New Directions in the Competition Model

Brian MacWhinney

Department of Psychology

Carnegie Mellon University

The Competition Model stands as one Elizabeth Bates' major theoretical contributions to psycholinguistics. It was my honor to work with her for over twenty years in the development of this model from our first co-authored paper in 1978 up through our applications of the model to second language and aphasia in the late 1980s and early 1990s. The classic version of the model can be found in the volume that we co-edited in 1989 {MacWhinney, 1989 #5822}. Recently Bates, Devescovi, & Wulfeck {, 2001 #9699} have summarized a wide range of newly accumulated data, particularly on the application of the model to crosslinguistic studies of aphasia. In addition, a recent article by Dick et al. {, 2001 #9700} shows how the comparison of normals and aphasics in a Competition Model framework can illuminate the issue of the distributed nature of language localization in the brain.

The current paper seeks to elaborate the Competition Model in some slightly different directions. The focus here is on applications to second language learning and the development of a unified model for first language learning, second language learning, and multilingualism. I should state at the outset that, although some of these elaborations are compatible with conceptual developments contributed by Liz and her colleagues in San Diego, Taiwan, Rome, and elsewhere, other aspects of my elaborations go in directions with which she would initially disagree. In particular, the elaboration of the role of linguistic arenas seems that will be developed here may seem to represent a concession to the theory of modularity of mind. In addition, the restatement of the theory of cue cost in terms of chunking and storage may seem like a restatement, rather than a conceptual advance. However, I hope to show that the notion of arenas does not require an acceptance of modularity and that providing a specific characterization of the mechanisms of chunking and storage helps provide additional explanatory power to the model.

Can we have a unified model?

The idea that we could develop a unified model for all forms of language acquisition flies in the face of much of current accepted wisdom and practice. It is relatively easy to point to some core differences between first language learning, second language learning, multilingualism, and language loss in aphasia that would seem to problematize the construction of a unified model. Native language acquisition differs from second language acquisition in several fundamental ways. First, infants who are learning language are also engaged in learning about how the world works. In comparison, second language learners already know a great deal about the world. Second, infants are able to rely on a highly malleable brain that has not yet been committed to other tasks {MacWhinney, 2000 #7795}. Third, infants can rely on an intense system of social support from their caregivers {Snow, 1999 #8630}. Together, these three differences might suggest that it would make little sense to try to develop a unified model of first and second language acquisition. In fact, many researchers have decided that the two processes are so different that they account for them with totally separate theories. For example, Krashen {, 1994 #7256} sees L1 learning as involving "acquisition" and L2 learning as based instead on "learning." Others {Bley-Vroman, 1988 #5724;Clahsen, 1986 #5712} argue that Universal Grammar (UG) is available to children up to some critical age, but not to older learners of L2.

On the other hand, even those researchers who have traditionally emphasized the differences between L1 and L2 acquisition have been forced to recognize the fact that L1 learning processes play a large role in L2 learning {Felix, 1983 #1271}. For example, the method we use for learning new word forms in a second language is basically an extension of the methods we used for learning words in our first language. Similarly, when we come to combining second language words into sentences, we use many of the same strategies we used as children when learning our first language. Furthermore, the fact that L2 learning is so heavily influenced by transfer from L1 means that it would be impossible to construct a model of L2 learning that did not take into account the structure of the first language. Thus, rather than attempting to build two separate models of L1 and L2 learning, it makes more sense to consider the shape of a unified model in which the mechanisms of L1 learning are seen as a subset of the mechanisms of L2 learning. Although these L1 learning mechanisms are less powerful in the L2 learner, they are still partially accessible {Flynn, 1996 #9696}. Therefore, it is conceptually simpler to formulate a unified model.

We can use this same logic to motivate the extension of a unified model to the study of both childhood and adult multilingualism. In the case of childhood multilingualism, there is now an emerging consensus {De Houwer, in press #9702} that children acquire multiple languages as separate entities. However, there is also good evidence that these multiple languages interact in children through processes of transfer and code switching {Meuter, in press #9707} much as they do in adults. These processes are best understood within the context of a unified acquisitional model. Similarly, current theories of adult bilingualism have tended to emphasize bilingual competence as a steady state with minimal developmental inputs {La Heij, in press #9704}. However, this view fails to consider how dynamic aspects of code switching and interference arise from years of interaction between the languages during the child's development. Furthermore, adult multilinguals continue to develop competence in particular domains such as the skill of simultaneous interpretation {Christoffels, in press #9703}. These acquisitions depend on many of the same learning mechanisms we see operative in the earliest stages of first language acquisition, as well as other mechanisms evidenced in second language learners.

These initial considerations suggest that we need to at least consider what it might mean to construct a unified model for first language acquisition, childhood multilingualism, second language acquisition, and adult multilingualism. This chapter outlines the first stages of this attempt. It relies on the Competition Model {Bates, 1982 #228;MacWhinney, 1987 #2710} as the starting point for this new unified model. Although the Competition Model was not originally designed to account for all aspects of second language learning and multilingualism, it has certain core concepts that fit in well with a broader, fuller account. In particular, we can build on the core Competition Model insight that cue strength in the adult speaker is a direct function of cue validity. However, the unified account needs to supplement the theory of cue validity with additional theoretical constructs to deal with what we have come to refer to as "cue cost" and "cue support." Figure 1 represents the overall shape of the model that I will develop here. This figure is not to be interpreted as a processing model. Rather, it is a logical decomposition of the general problem of language learning into a series of smaller, but interrelated structural and processing components.

Earlier versions of the Competition Model included the core concept of competition, as well as the three components of arenas, mappings, and storage at the top the figure. The new aspects of the Unified Competition Model include the components of chunking, codes, and resonance given at the bottom of the figure. Before examining the operation of the new model, let us briefly define its seven components.

1. Competition. At the core of the model is a processing system that selects between various options or cues on the basis of their relative cue strength. In the classic version of the model, competition was based on cue summation and interactive activation. In the unified model, competition is viewed as based on resonance, as well as cue summation.

2. Arenas. The linguistic arenas within which competition occurs are the four traditional levels recognized in most psycholinguistic processing models -- phonology, lexicon, morphosyntax, and conceptualization. In production, these arenas involve message formulation, lexical activation, morphosyntactic arrangement, and articulatory planning. In comprehension, the competitive arenas include auditory processing, lexical activation, grammatical role decoding, and meaningful interpretation. Processing in each of these different arenas is subserved by a different combination of neuronal pathways. In addition to the eight competitive arenas we have listed, older learners also make use of two arenas of orthographic competition, one for reading and one for writing.
3. Cues. At the core of the Competition Model – both in its classical form and the newer unified form – is a notion of the linguistic sign as a mapping between form and function. The theory of mappings is similar in many ways to the theory of linguistic options articulated in Halliday's systemic grammar. In these mappings, forms serve as cues to functions during comprehension and functions serve as cues to forms during production. In other words, in production, forms compete to express underlying intentions or functions. In comprehension, functions or interpretations compete on the basis of cues from surface forms. The outcome of these competitions is determined by the relative strength of the relevant cues. For example, in English, the positioning of the subject before the verb is a form that expresses the function of marking the perspective or agent. Or, to give another example, the pronoun "him" is a form that expresses the functions of masculine gender and the role of the object of the verb. The Competition Model focuses primarily on the use of forms as cues to role assignment, coreference, and argument attachment as outlined in MacWhinney {, 1987 #2710}. Mappings are social conventions

that must be learned for each of the eight linguistic arenas, including lexicon, phonology, morphosyntax, and mental models.

4. Storage. The learning of new mappings relies on storage in both short-term and long-term memory. Gupta & MacWhinney {, 1997 #6908} have developed an account of the role of short-term memory in the construction of memories for the phonological forms of words and the mapping of these forms into meaningful lexical items. Short-term memory is also crucially involved in the online processing of specific syntactic structures {MacWhinney, 1988 #3335;Gibson, 1996 #7467}. Recently, MacWhinney {, 1999 #7785} has examined how the processes of perspective switching and referent identification can place demands on verbal memory processes during mental model construction. The operation of these memory systems constrains the role of cue validity during both processing and acquisition. For example, the processing of subject-verb agreement for inverted word orders in Italian is not fully learned until about age 8 {Devescovi, 1998 #9495}, despite its high cue validity and high cue strength in adult speakers.
5. Chunking. The size of particular mappings depends on the operation of processes of chunking. Work in first language acquisition has shown us that children rely on both combinatorial processing and chunking to build up syllables, words, and sentences. For example, a child may treat learn "what's this" as a single unit or chunk, but will compose phrases such as "more cookie" and "more milk" by combination of "more" with a following argument. MacWhinney {, 1982 #2699;, 1978 #2690} and Stemberger & MacWhinney {, 1986 #3989} show how large rote chunks compete with smaller analytic chunks in both children and adult learners

6. Codes. When modeling bilingualism and L2 acquisition, it is important to have a clear theory of code activation. The Competition Model distinguishes two components of the theory of code competition. The first component is the theory of transfer. This theory has been articulated in some detail in Competition Model work in terms of predictions for both positive and negative transfer in the various linguistic arenas. The second component is the theory of code interaction, which determines code selection, switching, and mixing. The Competition Model relies on the notion of resonance, discussed below, to account for coactivation processes in both L2 learners and bilinguals. The choice of a particular code at a particular moment during lexicalization depends on factors such as activation from previous lexical items, the influence of lexical gaps, expression of sociolinguistic options {Ervin-Tripp, 1969 #1230}, and conversational cues produced by the listener.
7. Resonance. Perhaps the most important area of new theoretical development in the Unified Competition Model is the theory of resonance. This theory seeks to relate the Competition Model to research in the area of embodied or embedded cognition, as well as newer models of processing in neural networks.

The seven-component model sketched out above includes no separate component for learning. This is because learning is seen as an interaction between each of the various subcomponents during the processes of competition and resonance. We will now explore each of the seven components of the model in more detail.

Competition

The basic notion of competition is fundamental to most information-processing models in cognitive psychology. In the Unified Model, competition takes on slightly different forms in each of the eight competitive arenas. We think of these arenas not as encapsulated modules, but as playing fields that can readily accept input from other arenas, when that input is made available. In the course of work on the core model and related mechanisms, my colleagues and I have formulated working computational models for most of these competitive arenas.

1. In the auditory arena, competition involves the processing of cues to lexical forms based on both bottom-up features and activation from lexical forms. Models of this process include those that emphasize top-down activation {Elman, 1988 #4747} and those that exclude it {Norris, 1994 #7019}. In the Competition Model, bottom-up activation is primary, but top-down activation will occur in natural conditions and in those experimental tasks that promote resonance.
2. In the lexical arena, competition occurs within topological maps {Li, under review #9590} where words are organized by semantic and lexical type.
3. In the morphosyntactic arena, there is an item-based competition between word orders and grammatical markings centered on valence relations {MacDonald, 1994 #7187;MacWhinney, 1987 #2712}.
4. In the interpretive arena, there is a competition between fragments of mental models as the listener seeks to construct a unified mental model {MacWhinney, 1989 #2725} that can be encoded in long-term memory {Hausser, 1999 #9374}.
5. In the arena of message formulation, there is a competition between communicative goals. Winning goals are typically initialized and topicalized.

6. In the arena of expressive lexicalization, there is a competition between words for the packaging and conflation of chunks of messages {Langacker, 1989 #7677}.
7. In the arena of sentence planning, there is a competition of phrases for initial position and a competition between arguments for attachment to slots generated by predicates {Dell, 1993 #5790}.
8. In the arena of articulatory planning, there is a competition between syllables for insertion into a rhythmic phrasal output pattern {Dell, 1993 #5790}.

Cues

Experimental work in the Competition Model tradition has focused on measurement of the relative strength of various cues to the selection of the agent, using a simple sentence interpretation procedure. Subjects listen to a sentence with two nouns and a verb and are asked to say who was the actor. In a few studies, the task involves direct-object identification {Sokolov, 1988 #3925;Sokolov, 1989 #3926}, relative clause processing {MacWhinney, 1988 #3335}, or pronominal assignment {MacDonald, 1990 #5192;McDonald, 1995 #5198}, but usually the task is agent identification. Sometimes the sentences are well-formed grammatical sentences, such as *the cat is chasing the duck*. Sometimes they involve competitions between cues, as in the ungrammatical sentence **the duck the cat is chasing*. Depending on the language involved, the cues varied in these studies include word order, subject-verb agreement, object-verb agreement, case-marking, prepositional case marking, stress, topicalization, animacy, omission, and pronominalization. These cues are varied in a standard orthogonalized ANOVA design with three or four sentences per cell to increase statistical reliability. The basic question is always the same: what is the relative order of cue strength in the given language and how do these cue strengths interact?

In English, the dominant cue for subject identification is preverbal positioning. For example, in the English sentence *the eraser hits the cat*, we assume that *the eraser* is the agent. However, a parallel sentence in Italian or Spanish would have *the cat* as the agent. This is because the word order cue is not as strong in Italian or Spanish as it is in English. In Spanish, the prepositional object marker “a” is a clear cue to the object and the subject is the noun that is not the object. An example of this is the sentence *el toro mató al torero* (The bull killed to-the bullfighter). No such prepositional cue exists in English. In German, case marking on the definite article is a powerful cue to the subject. In a sentence such as *der Lehrer liebt die Witwe* (The teacher loves the widow), the presence of the nominative masculine article *der* is a sure cue to identification of the subject. In Russian, the subject often has a case suffix. In Arabic, the subject is the noun that agrees with the verb in number and gender and this cue is stronger than the case-marking cue. In French, Spanish, and Italian, when an object pronoun is present, it can help identify the noun that is not the subject. Thus, we see that Indo-European languages can vary markedly in their use of cues to mark case roles. When we go outside of Indo-European to languages like Navajo, Hungarian, or Japanese, the variation becomes even more extreme.

To measure cue strength, Competition Model experiments rely on sentences with conflicting cues. For example, in *the eraser push the dogs* the cues of animacy and subject-verb agreement favor “the dogs” as agent. However, the stronger cue of preverbal positioning favors “the eraser” as agent. As a result, English-speaking adult subjects strongly favor “the eraser” even in a competition sentence of this type. However, about 20% of the participants will choose “the dogs” in this case. To measure the validity of cues in the various languages we have studied, we rely on text counts where we list the cues in favor of each noun and track the relative availability and reliability of each cue. Cue availability is defined as the presence of the cue in some contrastive form. For example, if both of the nouns in a sentence are animate, then the animacy cue is not contrastively available.

By looking at how children, adult monolinguals, and adult bilinguals speaking about 18 different languages process these various types of sentences, we have been able to reach these conclusions, regarding sentence comprehension:

1. When given enough time during sentence comprehension to make a careful choice, adults assign the role of agency to the nominal with the highest cue strength.
2. When there is a competition between cues, the levels of choice in a group of adult subjects will closely reflect the relative strengths of the competing cues.
3. When adult subjects are asked to respond immediately, even before the end of the sentence is reached, they will tend to base their decisions primarily on the strongest cue in the language.
4. When the strongest cue is neutralized, the next strongest cue will dominate.
5. The fastest decisions occur when all cues agree and there is no competition. The slowest decisions occur when strong cues compete.
6. Children begin learning to comprehend sentences by first focusing on the strongest cue in their language.
7. As children get older, the strength of all cues increases to match the adult pattern with the most valid cue growing most in strength.
8. As children get older, their reaction times gradually get faster in accord with the adult pattern.

9. Compared to adults, children are relatively more influenced by cue availability, as opposed to cue reliability.
10. Cue strength in adults and older children (8-10 years) is not related to cue availability (since all cues have been heavily encountered by this time), but rather to cue reliability. In particular, it is a function of conflict reliability, which measures the reliability of a cue when it conflicts directly with other cues.

This list of findings from Competition Model research underscores the heuristic value of the concept of cue strength.

Storage

One of the core findings of Competition Model research has been that, when adult subjects are given plenty of time to make a decision, their choices are direct reflections of the cumulative validity of all the relevant cues. In this sense, we can say that off-line decisions are optimal reflections of the structure of the language. However, when subjects are asked to make decisions on-line, then their ability to sample all relevant cue is restricted. In such cases, we say that "cue cost" factors limit the application of cue validity. These cue cost factors can involve various aspects of processing. However, the most important factors are those that require listeners to maintain the shape cues in working memory.

Theories of the neural basis of verbal memory view this storage as involving a functional neural circuit that coordinates inputs from Broca's area, lexical storage in the temporal lobe, and additional structures that support phonological memory. Unlike local lexical maps, which are neurologically stable, this functional circuit is easily disrupted and relies heavily on access to a variety of cognitive resources.

At the core of syntactic processing is the learning and use of item-based constructions {MacWhinney, 1975 #2683}. Item-based constructions open up slots for arguments that may occur in specific positions or that must receive specific morphological markings. Although item-based constructions are encoded in local maps, they specify combinations that must be processed through functional circuits. The importance of item-based constructions has been re-emphasized in a new line of research recently reviewed by Tomasello {, 2000 #9481}. The account of MacWhinney {, 1982 #2699} held that children first learn that a verb like *throw* takes three arguments (thrower, object thrown, recipient). Then, by comparing groups of these item-based patterns through analogy, children can then extract broader class-based patterns. In this case, they would extract a pattern that matches the set of transfer verbs that take the double object construction as in *John threw Bill the ball*. By the end of the third year, these new constructions {Goldberg, 1999 #8629} begin to provide the child with the ability to produce increasingly fluent discourse. Second language learners go through a similar process, sometimes supported by pattern drills.

By maintaining words and constructions in short-term sentence memory, learners can facilitate a wide range of additional learning and processing mechanisms. Perhaps the most remarkable of these processes is the learning of the skill of simultaneous translation ({Christoffels, in press #9703}. Practitioners of this art are able to listen in one language and speak in the other in parallel, while also performing a complex mapping of the message of the input language to the very different syntax of the output language. The very existence of simultaneous translation underscores the extent to which two languages can be coactivated {Spivey, 1999 #9695} for long periods of time {Meuter, in press #9707}.

The problems involved in simultaneous translation nicely illustrate how language can place a heavy load on functional neural circuits. Let us take a simple case to illustrate the problem. Consider a German sentence with a verb in final position. If the German sentence is short, the interpreter will have little problem converting the German SOV order to English SVO. For example, a sentence like *Johannes hat den Mann mit dem dunkele Mantel noch nicht kennengelernt* "John has not yet met the man with the dark coat" will cause few problems, since the interpreter can lag behind the speaker enough to take in the whole utterance along with the verb before starting to speak. The interpreter prepares an utterance with a subject and object already in final form. When the verb comes along, it is simply a matter of translating it to the English equivalent, dropping it into the prepared slot, and starting articulatory output. However, if there is additional material piled up before the verb, the problem can get worse. Typically, simultaneous interpreters try not to lag more than a few words behind the input. To avoid this, one solution would be to store away the short subject and dump out the large object as the head of a passive as in, "The man with the dark coat has not yet been met by John." Another, rather unhappy, solution is topicalization, as in "John, in regard to the man with the dark coat, he hasn't seen him yet." Similar problems can arise when translating from relative clauses in languages with VSO order such as Tagalog or Arabic. Studies of Hungarian {MacWhinney, 1988 #3335} and Japanese {Hakuta, 1981 #1741} show that the stacking up of unlinked noun phrases can be even worse in SOV languages.

If interpreters had access to an unlimited verbal memory capacity, there would be little worry about storing long chunks of verbal material. However, we know that our raw memory for strings of words is not nearly large enough to accommodate the simultaneous interpretation task. In fact, the conventional estimate of the number of items that can be stored in short-term memory is about four. The interpreter's task is made even more difficult by the fact that they must continue to build mental models of incoming material {MacWhinney, 1999 #7785} while using previously constructed mental models as the basis for ongoing articulation. In order to do this successfully, the interpreter must be able to delineate chunks of comprehended material that are sufficient to motivate full independent output productions. In effect, the interpreter must maintain two separate conceptual foci centered about two separate points in conceptual space. The first attentional focus continues to take in new material from the speaker in terms of new valence and conceptual relations. The second attentional focus works on the comprehended structure to convert it to a production structure. The location of the production focus is always lagged after that of the comprehended structure, so the interpreter always has a split in conceptual attention. As a result of the load imposed by this attentional split and ongoing activity in two channels, interpreters often find that they cannot continue this line of work past the age of 45 or so.

Interpreters are not the only speakers who are subject to load on their use of functional neural circuits. It is easy to interfere with normal language processing by imposing additional loads on the listener or speaker. Working within a standard Competition Model experimental framework, Kilborn {, 1989 #4801} has shown that even fully competent bilinguals tend to process sentences more slowly than monolinguals. However, when monolinguals are asked to listen to sentences under conditions of white noise, their reaction times are identical to those of the bilinguals. Similarly Blackwell and Bates {, 1995 #5947} and Miyake, Just and Carpenter {, 1994 #6918} have shown that, when subjected to conditions of noise, normals process sentences much like aphasics. Gerver {, 1974 #6985} and Seleskovitch {, 1976 #6986} report parallel results for the effects of noise on simultaneous interpretation.

Chunking

The component of chunking is a recent addition to the Competition Model. However, this idea is certainly not a new one for models of language learning. Chunking operates to take two or more items that frequently occur together and combine them into a single automatic chunk. Chunking is the basic learning mechanism in Newell's general cognitive model {Newell, 1990 #5300}, as well as in many neural network models. MacWhinney and Anderson {, 1986 #2719} showed how the child can use chunking processes to build up larger grammatical structures and complex lexical forms. Ellis {, 1994 #7259} has shown how chunking can help us understand the growth of fluency in second language learning. Gupta & MacWhinney {, 1997 #6908} show how chunking can also apply to the learning of the phonological shape of individual words for both L1 and L2.

Chunking plays a particularly interesting role in the acquisition of grammar. For second language learners, mastering a complex set of inflectional patterns is a particularly daunting challenge. These problems are a result of the tendency of L2 learners to fail to pick up large enough phrasal chunks. For example, if learners of German would pick up not just that *Mann* means "man", but also learn phrases such as *der alte Mann, meines Mannnes, den junge Männern,* and *ein guter Mann*, then they would not only know the gender of the noun, but would also have a good basis for acquiring the declensional paradigm for both the noun and its modifiers. However, if they analyze a phrase like *der alte Mann* into the literal string "the + old + man" and throw away all of the details of the inflections on "der" and "alte," then they will lose an opportunity to induce the grammar from implicit generalization across stored chunks. If, on the other hand, the learner stores larger chunks of this type, then the rules of grammar can emerge from analogic processing of the stored chunks.

Chunking also leads to improvements in fluency. For example, in Spanish, L2 learners can chunk together the plan for *buenos* with the plan for *dîas* to produce *buenos días*. They can then combine this chunk with *muy* to produce *muy buenos días* "very good morning." Chunking {Ellis, 1994 #7259} allows the learner to get around problems with Spanish noun pluralization, gender marking, and agreement that would otherwise have to be reasoned out in detail for each combination. Although the learner understands the meanings of the three words in this phrase, the unit can function as a chunk, thereby speeding production.

Codes and Transfer

Any general model of second language learning must be able to account for interlanguage phenomena such as transfer and code switching. In addition, it must offer an account of age-related learning effects that have been discussed in terms of critical periods and fossilization. Because of space limitations, I will not include a discussion of code-switching theory here, focusing instead on the theory of transfer and its impact on age-related effects.

The basic claim is that whatever can transfer will. This claim is theoretically important for at least two reasons. First, because the competition model emphasizes the interactive nature of cognitive processing, it must assume that, unless the interactions between languages are controlled and coordinated, there would be a large amount of transfer. Second, the model needs to rely on transfer to account for age-related declines in L2 learning ability without invoking the expiration of a genetically programmed critical period {Birdsong, in press #9706}.

For simultaneous bilingual acquisition the model predicts code blending in young children only when parents encourage this or when there are gaps in one language that can be filled by "borrowing" from the other. This prediction follows from the role of resonance in blocking transfer. When the child's two languages are roughly similar in dominance or strength, each system generates enough system-internal resonance to block excessive transfer. However, if one of the languages is markedly weaker {Dopke, in press #9176}, then it will not have enough internal resonance to block occasional transfer. The situation is very different for L2 learners, since the balance between the languages is then tipped so extremely in favor of L1. In order to permit the growth of resonance in L2, learners must apply additional learning strategies that would not have been needed for children. These strategies focus primarily on optimization of input, promotion of L2 resonance, and avoidance of processes that destroy input chunks.

In the next sections, we briefly review the evidence for transfer from L1 to L2. We will see that there is clear evidence for massive transfer in audition, articulation, lexicon, sentence interpretation, and pragmatics. In the area of morphosyntax and sentence production, transfer is not as massive, largely because it is more difficult to construct the relations between L1 and L2 forms in these areas. Pienemann et al. {, in press #9701} have argued that transfer in these areas is less general than postulated by the Competition Model. However, we will see that their analysis underestimates transfer effects in their own data.

Transfer in Audition

Phonological learning involves two very different processes. Auditory acquisition is primary and begins even before birth {Moon, 1993 #7540}. It relies on inherent properties of the mammalian ear {Moon, 1993 #7540} and early pattern detection through statistical learning. This same statistical learning mechanism is operative in children, adults, and cotton-top tamarins

{Hauser, 2001 #9444}. Recent research on early auditory processing {Sebastián-Galles, in press #9709} has yield three major findings. First, it appears that children begin to separate prosodically distinct languages from the first months. This means, for example, that children who are growing up in a home where Swedish and Portuguese are being spoken will have perhaps 16 months of experience in distinguishing these two languages by the time they come to saying their first words. The fact that these languages are separated in audition so early makes findings of early separation in production less surprising and more clearly understandable in Competition Model terms.

Recent research {Werker, 1995 #8620} has also shown that children begin to "lock in" the sounds of their first language(s) by the end of the first year and become relatively insensitive to distinctions in other languages. This commitment to the sounds of L1 can be reversed through childhood. However, for at least some sounds, it is difficult to obtain native-like contrast detection during adulthood. The classic example of this is the difficulty that Japanese adults have in distinguishing /l/ and /r/ in English {Lively, 1990 #5467}. Examples of this type demonstrate the basic claim for generalized transfer effects in the Competition Model. But note that what is transferring here from Japanese is not a contrast, but the L1 tendency to block out a contrast. At the same time, there are other non-L1 distinctions that can easily be perceived by adults. It appears that a full account of which contrasts can be learned and which will be blocked will need to be grounded on a dynamic model of auditory perception that is not yet available.

Finally, work on early audition has shown that children are picking up the auditory shapes of words well before they have their own productive vocabulary. Moreover, they are making the first steps toward classifying words into phrases and combinations on the auditory level even before they understand their meanings. These same mechanisms play an important role in L2 learning, as suggested by the Input Hypothesis. Through exposure to large amounts of auditory input in L2 that echo in a resonant way on the auditory level, L2 learners can also begin acquisition even before they demonstrate much in the way of independent productive ability.

Transfer in Articulation

The major challenge facing the L1 learner is not the acquisition of perceptual patterns, but the development of articulatory methods for reproducing these patterns {Menn, 1995 #7673}. The coordination of motor mechanisms for speech output is a relatively late evolutionary emergence {MacWhinney, 2003 #9477} and it is not surprising that it is relatively difficult skill for the child to control. However, by age 5, most children have achieved control over articulatory processes.

For the adult L2 learner and the older child, the situation is much different. For them, learning begins with massive transfer of L1 articulatory patterns to L2 {Hancin-Bhatt, 1994 #7035;Flege, 1984 #6820}. This transfer is at first successful in the sense that it allows for a reasonable level of communication. However, it is eventually counter-productive, since it embeds L1 phonology into the emergent L2 lexicon. In effect, the learner treats new words in L2 as if they were composed of strings of L1 articulatory units. This method of learning leads to short term gains at the expense of long-term difficulties in correcting erroneous phonological transfer. Older children acquiring a second language can rely on their greater neuronal flexibility to quickly escape these negative transfer effects. In doing so, they are relying on the same types of adolescent motor abilities that allow adolescents to become proficient acrobats, gymnasts, dancers, and golfers. Adults have a reduced ability to rewire motor productions on this basic level. However, even the most difficult cases of negative transfer in adulthood can be corrected through careful training and rehearsal {Flege, 1995 #6796}. To do this, adults must rely on resonance, selective attention, and learning strategies to reinvigorate a motor learning process that runs much more naturally in children and adolescents.

Transfer in Lexical Learning

In the arena of lexical processing, the L2 learner can achieve rapid initial progress by simply transferring the L1 conceptual world *en masse* to L2. Young bilinguals can also benefit from this conceptual transfer. When learners first acquire a new L2 form, such as “silla” in Spanish, they treat this form as simply another way of saying “chair”. This means that initially the L2 system has no separate conceptual structure and that its formal structure relies on the structure of L1. L2 relies on L1 forms to access meaning, rather than accessing meaning directly. In this sense, we can say that L2 is parasitic on L1, because of the extensive amount of transfer from L1 to L2. The learner’s goal is to reduce this parasitism by building up L2 representations as a separate system. They do this by strengthening the direct linkage between new L2 forms and conceptual representations.

Given the fact that connectionism predicts such massive transfer for L1 knowledge to L2, we might ask why we do not see more transfer error in second language lexical forms. There are three reasons for this.

1. First, a great deal of transfer occurs smoothly and directly without producing error. Consider a word like *chair* in English. When the native English speaker begins to learn Spanish, it is easy to use the concept underlying “chair” to serve as the meaning for the new word *silla* in Spanish. The closer the conceptual, material, and linguistic worlds of the two languages, the more successful this sort of positive transfer will be. Transfer only works smoothly when there is close conceptual match. For example, Ijaz {, 1986 #4797} has shown how difficult transfer can be for Korean learners of English in

semantic domains involving transfer verbs, such as *take* or *put*. Similarly, if the source language has a two-color system {Berlin, 1969 #300}, as in Dani, acquisition of an eight-color system, as in Hungarian, will be difficult. These effects underscore the extent to which L2 lexical items are parasitic on L1 forms.

2. Second, learners are able to suppress some types of incorrect transfer. For example, when a learner tries to translate the English noun *soap* into Spanish by using a cognate, the result is *sopa* or "soup." Misunderstandings created by "false friend" transfers such as this will be quickly detected and corrected. Similarly, an attempt to translate the English form *competence* into Spanish as *competencia* will run into problems, since *competencia* means competition. In laboratory settings, the suppression of these incorrect form relatives is incomplete, even in highly proficient bilinguals. However, this persistent transfer effect is probably less marked in non-laboratory contexts.
3. Third, error is minimized when two words in L1 map onto a single word in L2. For example, it is easy for an L1 Spanish speaker to map the meanings underlying "saber" and "conocer" {Stockwell, 1965 #5239} onto the L2 English form "know." Dropping the distinction between these forms requires little in the way of cognitive reorganization. It is difficult for the L1 English speaker to acquire this new distinction when learning Spanish. In order to control this distinction correctly, the learner must restructure the concept underlying "know" into two new related structures. In the area of lexical learning, these cases should cause the greatest transfer-produced errors

Transfer in Sentence Comprehension

Transfer is also pervasive in the arena of sentence interpretation. There are now over a dozen Competition Model studies that have demonstrated the transfer of a “syntactic accent” in sentence interpretation {Bates, 1981 #227;Kilborn, 1989 #2245;Kilborn, 1989 #4801;Kilborn, 1987 #2243;Harrington, 1987 #1794;Gass, 1987 #1472;Liu, 1992 #5646;McDonald, 1987 #2865;McDonald, 1987 #2868;McDonald, 1989 #2871;McDonald, 1991 #4825;de Bot, 1988 #4735}. Frenck-Mestre {, in press #9705} presents a particularly elegant design demonstrating this type of effect during on-line processing. These studies have shown that the learning of sentence processing cues in a second language is a gradual process. The process begins with L2 cue weight settings that are close to those for L1. Over time, these settings change in the direction of the native speakers’ settings for L2.

This pattern of results is perhaps most clearly documented in McDonald’s studies of English-Dutch and Dutch-English second language learning {McDonald, 1987 #2868}. This study shows a linear decline in the strength of the use of word order by English learners of Dutch over increased levels of competence and exactly the opposite pattern for Dutch learners of English. These results and others like them constitute strong support for the Competition Model view of second language learning as the gradual growth of cue strength.

Transfer in Pragmatics

The acquisition of pragmatic patterns is also heavily influenced by L1 transfer. When we first begin to use a second language, we may extend our L1 ideas about the proper form of greetings, questions, offers, promises, expectations, turn taking, topic expansion, face-saving, honorifics, presuppositions, and implications. If the two cultures are relatively similar, much of this transfer will be successful. However, there will inevitably be some gaps. In many cases, the L2 learner will need to eventually reconstruct the entire system of pragmatic patterns in the way they were learned by the child acquiring L1. Much of this learning is based on specific phrases and forms. For example, the L1 learners understanding of greetings is tightly linked to use of specific phrases such as *Guten Morgen* or *bye-bye*. Learning about how and when to use specific speech acts is linked to learning about forms such as *could you? listen*, and *why not?* Learning these forms in a concrete context is important for both L1 and L2 learners. However, pragmatics involves much more than simple speech act units or pairs. We also need to learn larger frames for narratives, argumentation, and polite chatting. By following the flow of perspectives and topics in conversations {MacWhinney, 1999 #7785}, we can eventually internalize models of how discourse represents reality in both L1 and L2.

Transfer in Morphology

Learning of the morphological marking or inflections of a second language is very different from learning of the other areas we have discussed. This is because, in morphosyntax, it is typically impossible to transfer from L1 to L2. For example, an English learner of German cannot use the English noun gender system as a basis for learning the German noun gender system. This is because English does not have a fully elaborated noun gender system. Of course, English does distinguish between genders in the pronouns ("he" vs. "she") and this distinction is of some help in learning to mark German nouns that have natural gender such as der Vater ("the-MASC father) and die Mutter ("the-FEM mother"). However, one really does not need to rely on cues from English "he" and "she" to realize that fathers are masculine and mothers are feminine.

On the other hand, there can be some real transfer effects to German from other languages that have full nominal gender systems. For example, a Spanish speaker might well want to refer to the moon as feminine on the basis of "la luna" in Spanish and produce the erroneous form die Mond in German,rather than the correct masculine form "der Mond."

Similarly, a Spanish learner of Chinese cannot use L1 knowledge to acquire the system of noun classifers, because Spanish has no noun classifiers. Chinese learners of English cannot use their L1 forms to learn the English contrast between definite, indefinite, and zero articles. This is because Chinese makes no overt distinctions in this area, leaving the issue of definiteness to be marked in other ways, if at all.

The fact that morphosyntax is not subject to transfer is a reflection of the general Competition Model dictum that "everything that can transfer will." In the areas of phonology, lexicon, orthography, syntax, and pragmatics, we see attempts to transfer. However, in morphology we see no transfer, because there is no basis for transfer. The exception here is between structurally mapable features, as in the example of gender transfer from Spanish to German.

Although there is no transfer of the exact forms of morphosyntax, and little transfer of secondary mappings such as thinking that the moon is feminine, there is important positive and negative transfer of the underlying functions expressed by morphological devices. Concepts such as the instrumental, locatives, or benefactives often have positive transfer between languages. For example, many languages merge the instrumental "with" and the comitative "with." If L1 has this merger, it is easy to transfer the merged concept to L2. Similarly, semantically grounded grammatical distinctions such as movement towards and movement from can easily be transferred across languages. However in other areas, transfer is less positive. One remarkable area of difficulty is in the learning of article marking in English by speakers of Chinese, Japanese, or Korean. These languages have no separate category of definiteness, instead using classifiers and plurals to express some of the functions marked by the English definite. Moreover, the complexity of the subcomponents of definiteness in English stands as a major barrier for speakers of these languages.

Transfer in Sentence Production

Pienemann et al. {, in press #9701} present evidence that the Competition Model claim that "everything that can transfer will" does not hold in the area of L2 sentence production. Instead, they suggest that "only those linguistic forms that the learner can process can be transferred to L2." Their analysis of this issue is exceptionally detailed and the additional evidence they bring to bear is bound to lead to a very helpful sharpening of the issues at stake. They present the case of the learning of the German V2 rule by speakers of L1 Swedish. The V2 rules in Swedish and German allow speakers to front adverbs like "today" or "now." This produces sentences with the verb in second position with forms such as "Today likes Peter milk." The surprising finding is that Swedes don't produce this order from the beginning, starting instead with "Today Peter likes milk." This finding is only surprising if one believes that what learners transfer are whole syntactic frames for whole sentences. However, the Competition Model holds that the basic unit of both L1 and L2 acquisition is the item-based pattern. In this case, learners first learn to place the subject before the verb, as in "Peter likes milk". Later they add the adverb to produce "Peter likes milk today." Only in the final stages of learning, do they then pick up the item-based frame that allows adverbs to take the initial slot. The important point here is that in this part of sentence production, much as in morphology, the mapping from

L1 to L2 is low-level and conservative. Thus, the failure to see a transfer of the V2 rule from Swedish to German is based on the fact that Swedes are learning German from item-based patterns, not by picking up whole sentence frames at a time. The emphasis on learning from item-based patterns should hold for all beginning L2 learners. For example, we would not expect to see early transfer to Italian of the English cleft structure, although the structure is present in both languages and learners will eventually make the mapping. The problem is that during the first stages of learning, learners are just not working on the sentence level.

The opposite side of this coin is that, when L2 structures can be learned early on as item-based patterns, this learning can block transfer from L1. Pienemann et al. {, in press #9701} present the example of learning of Japanese SOV order by speakers of L1 English. These learners almost never generalize English SVO to Japanese. Of course, the input to L2 learners consistently emphasizes SOV order and seldom presents any VO sequences, although these do occur in colloquial Japanese. This learning is best understood in terms of the account of MacWhinney {, 1982 #2699;, 1987 #2710}. Learners acquire a few initial Japanese verbs as item-based constructions with slots for objects in preverbal position marked by the postposition "o" and topics in initial position marked by the postpositions "wa" or "ga." After learning a few such items, they generalize to the "feature-based" construction of SOV. This is positive learning based on consistent input in L2. If L1 were to have a transfer effect at this point, it would be extremely brief, since L2 is so consistent and these item-based constructions are in the focus of the learner's attention.

What these two examples illustrate is that L1 transfer in the areas of sentence production and morphosyntax is limited by the fact that morphosyntax is the most language-specific part of a target language. Because the mappings are hard to make, transfer in this area is minimized.

Once relations between the two languages can be constructed, as in the case of the transfer of the English cleft to Spanish, some positive transfer can be expected. However, we should not expect to see consistent early transfer in this particular area. Thus, the analyses of Pienemann et al. {, in press #9701} are remarkably close to those found in the Competition Model, once the importance of item-based patterns is recognized.

Resonance

As we mentioned earlier, the Unified Competition Model includes three new components that were not found in the classic model. These are chunking, codes, and resonance. The theory of chunking is certainly not a new one and could well have been included in the model many years ago. The theory of code relations is also not entirely new, since it incorporates and extends ideas about transfer that have been in development within the Competition Model for nearly 15 years. The component of resonance, on the other hand, is new to the theory. Despite this newness to the model, it plays an important central role in understanding code separation, age-related effects, and the microprocesses of learning and processing.

It is fairly easy to get an intuitive grasp of what resonance means in L1 and L2 learning. Resonance occurs most clearly during covert inner speech. Vygotsky {, 1962 #4273} observed that young children would often give themselves instructions overtly. For example, a two-year-old might say, “pick it up” while picking up a block. At this age, the verbalization tends to guide and control the action. By producing a verbalization that describes an action, the child sets up a resonant connection between vocalization and action. Later, Vygotsky argues, these overt instructions become inner speech and continue to guide our cognition. L2 learners go through a process much like that of the child. At first, they use the language only with others. Then, they begin to talk to themselves in the new language and start to “think in the second language.” At this point, the second language begins to assume the same resonant status that the child attains for the first language.

Once a process of inner speech is set into motion, it can also be used to process new input and relate new forms to other forms paradigmatically. For example, if I hear the phrase "ins Mittelalter" in German, I can think to myself that this means that the stem "Alter" must be "das Alter." This means that the dative must take the form "in welchem Alter" or "in meinem Alter." These resonant form-related exercises can be conducted in parallel with more expressive resonant exercises in which I simply try to talk to myself about things around me in German, or whatever language I happen to be learning.

On a mechanistic level, resonance is based on the repeated coactivation of reciprocal connections. As the set of resonant connections grows, the possibilities for cross-associations and mutual activations grow and the language starts to form a coherent co-activating neural circuit. Although this idea of resonance seems so basic and perhaps obvious, it is important to note that modern connectionist models have provided virtually no place for learning in resonant models. This is because current popular neural network models, such as back-propagation, work in only a feed-forward fashion, so resonant links cannot be established or utilized. Self-organizing maps such as the DisLex model of Li et al. {, under review #9590} can provide local resonance between sound and meaning, but have not yet been able to model resonance on the syntactic level. Grossberg's {, 1987 #5522} Adaptive Resonance Theory (ART) would seem to be one account that should capture at least some ideas about resonance. However, the resonant connections in that model only capture the role of attentional shifts in motivating the recruitment of additional computational elements.

Perhaps the model that comes closest to expressing the core notion of resonance is the interactive activation (IA) model of the early 1980s. Interactive activation models such as BIA and BIMOLA {Thomas, in press #9708} have succeeded in accounting for important aspects of bilingual lexical processing. Although these models have not explicitly examined the role of resonance, they are at least compatible with the concept.

We can also use resonance as a way of understanding certain dynamic multilingual processes. For example, variations in the delays involved in code switching in both natural and laboratory tasks can be interpreted in terms of the processes that maintain language-internal resonant activations. If a particular language is being repeatedly accessed, it will be in a highly resonant state. Although another language will be passively accessible, it may take a second or two before the resonant activation of that language can be triggered by a task. Thus, a speaker may not immediately recognize a sentence in a language that has not been spoken in the recent context. On the other hand, a simultaneous interpreter will maintain both languages in continual receptive activation, while trying to minimize resonant activations in the output system of the source language.

I would argue that multilingual processing relies more on activation and resonance than on inhibition {Green, 1998 #9696}. Of course, we know that the brain makes massive use of inhibitory connections. However, these are typically local connections that sharpen local competitions. Inhibition is also important in providing overt inhibitory control of motor output, as in speech monitoring. However, inhibition by itself cannot produce new learning, coactivation, and inner speech. For these types of processing, resonant activation is more effective.

The cognitive psychology of the 1970s {Atkinson, 1975 #137} placed much emphasis on the role of strategic resonance during learning. More recently, the emphasis has been more on automatic processes of resonance, often within the context of theories of verbal memory. The role of resonance in L1 learning is an area of particular current importance. We know that children can learn new words with only one or two exposures to the new sounds. For this to work successfully, children must resonantly activate the phonological store for that word. In the model of Gupta and MacWhinney {, 1997 #6908}, this resonance will involve keeping the phonological form active in short term memory long enough for it to be reliably encoded into the central lexical network {Li, under review #9590}. This preservation of the auditory form in the phonological buffer is one form of resonant processing.

Resonance can facilitate the sharpening of contrasts between forms. Both L1 and L2 learners may have trouble encoding new phonological forms that are close to words they already know. Children can have trouble learning the two new forms "pif" and "bif" because of their confusability, although they can learn "pif" when it occurs along with "wug" {Stager, 1997 #9694}. This same phonological confusability effect can impact second language learners. For example, when I came to learn Cantonese, I needed to learn to pay careful attention to marking with tones, lest I confuse *mother, measles, linen, horse,* and *scold*, as various forms of /ma/. Once a learner has the tonal features right, it is still important to pay attention to each part of a word. For example, when I was learning the Cantonese phrase for "pivoting your foot inward," I initially encoded it as *kau geu*, instead of the correct form *kau geuk*. This is because there is a tendency in Cantonese to reduce final /k/. However, the reduced final /k/ is not totally absent and has an effect on the quality of the preceding vowel. At first, I did not attend to this additional component or cue. However, after my encoding for *kau geu* became automated, my attentional focusing was then freed up enough so that I could notice the presence of the final /k/. This expansion of selective attention during learning is a very general process.

Once the auditory form is captured, the learner needs to establish some pathway between the sound and its meaning. Because few words encode any stable conventional phonological symbolism, pathways of this type must be constructed anew by each language learner. It has been proposed that activation of the hippocampus {McClelland, 1995 #7589} is sufficient to encode arbitrary relations of this sort. If this were true, second language learners would have virtually no problem picking up long lists of new vocabulary items. Although the hippocampus certainly plays a role in maintaining a temporary resonance between sound and meaning, it is up to the learner to extract additional cues that can facilitate the formation of the sound-meaning linkage.

Resonant mappings can rely on synaesthesia {Ramachandran, 2001 #9693}, onomatopoeia, sound symbolism, postural associations {Paget, 1930 #8638}, lexical analysis or a host of other provisional relations. It is not necessary that this symbolism be in accord with any established linguistic pattern. Instead, each learner is free to discover a different pattern of associations. This nonconventional nature of resonant connections means that it will be difficult to demonstrate the use of specific resonant connections in group studies of lexical learning. However, we do know that constructive mnemonics provided by the experimenter {Atkinson, 1975 #137} greatly facilitate learning. For example, when learning the German word *Wasser*, we can imagine the sound of water running out of a faucet and associate this sound with the /s/ of *Wasser*. For this word, we can also associate the sound of the German word to the sound of the English word *water*. At the same time, we can associate Wasser with collocations such as *Wasser trinken* which themselves resonate with *Bier trinken* and others. Together, these resonant associations between collocations, sounds, and other words help to link the German word *Wasser* into the developing German lexicon. It is likely that children also use these mechanisms to encode the relations between sounds and meanings. Children are less inhibited than are adults in their ability to create ad hoc symbolic links between sounds and meanings. The child learning German as an L1 might associate the shimmering qualities of *Wasser* with a shimmering aspect of the sibilant; or the child might imagine the sound as plunging downward in tone in the way that water comes over a waterfall. The child may link the concept of *Wasser* tightly to a scene in which someone pours *ein Glas Wasser* and then the association between the sound of *Wasser* and the image of the glass and the pouring are primary. For the first language learner, these resonant links are woven together with the entire nature of experience and the growing concept of the world.

A major dimension of resonant connections is between words and our internal image of the human body. For example, Bailey, Chang, Feldman, & Narayanan {, 1998 #7892} characterize the meaning of the verb "stumble" in terms of the physical motion of the limbs during walking, the encountering of a physical object, and the breaking of gait and posture. As Tomasello {, 1992 #6719} has noted, each new verb learned by the child can be mapped onto a physical or cognitive frame of this type. In this way, verbs and other predicates can support the emergence of a grounded mental model for sentences. Workers in L2 {Asher, 1977 #134} have often emphasized the importance of action for the grounding of new meanings and this new literature in cognitive grammar provides good theoretical support for that approach. Item-based patterns are theoretically central in this discussion, since they provide a powerful link between the earlier Competition Model emphasis on processing and cue validity and the newer theories of grounded cognition {MacWhinney, 1999 #7785}.

Resonance can make use of analogies between stored chunks, as describe below in the theories for storage and chunking. Gentner & Markman {, 1997 #7722}, Hofstadter {, 1997 #9522} and others have formulated models of analogical reasoning that have interesting implications for language acquisition models. Analogies can be helpful in working out the first examples of a pattern. For example, a child learning German may compare *steh auf!* “stand up!” with *er muß aufstehen* “He must get up.” The child can see that the two sentences express the same activity, but that the verbal prefix is moved in one. Using this pattern as the basis for further resonant connections, the child can then begin to acquire a general understanding of verbal prefix placement in German.

The adult second language learner tends to rely on rather less imaginative and more structured resonant linkages. One important set of links available to the adult is orthography. When an L2 learner of German learns the word *Wasser,* it is easy to map the sounds of the word directly to the image of the letters. Because German has highly regular mappings from orthography to pronunciation, calling up the image of the spelling of *Wasser* is an extremely good way of activating its sound. When the L2 learner is illiterate or when the L2 orthography is unlike the L1 orthography, this backup system for resonance will not be available. L2 learning of Chinese by speakers of languages with Roman scripts illustrates this problem. In some signs and books in Mainland China, Chinese characters are accompanied by romanized pinyin spellings. This allows the L2 learner a method for establishing resonant connections between new words, their pronunciation, and their representations in Chinese orthography. However, in Taiwan and Hong Kong, characters are seldom written out in pinyin in either books or public notices. As a result, learners cannot learn from these materials. In order to make use of resonant connections from orthography, learners must then focus on the learning of the complex Chinese script. This learning itself requires a large investment in resonant associations, since the Chinese writing system is based largely on radical elements that have multiple resonant associations with the sounds and meanings of word.

Resonance can also play an important role in the resolution of errors. For example, I recently noted that I had wrongly coded the stress on the Spanish word *abanico* "fan" as on the second syllable, as in *abánico*. To correct this error, I spent time both rehearsing the correct stress pattern a few times and then visualizing the word as spelled without the stress mark or with the stress on the second syllable, which is normally not written in Spanish spelling. I also tried to associate this pattern in my mind with the verb *abanicar* "fan" and even the first person singular of this verb that has the form *abanico*. Having rehearsed this form in these various ways and having established these resonant connections, the tendency to produce the only incorrect form was somewhat reduced, although it will take time to fully banish the traces of the incorrect pattern.

Age-related effects

At this point, it may be helpful to review how the Unified Competition Model accounts for age-related changes in language learning ability. The default account in this area has been the Critical Period Hypothesis (CPH) which holds that, after some time in late childhood or puberty, second languages can no longer be acquired by the innate language acquisition device, but must be learned painfully and incompletely through explicit instruction.

The Unified Competition Model attributes the observed facts about age-related changes to very different sources. The model emphasizes the extent to which repeated use of L1 leads to its ongoing entrenchment. This entrenchment operates differentially across linguistic areas, with the strongest entrenchment occurring in output phonology and the least entrenchment in the area of lexicon, where new learning continues to occur in L1 in any case. To overcome entrenchment, learners must rely on resonant processes that allow the fledgling L2 to resist the intrusions of L1, particularly in phonology {Dijkstra, 1999 #9697;Colomé, 2001 #9698}. For languages with familiar orthographies, resonance connections can be formed between writing, sound, meaning, and phrasal units. For languages with unfamiliar orthographies, the domain of resonant connections will be more constrained. This problem impacts older learners severely because they have become increasingly reliant on resonant connections between sound and orthography.

Because learning through resonant connections is highly strategic, L2 learners will vary markedly in the constructions they can control or which are missing or incorrectly transferred. In addition to the basic forces of entrenchment, transfer, and strategic resonant learning, older learners will be affected by problems with restricted social contacts, commitments to ongoing L1 interactions, and declining cognitive abilities. None of these changes predict a sharp drop at a certain age in L2 learning abilities. Instead, they predict a gradual decline across the life span.

Conclusion

This concludes our examination of the Unified Competition Model. Many of the pieces of this model have already been worked out in some detail. For example, we have a good model of cue competition in syntax for both L1 and L2. We have good models of L1 lexical acquisition. We have good data on phonological and lexical transfer in L2. We have clear data on the ways in which processing load impacts sentence processing in working memory. We are even learning about the neuronal bases of this load {Booth, 2001 #7987}. Other areas provide targets for future work. But the central contribution of the Unified Model is not in terms of accounting for specific empirical findings. Rather, the Unified Model provides us with a high-level road map of a very large territory that we can now fill out in greater detail.

References

Figure Captions:

Figure 1: The seven components of the Unified Competition Model