complex hierarchical relations involving multiple relative clauses (e.g., *the nurse the doctor argued that the rude patient had angered is refusing* *to work late*), representations that native speakers can compute and use rapidly on-line for comprehension. Contrary to Dussias and Sagarra (2007), Clahsen and Felser cited studies that failed to find relative clause attachment preferences in the L2 (for either the first NP or the second NP). As evidence for the shallow structure hypothesis, the authors argued that:

(1) ERP waveforms (e.g., left anterior negativity) that are supposed to reflect early automatic grammatical analysis are absent; and
(2) Cross-grammatical processing strategies due to cross-language influence from L1 to L2 are also absent (but see the counter evidence discussed in this section and in Chapter 10).

Clearly, there are many unresolved questions with regard to whether and how grammatical acquisition differs in L1 versus L2, and whether and how native language-specific experience interacts with L2 properties and age of L2 acquisition in influencing the process and outcome of successive language acquisition. But it is clear that we are starting to understand the critical period effects better, and that effects of age of acquisition depend on language-specific characteristics and cross-language interactions. There is overwhelming evidence that it is the complex and dynamic interplay between languages, and between the learner and the environment, that determines the success and the neurocognitive representation of single and multiple languages.

Research Questions

1. The critical period hypothesis (CPH) has been a popular hypothesis but data obtained from successive language acquisition suggest that the original CPH is likely to be wrong. What problems does it have when explaining second language acquisition?
2. What are the alternatives to the CPH in explaining the apparent age-related differences in successive language acquisition? What evidence is there that the CPH may be outdated?
3. Cross-language influence occurs at many levels for second language learners. Discuss one example each from phonological learning, lexical learning, and grammatical learning that illustrate some common principles of cross-language influences.
4. We believe that our first language is stable because it is our native language, but evidence suggests that it is also susceptible to change (permeable). Give some examples that support the idea of L1 permeability. Can you also think of personal examples (from yourself or bilinguals you know) that support this idea?

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