Extending the Competition Model

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BioStatement:

Brian MacWhinney directs the CHILDES (Child Language Data Exchange System) Project for the computational study of child language transcript data and the TalkBank system for the study of conversational interactions. With Elizabeth Bates, and other colleagues from many countries, he has developed a model of first and second language acquisition and processing called the Competition Model.

Abstract: 200 words

This paper presents an extended formulation of the Competition Model. The extended model, called the Unified Competition Model is designed to account for a larger range of phenomena in first and second language acquisition, including bilingualism. As in the classic version of the Competition Model, competition is at the core of a set of non-modular interacting forces. However, now the various inputs to competition are described in terms of six additional subcomponents: arenas, mappings, chunking, storage, codes, and support. Learning is viewed as a resonant process that relies on storage, chunking, and support to acquire new mappings.

Keywords: competition, model, processing, learning, bilingualism, multilingualism

This paper outlines a model that can account for both first (L1) and second (L2) language acquisition. Initially, one might wonder whether it makes sense to link these two apparently very different processes. After all, we know that L1 acquisition differs from L2 acquisition in fundamental ways. First of all, while infants are learning about language, they are also 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}. L2 learners are forced to map L2 forms onto neural territory already occupied by L1. Third, infants can rely on an intense system of social support from their caregivers {Snow, 1999 #8630}. Classroom L2 learners spend a few hours in a classroom and then reenter an environment where they speak L1 again. Learners acquiring L2 in a naturalistic context may use the second language in some narrow work contexts, but spend most of their time at home using L1. 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.

However, if we take a close look at the microprocesses involved in both L1 and L2 learning, we will find a shared core of learning mechanisms. There are some highly strategic processes unique to L2. And some of the processes crucial to L1 acquisition are weakened in L2 acquisition. But there is still a shared core of processes that is sufficiently large to justify our interest in constructing a unified theory. In addition, the basic architecture of the linguistic and

cognitive system is similar enough for monolinguals, bilinguals, and second language learners to motivate us to search for a single account that will work for all three groups. 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 L1. Thus, rather than attempting to build separate models for L1 learning, L2 learning, and bilingualism, 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 and bilingualism. Although these L1 learning mechanisms are less powerful in the L2 learner, they are still partially accessible. Therefore, a unified model is both conceptually simpler and descriptively more powerful. Ideally, this unified model should allow us to understand not only L1 and L2 acquisition, but also the dynamics of simultaneous bilingual acquisition in childhood.

The Competition Model {Bates, 1982 #228;MacWhinney, 1987 #2710} provides us with a good starting point for the construction of this new unified model. Empirical work in this framework has yielded a large body of crosslinguistic, developmental data on the processing of thematic relations in sentence comprehension. This work can serve as the foundation stone and guidepost for the larger extended model. The overall shape of the extended model is given in Figure 1.

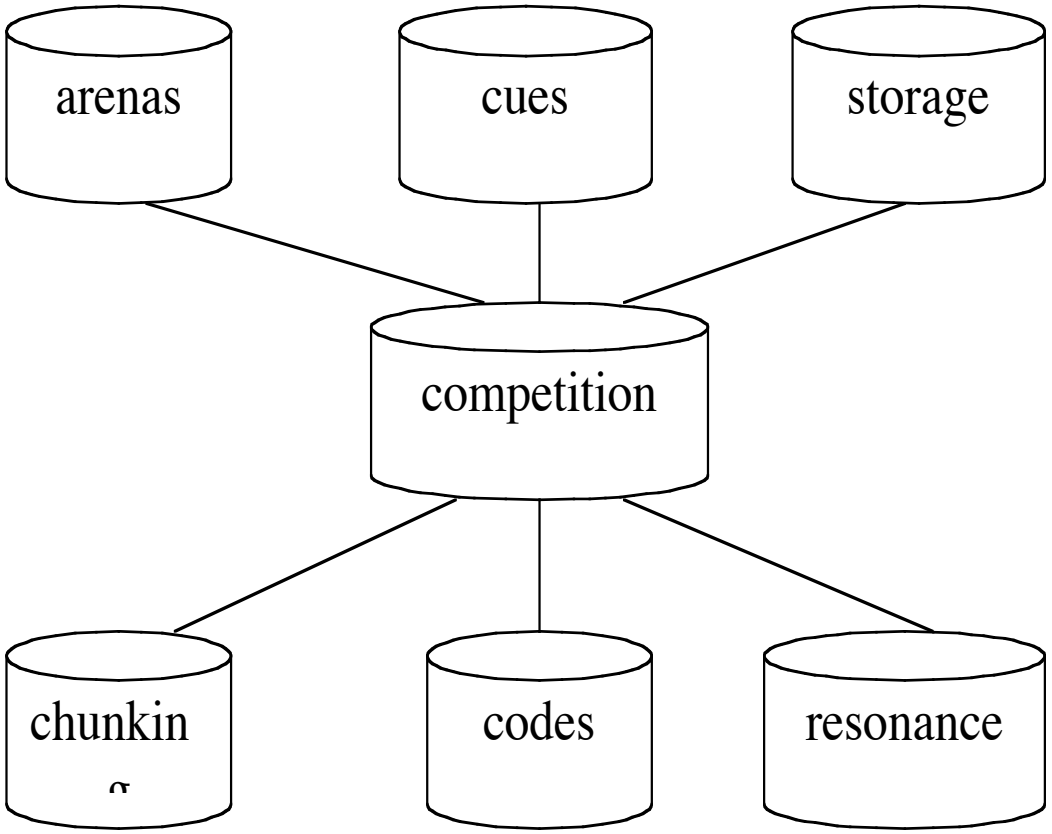

Figure 1: The Unified Competition Model

Figure 1 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 components. These components are:

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 extended version, 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 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 and Mappings. At the core of the Competition Model 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 {, 1966 #1759} systemic grammar . In production, forms compete to express underlying intentions or functions. In comprehension, functions or interpretations compete on the basis of cues from surface forms. 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. 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.
5. 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.
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 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 or cue support. This theory seeks to relate the Competition Model to newer research in the area of embodied or embedded cognition, as we will discuss below.

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.

1. Competition

The basic notion of competition is fundamental to most information-processing models in cognitive psychology. In the classic version of the model, competition was based on cue summation and interactive activation. Specifically, the strength of a given competitor is estimated by the choice ratio of the product of the strengths of the cues in favor of the competitor in the numerator over the product of the all the cues present in the denominator. This notion of

competition is based on the idea of the spread of activation in a single direction. In the unified model, competition is viewed as based on resonance, as well as activation summation.

2. Arenas

In the Unified Competition Model, competition takes on slightly different forms in each of the eight competitive arenas. We have formulated working computational models for most of these 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.

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 under conditions promoting 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}.

3. Cues and Mappings

Experimental work in the Competition Model tradition has focused primarily on 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 value of the concept of cue strength.

4. Chunking

The unified model holds that learners will control mappings at various levels of chunking or analysis. Chunking is the basic learning mechanism in Newell's general cognitive model {Newell, 1990 #5300}, as well as in many neural network models. MacWhinney {, 1975 #2684} treated levels of chunking in terms of the three processes of rote, analogy, and combination. Rote involves the extraction of large chunks that can later be analyzed into smaller chunks. Analogy extracts new patterns on the basis of comparison between stored chunks. In addition to these three pathways, it is important to recognize that chunking can take small existing units and chunk them into larger proceduralized chunks {Ellis, 1995 #7714}. In general, we can view chunking then as a series of processes that construct new items out of old.

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 would pick up not just that *Mann* means "man", but also learn phrases such as *der alte Mann* 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. If 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 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.

5. Storage

The combination of chunks into larger phrases and sentences involves a functional neural circuit that includes Broca's area, lexical storage in the temporal lobe, and additional structures that support phonological memory. Unlike local maps, which are neurologically stable, this functional circuit is more 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}. These constructions open up slots for arguments that may occur in specific positions or receive specific morphological markings. The importance of item-based constructions has been re-emphasized in a new line of research recently reviewed by Tomasello {, 2000 #9481}. The original 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 who are acquiring language in an instructional context often 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. 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 mental energy required by this feat is so intense that translators seldom continue in this line of work past the age of 45 or so.

6. 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 Competition Model postulates a fundamental link between age-related effects and transfer. The basic Competition Model claim is that whatever can transfer will. In fact, the learning of a second language in adulthood involves massive transfer from L1 to L2. This transfer is particularly heavy in the areas of phonology and lexicon, but there is also transfer in the general features of morphosyntax.

In the arenas of audition and articulation, L2 learning begins with massive transfer of L1 patterns {Hancin-Bhatt, 1994 #7035;Flege, 1984 #6820}. At first, this transfer is successful in the sense that it allows for a reasonable level of communication. However, it is eventually counter-productive, since it embeds nonnative L1 phonological features 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. Older children acquiring a second language can rely on residual neuronal plasticity 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. Local area maps are already committed to L1 patterns and the best that most L2 learners can do is to overlay L2 on top of this L1 framework. 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.

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. Kroll and Sholl {, 1992 #6861} emphasize the extent to which 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.

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}. 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}.

For young children who are acquiring two languages simultaneously, the preservation of a relative balance between the two languages can minimize transfer and avoid situations in which one language becomes parasitic on the other. However, even minor shifts in language dominance in childhood can lead to the introduction of strong transfer effects {Dopke, in press #9176}.

Although transfer can account for many of the age-related effects we see in L2 learning, it would be a mistake to ignore the role of decreasing neurological capacity and declining social support systems in older adults. A full account of age-related effects will need to take account of all of these factors, as well as some compensatory factors that facilitate certain types of learning in adulthood.

7. Resonance

Resonance uses the connections between arenas and forms of representation to facilitate both processing and learning. The presence of resonant relations demonstrates the fact that, although arenas process different types of information, they are not fully modularized or encapsulated. Instead their relative separation is provisional and emergent. The notion of resonance during processing can be illustrated by the phonological recoding that occurs during reading {Booth, 1999 #7793}. When we read words, resonant connections coactivate their orthographic form, their phonological form, and their meaning. The coactivation of each form of the word further supports the processing of each of the separate levels.

Resonance also plays are major role during learning. When a child or adult learner hears a new word, they must resonantly activate the phonological store for that word. In the model of Gupta and MacWhinney {, 1997 #6908}, this 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.

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" 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/. This expansion of selective attention during learning is a very general resonant 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 accord with any established pattern. Because each learner will discover a different pattern of associations, 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.

Resonance can make use of analogies between stored chunks, as describe below in the theories for storage and chunking. Gentner and 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.

On the level of the sentence, linguistic forms allow us to achieve resonance between otherwise partially separated cognitive arenas. According to the Perspective Hypothesis {MacWhinney, 1999 #7785;MacWhinney, 1977 #2689}, grammar is viewed as a set of devices that mark the flow of perspective across five cognitive domains: direct perception, space-time deixis, causal action, social roles, and belief systems. Within each of these domains, speakers and listeners construct mental models in which models of the human actor operate in a simulated world of space, time, causation, and social roles. By marking the perspective of a human actor across these dimensions, language allows us to unify very different levels of cognition into a single narrative or conversational flow.

The Perspective Hypothesis is one of a larger class of new proposals in the general field of Embodied or Grounded Cognition. These models place increasing emphasis on the role of physical action in the grounding of new meanings. For example, Bailey, Chang, Feldman, and

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.

For the second language learner, the development of resonant connections can depend heavily on securing good L2 input. If the learning context includes a language-learning laboratory, the student can use videotapes, audiotapes, and computerized lessons as further sources of input. In more naturalistic contexts, learners can depend on friends and media to provide comprehensible input. Even in the most favorable naturalistic contexts, the L2 learner often does not have access to the rich system of social support that provides high quality language input to the child {Snow, 1995 #6988;Locke, 1995 #7525}. In extreme situations, the L2 learner is overtly excluded from close personal interactions. In such cases, it becomes difficult to engage in the type of rich ongoing use of language that can maximally support learning. To compensate for this, the learner can develop a system of autosupport to improve the outcome of language learning. Concrete autosupport strategies include listening to television, radio, and movies, rehearsing taped dialogs, practicing new lexical items, and direct study of grammatical theory. These activities allow the adult learner to receive input that promotes the

functioning of neuronal storage loops for rehearsal, memory, and learning. In effect, the learner must maximize the use of resonance to compensate for the negative effects of L1 transfer, neurophysiological decline, and the absence of social support. However, the adult's reliance of resonance must be even more strategic than that of the child, since this mechanism now takes on such an important compensatory role.

8. Conclusion

This concludes our brief 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 remain sketchy. But the important contribution of this version of the model is not in terms of 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.

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