

Competition and Lexical Categorization

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Categorization is everywhere. Life is full of decisions and choices and every choice involves a selection between a variety of competing options. These choices are guided by the category structure of the competing options, both in language as elsewhere in cognition. We categorize as we listen, we categorize as we talk. Categorization affects all aspects of the language system: the assignment of words to parts of speech, the interpretation of semantic features, the detection of phonological segments, and the application of syntactic rules. As speakers, whenever we choose a register, a genre, or the rhetorical form of an argument, we are making decisions based on various categorizations of our goals and the shape of the knowledge shared by the speaker and the listener. As listeners, we are continually trying to categorize the speaker's message in terms of sound segments, words, and logical structures.

Although there is no area of language that is not affected by the categorization process, linguists and psycholinguists have only recently begun to examine the actual dynamics of categorization and the ways in which these dynamics affect the shape of language. In this paper I will present an approach to categorization that focuses on the notions of competition and extension. This model is called the Competition Model. I will first show how competition provides a way of understanding the semantic ranges of words. I will use locative prepositions and common nouns to provide examples of lexical competitions. Next I will discuss the acquisition of basic word meaning by children. Then I will show how words force each other to take on various polysemic and extended meanings. Finally, I will apply these analyses to the historical development of grammatical meanings, taking as a particular example the development of the Hungarian accusative and the conjugation of the verb.

In order to provide some historical context, it may be useful to distinguish three major currents in categorization theory. The first current begins with Aristotle and continues, now somewhat weakened, into the Modern period. This is the Classical Theory of categorization which is closely linked to the development of Analytic Philosophy. In Aristotle's *Logic*, category membership is defined in terms of a theory based on the notion of "substance." According to Aristotle, substance does not "admit of variation of degree." Particular categories are defined by a set of criterial attributes which make class membership fully sharp and categorical. The Aristotelian approach has led to many insights. Although it eventually proved to be descriptively inadequate, it served a great heuristic value for over two millennia of scientific and philosophical research.

The second major current of categorization theory is Prototype Theory. In this century, the work of students of language and perception such as Lakoff (1987), Massaro (1987), Posner and Keele (1968, 1970), Rosch (1977), Whorf (1967), Wittgenstein (1953), and Zadeh (1971) has allowed us to replace the Classical Theory with a theory based on fuzzy sets and prototypes. This second major current in categorization theory stems from the work of Posner and Keele, as elaborated by Rosch during the 1970's under the name of Prototype Theory. In Prototype Theory, categories are no longer so sharp and categorical as they were in Classical Theory. They are defined by best members, family resemblances, feature weightings, and central tendencies rather than by criterial

attributes. Prototype Theory is a major advance over Classical Theory, particularly in terms of its ability to deal with the psychological aspects of real-life categorization. There is now a rich literature documenting the motivation for the shift from Classical Theory to Prototype Theory. For a full discussion of the various advantages of Prototype Theory over Classical Theory see Lakoff (1987).

Despite the many ways in which it improves on Classical Theory, Prototype Theory is incomplete in a number of regards. First, it fails to place sufficient emphasis on the relations between concepts. In practice, researchers working with Prototype Theory tend to define concepts not in terms of their competitions with other concepts, but in terms of feature intersects and goodness of membership. Second, Prototype Theory has never provided an account of the way that categorization occurs in real time as a cognitive process. Third, Prototype Theory was never articulated in a way that could explain how concepts develop over time in language acquisition and language change. Fourth, Prototype Theory by itself does not provide a theory of representation. In practice the various features or cues to each prototype are usually described in a fairly *ad hoc* fashion.

The third major current in categorization theory is Competition Theory. The theory of competition has been articulated in models such as the Parallel Distributed Processing (PDP) Model of Rumelhart and McClelland (1986) and the Competition Model of Bates and MacWhinney (Bates and MacWhinney, 1982, 1987; MacWhinney, 1982, 1985, 1986, 1987, 1988; MacWhinney and Bates, in press). Other models making extensive use of competition as a fundamental process include Thibadeau, Just and Carpenter (1982), Anderson (1983), Feldman (1981), and many others. In the present paper, I will focus the discussion on the Competition Model framework. The main idea underlying the Competition Model is that mental processing involves a continual decision-making process in which there are many possible candidates competing for each categorization decision and the language user must be able to evaluate the candidacy of each alternative in terms of the cues that support it. In the Competition Model, the process of language learning is usually understood in terms of ways in which the learner comes to adapt his behavior to conform increasingly more closely to the actual way in which cues function in the environment. I will not provide a complete characterization of the Competition Model here, instead referring the reader to the papers on the subject in MacWhinney (1987) and MacWhinney and Bates (in press).

An important aspect of competition is its ability to help us understand how old categories are able to extend themselves into new habitats. How is it that we are so quick in assimilating new words, new experiences, and new concepts into the larger framework of our language and thoughts? How do we deal with the many different ways in which ideas combine and the new meanings that arise from these combinations? In this paper we will explore these extensions in terms of the projection of old semantic pathways into new territories. In this area the Competition Model account of semantic extension is based on principles borrowed from the PDP framework. The PDP account and its relation to the Competition Model is discussed in Taraban, McDonald, and MacWhinney (this volume). Although the PDP formalisms will be useful in eventually constructing a

more powerful understanding of categorization processes, at this point it is important to conduct a non-computational overview of the general domain. This first step is offered as a preliminary to more explicitly computational work. In this paper, I explore ways in which categorization theory can be enriched by a broadened view of the Competition Model that deals with ways in which language can be extended. The four specific domains I will examine are word meaning, the acquisition of word meaning, polysemy, and grammatical entanglement.

1. Word Meaning

We are taught in school that two words that "mean the same thing" are synonyms. We are given pairs such as "umbrella" and "brolly" or "boy" and "lad" and told that these are good examples of synonyms. It is certainly true that there is a strong overlap in meaning between such "synonyms" and we are willing to think of this overlap as synonymy. As cooperative students, we seldom call into question the general idea that two words can in fact mean the same thing. However, as we look more closely at such examples, we find that the supposed identity of meaning is really not all that clear. In terms of actual usage, there are often register, dialect, or referential differences between even the closest of referents. Looking at such facts, Bolinger (1965) reached the conclusion that "when I say two different things I mean two different things by them" and his conclusion has been echoed by other researchers. Linguists refer to this basic notion as the Principle of Contrast and, as Clark (in press) notes, it is "taken for granted" within linguistics. Pinker (1987) calls this constraint the "Unique Entry Principle", Chomsky and Lasnik (1977) call it the "Uniqueness Principle," and Markman (1984) calls it "Mutual Exclusivity." Of these principles, only Contrast and Mutual Exclusivity have been formulated to make clear analyses of lexical development. As Clark (1987) notes, the notion of Mutual Exclusivity is significantly stronger than the notion of Contrast, since Mutual Exclusivity requires complete set disjunction and Contrast only requires distinctiveness. In this regard, the Principle of Contrast is conceptually the closest to the Principle of Competition. Each of these three principles recognizes the importance of a fundamental constraint against synonymy. As we will see below, this constraint plays a crucial role in many accounts of language learning (MacWhinney, 1987).

1.1 Competition between Meanings

The Principle of Competition provides us with another way of understanding why language avoids synonymy. Consider a pair of words like "cup" and "mug." In the Competition Model account these two forms are seen as occupying neighboring, but separate, parts of a multidimensional semantic topography. The semantic range of each item in this multidimensional space is determined by its range of values on a large number of dimensions or "planes." Each of the value sets on a given dimension is a "cue" to the selection of the word. If an object has a set of cues that place it within the "cup" part of the topography, we call it a "cup." If it has a series of cues that place it within the "mug" part of the topography, we will call it a "mug." Cues such as "object,"

"holds liquid," or "ceramic" are shared by both "cup" and "mug." These shared cues help distinguish "cup" and "mug" from "dog" and "Brooklyn Bridge." Other cues are crucial in governing the competition between "cup" and "mug." For example, the cues "ceramic," "heat-resistant," "handled," "cylindrical," and "taller-than-wide" all activate the item "mug" in the adult language. Such cues may vary in their availability and reliability (MacWhinney and Bates, in press). For example, the "heat-resistance" cue is not always "available," since we may not be able to judge whether a given drinking utensil is capable of holding hot liquids until we actually use it. Even if this cue is available, it still may not be entirely reliable, since many porcelain cups are as capable of holding hot liquids as are mugs. Similarly, the "handled" cue which is shared by both "cup" and "mug" is not always required since some cups may not have handles. On the other hand, the combination of the "cylindrical" cue with the "handled" cue seems to be quite reliable as a predictor of "mug." Although a cylindrical, heat-resistant, ceramic container without handles might be a "cup," one with handles is a pretty good case of a "mug," as long as it is not too short or too tall (Labov, 1973). In general the semantic range of "cup" is wider than that of "mug." This is because "mug" is delimited by the intersect of quite a few semantic features and the more features used to delimit a semantic space, the smaller it becomes.

In the Competition Model, the matching of words to objects is determined by a feature matching process. This process involves summing the strengths of the cues favoring a particular candidate and dividing that number by the sum of all available cues. In a variant of this basic model (McDonald, in press), cue strengths are multiplied instead of added. In either case, the candidate with the highest cue strength is predicted to win in the competition. This kind of cue summation model is extremely common in psychological models. Massaro (1987) presents a detailed account of the application of such cue integration models to various areas of perceptual processing. The particular computational instantiation of this model which is most appropriate to the Competition Model is the PDP account in which "microfeatures" can be used to activate lexical items. The exact structure of this activation network may be more complex than simply a projection of features onto lexical items. It may be that a variety of "raw" perceptual features activate a set of intermediate conceptual features which, in turn, activate lexical items. For example, there may be several features activating the concept "taller-than-wide." The learning of the network would require the setting of weights between perceptual features, conceptual features, and the competing lexical items.

It is important to realize that competition is not a private affair between only two words. In some cases, the principle competitors may be simply "cup" and "mug." In other cases, words like "glass," "dish," "tumbler," and "beaker" may play a larger role in the competition. The semantic topography controlled by each word is a result of these many-sided competitions. Each competing form comes to adapt itself to the particular constellation of cues in the semantic landscape actually used by other speakers of the language. This adaptation requires repeated exposure to many exemplars, particularly to cases where cues conflict (McDonald, in press).

The situation is much like that in population genetics. If two species of birds are competing for exactly the same ecological niche, one of the two species will win out and the other species will move into another niche or die out altogether. The niche of the losing species may overlap partly with that of the winning species, but this overlap cannot be exact. Why must this be true? Because the two species are genetically different, they must also differ in one or more phenotypic characteristics. Each difference has some level of impact on the survivability of the species in each microenvironment of its niche. In some cases the impact will be small, in others it will be large. Each impact will be felt in terms of the ability of the species to compete in a given microenvironment. To the degree the species loses out in many microenvironments, its overall survival can be threatened. If a species loses out in some competitions while winning in others, it may shift over to new areas of competition and its entire niche will change significantly. If one species has a thicker beak, it will be able to eat seeds with a tougher shell or husk, perhaps coming to dominate in areas around certain species of trees. However, this thickness of the beak may be a disadvantage in catching small insects and the other species will dominate in areas around ponds and meadows where insects abound.

1.2 Competition and Cooperation

No single idea can win out in mental processing unless it cooperates properly with other ideas. The fact that an object is cylindrical is not enough by itself to allow something to be called a "mug." Rather cylindricality must cooperate with features such as "handled" and "taller than wide" to emerge as the winner in the competition with "cup." Cooperation allows a percept or an action to gain strength from the other actions with which it interlocks. The better the fit with other active ideas, the more an idea can win out over its competitors. To illustrate this, Warren and Warren (1970) examined the perception of the first sound of the word "wheel." If this sound is degraded or replaced with a beep, the stimulus "*eel" could be perceived as "peel," "wheel," "deal," or a variety of other words. In a sentence such as "Bill oiled the squeaky*eel," subjects hear the word "wheel." In such cases, the sound "eel" is cooperating with expectations from "oil" and "squeaky" to support the candidacy of "wheel." In a sentence such as "Bill threw away the orange*eel," subjects hear the word as "peel." In that sentence, the sound "eel" is cooperating with expectations from "throw" and "orange" to support the candidacy of "peel." Without this cooperative support, neither of these two alternatives could predominate in the competition. Rumelhart, Smolensky, McClelland, and Hinton (1986) show how the processing of the two competing interpretations of the Necker cube also depends on cooperation. One can perceive the upper left vertex of the cube as being on the closest face. However, in order to do this one must also assume that the lower left vertex and the two vertices directly to the right of the left-most vertices are also on the front face. These interpretations must work together in a cooperative Gestalt or schema. Similarly, in a sentence such as "Bill oiled the orange *eel" the competition between "wheel" and "peel" is no longer so clearly resolved, since the clear cooperative Gestalts noted in the other sentences above are no longer available.

The general principle is that competition is based on cooperation. In language processing, the most common type of competition is not between species or individuals, but between lexical items. The domain of each lexical item or word is shaped both by the meanings and sounds to which it responds and by the response range of the lexical items with which it competes. When we process sentences, each lexical item sets up expectations for other lexical items. When processing is successful, these expectations interlock tightly. However, as in natural systems, there is always some variation in the system which can occasionally lead to error.

There can be no competition without cooperation. Every meaning that the child wishes to express represents a coalition of motives (Bates and MacWhinney, 1982). This is particularly easy to see in the area of lexical selection. When we choose to call an animal a "bird," we are expressing not just one lone intention, but a whole range of correlated attributes. The animal not only has feathers, a beak, and wings, but probably lays eggs, flaps its wings to fly, and has a song or call. These attributes live together peacefully in nature, happily correlated with each other. When it comes time to choose between calling the animal a "bird" or a "dog," the strength of this peaceful coalition works in its favor to defeat all competitors. However, in most such cases, none of the competitors are too sorely disappointed, since few of their features were activated anyway. In this sense, a well-oiled competition is cooperative in that it maximizes the chances in the long run for any given meaning to properly express itself lexically, while cutting to a minimum the amount of improper lexicalization.

Cooperation works in a similar way for those devices that express grammatical roles. For example, the subject-expressing devices of preverbal positioning and verb agreement work together to express a variety of naturally correlated role motives, including agency, causality, topicality, givenness, and perspective (MacWhinney, 1977). Text studies (Givón, 1979) show that, for any number of reasons, these motives are indeed highly correlated. But sometimes this natural coalition or "peaceful coexistence" breaks down. For example, the various devices expressing the notion of "subject" in English prototypically express the functions of agency, topicality, givenness, initial focus, and perspective (MacWhinney, 1977). In most English sentences, these motives cooperate peacefully and without competition. This is because these motives tend to cooccur in our perceptions of the real world. In some minority of cases, this peaceful coexistence breaks down and grammatical devices are forced to "divide the spoils." When this division occurs, the strongest motive will win out in the competition for a major device such as "subject." Secondary motives may be given "consolation prizes." The English passive is a good example of this. In the passive, the subject expresses the functions of topicality, perspective, and sometimes givenness, whereas the agent is either deleted or placed into a by-phrase. The by-phrase can be viewed as a consolation prize which is awarded to the motive of agentiality when it loses out in the competition for subject marking.

1.3 Locative prepositions -- an example

In the biological world, habitats are created by the forces of the physical world--tides, winds, ice, and weather. These forces of erosion work on a geological substrate of varying rock formations to form yet further complexities in the shape of habitats. In the world of language, the habitats of words are sculpted into our mental model of the world. This mental model has a texture just as complex as the strata of the earth's crust. In the biological world, some habitats are particularly pervasive, important, and stable. For example, there is a stable habitat for flying animals that consume marine organisms along the continental shelf, while nesting on land. Across the geologic record we see species after species, both in the dinosaurs and the birds, that has adapted to this particularly rich ecological niche. However, the actual adaptations involved are quite various. Some species travel far out to sea, some spend their time floating, some stay close to shore, while others are generalists and cover all parts of this habitat. The situation is similar in language. Across languages, we find certain ideas cropping up again and again as fundamental to human thinking and communication. However, the exact ways in which these basic semantic niches are carved up between competing words differ markedly from language to language.

As an example of a particular lexical field, let us look at the English locative prepositions "in," "on," "at," "over," "above," "across," and "by." These words not only illustrate the shape of a particular set of semantic habitats, they also provide us with examples of the importance of competition in understanding word meaning. They have been studied in some detail by Bennett (1975), Brugman (1983), Herskovits (1986), Langacker (1987), Talmy (1978), Miller and Johnson-Laird (1976) and many others. In studying the meaning of these prepositions, we will focus particularly on their use in prepositional phrases with nominal heads. In phrases such as "the cat on the mat" the object of the preposition is the reference location and the head of the prepositional phrase or the "subject of the preposition" is the located entity. Some locations and located entities can be combined with all of these prepositions, as in these examples:

1. The stick is in the pan.
2. The stick is on the pan.
3. The stick is over the pan.
4. The stick is above the pan.
5. The stick is across the pan.
6. The stick is by the pan.

Nothing about the inherent nature of the "stick" or the "pan" restricts these particular constructions. When we hear sentences like these we interpret them readily without forcing any of the words involved into extended or metaphorical readings. In PDP terms we can say that the net controlling these uses generalizes readily to new cases, since it has been trained with many exemplars exactly like these.

If we look at how a particular scene should be described, we usually find that one of these prepositions is better than the others. For example, when a stick is placed on both of the edges of the pan, it is best to use "across." Sometimes these competitions are more subtle. Consider the ways in which the word "at" competes with other prepositions. One competition is between "at" and "near" or "next to." If we say that "Frank is near his desk," we usually mean that he is not right "at" his desk. If Frank were right "at" his desk, we would say that he is "at his desk." When we choose one competing option over another, we are implicitly telling the listener that the option that did not win out was somehow less appropriate. Because of this, we need to think about characterizing the meanings of these words in terms of the contrasts or competitions in which they participate. In the case of "at" and "near" the contrast focuses on distance from the location. However, there are some locations for which "at" is not appropriate. For example, we would say that "the woman was near her grocery cart" rather than "the woman was at her grocery cart." It appears that "at" used in this way indicates a place where work or activity is conducted.

Another major competition involving the word "at" is with the word "in." We have contrasts such as

7. Marge is at the store.

8. Marge is in the store.

9. *Marge is at Paris.

10. Marge is in Paris.

In the first sentence, the "store" is viewed as a small point location. In the second it is viewed as a full large building. In the third sentence, it is difficult to see the whole city of Paris as a single point, although this can be done by viewing "Marge" as a conquering general whose battle campaign had brought her to just outside the gates of the city of Paris. For smaller locations, "at" can be used to designate temporary position by a landmark that is treated as a point. However, once the landmark becomes large enough, it can no longer be treated as a point and "in" wins out even if the the position is temporary. Sometimes the location is temporary because it is a position along a route. For example, the sentence "the restaurant is at the village" is a bit odd, but the sentence "there is a good restaurant at a village 6 miles from here" is perfectly fine (Herskovits, 1986). In this case, the point "at a village" is a temporary position along an itinerary. Yet another competition involving "at" is with the preposition "by." There are contrasts such as "house at the lake" and "house by the lake." Here again, "at" seems to indicate a certain temporariness of purpose or itinerary.

Searle (1979) discusses ways in which a preposition like "on" can be used to describe scenes far outside its core meaning. He takes as an example the sentence "the cat is on the mat" and asks whether we would or could use such a sentence to describe a cat in contact with the mat flying through outer space with no gravity enforcing the contact or a cat held up by wires on a stage that is only positioned over a mat. It seems that, in these weird cases, people would still use the word "on" to describe the situation, trusting that

their listeners could later fill in the added strange details. The point here is that, although these may not be prototypical uses of "on," there are no other competing prepositions that provide us with better ways of expressing the scenes. These particular meanings are closer to those of "on" than to any other preposition and that is why "on" wins this competition. We can think of these cases of cats held up by wires and flying through space next to mats as largely unexplored areas of the semantic topography which can nonetheless be accessed by words based in better known territory.

These relations between "at" and its competitors are dealt with in Prototype Theory by saying that some scenes are closer to the "core" meaning of one preposition than the other. However, this use of the word "core" is misleading in that it tends to make us think of semantic domains as having a single well-established core and a periphery that is tightly bound around the core much like the mantle and the crust of the earth is bound around its core. A more accurate view of semantic structure focuses on Wittgenstein's (1953) "family resemblance" view of category structure or Lakoff's (1987) "radial" category structure. In these more complex views, the habitat of a word may have several local cores about which further meanings cluster. For example, the word "on" has a cluster of meanings in the area of "on the table", another cluster in the area of "on call" and "on drugs," and yet another in the area of adverbial uses. One could call the locative meaning the "core" meanings. However, extensions of meanings in the second and third areas are governed more by those areas than by any core meanings in the first area.

The other problem with maintaining a heavy reliance on the notion of "core" meanings is that the notion of a core meaning, by itself, tells us little about where we should look for cores or whether one would expect to find cores distributed in particular points in semantic space. On the otherhand, by looking at words as competitors for semantic ecological niches, we come to see meaning as directly reflected in lexical contrasts (Clark, 1983) such as the ones discussed for "at." It appears to be the case that the shape of each word's ecological niche or "meaning" is most clearly defined and constrained by the various contrasts in which it participates. Saying this does not solve the question of where representational structure comes from. However it does suggest a way of studying the shape of the underlying representational topography by looking at lexical competition. When mapping the geologic formations, a field geologist can often use the distribution of particular types of plants as cues to the position of formations. Acid loving plants will follow limestone beds, whereas other plants may prefer sandy or silty soil from sandstones. In the same way, if we could study the exact shape of the various cue validities in the contrasts that people need to make we could use aspects of the Competition Model to form a basis for a theory of what representations should looklike. Of course, the careful collection of such data is not a trivial task and it is likely that, for the time being, we can best understand representational structure by focusing on the ways in which lexical items contrast and how that competition is resolved.

1.4 Semantic Range and Change

Words vary markedly in semantic range. Some words like "gyroscope" and "Dachshund" refer to a fairly small area in the total semantic topography. Within their particular ecological niche, they provide the most accurate single-word descriptions of particular items. Other words like "dog" or "instrument" range over a broader semantic topography, and other words like "thing," "object," "animal," "do," "type," and "so" have such a wide range of potential meanings that they begin to lose their semantic substance. Bybee and Pagliuca (1985) use as an example of this semantic bleaching the development of the verb "have" in various European languages. This word began with a meaning of "to hold in one's hand" and then came to mean increasingly "have in one's possession," "own," and then later "have as an idea." As the word became increasingly generalized away from the meaning of "hold in one's hand" it also became increasingly involved in the expression of general grammatical functions. In the final stages of this development "have" changed from expressing the grammatical function of agent-oriented obligatory action as in "I have to go to work" to expressing the epistemic modality of necessity as in "The train has to be late." This extension is induced by the fact that the verb have is now combining with the infinitive which expresses a variety of more general complement meaning types. As the verb "have" took on the competition for an increasingly large semantic range, it became so overextended that it could no longer properly express its original meaning of "hold in the hand." By becoming a lexical "fat cat," the word had lost strength in its original home territory. For this meaning, leaner words like "grab," and "got" have then adapted to better express the meaning in the original habitat of "have."

1.5 Non-semantic cues

In the Competition Model, the decision to choose one word over another is entirely governed by the strength of the cues that are associated to that word. However, not all of these cues need be semantic in the strict sense of the word. For example, the choice between "a" and "an" in English is governed by the phonological shape of the following noun. In the Competition Model this cue is on an equal footing with the various semantic cues that lead us to choose the indefinite article over the definite article. In German, the nominative singular definite article takes the forms *der*, *die*, and *das* with the choice between the three competing lexical forms being governed by a wide variety of cues, only some of which are semantic (Taraban et al., this volume).

The most extensive use of non-semantic cues to govern the competition between lexical items is in the vocabularies of bilinguals and multilinguals. For these speakers, words like *table*, *Tisch*, and *mesa* may occupy virtually the same area in semantic space. However, in these speakers, the added dimension of language-being-spoken becomes the single most important plane used to govern the competition between words. Because so much weight is placed on this single cue to govern so many competitions, often we find code-switching in bilingual speech. The more the bilingual can reinforce the differences between the two languages with added situational and semantic cues, the more strictly separate he can maintain the two languages.

2. The Development of Word Meaning

Having sketched out the basics of the Competition Model approach to lexical semantics, we can now take a look at how the model can help us understand the acquisition of word meaning by the child. From the viewpoint of the Competition Model, the child must first acquire the conceptual structure underlying language. After carving out the topography of an internal semantic world, the child then acquires words to reign over particular domains in that semantic topography. The process of word acquisition involves four basic processes: concept formation, episodic encoding, segmentation, and cue extraction. These processes are not steps that follow each other in lock-step sequence, but rather changing aspects of the unfolding of a general process by which the child sharpens his mapping of the semantic topography. Let us look at these developments from the viewpoint of the Competition Model.

2.1 Concept Formation

Before the child acquires language, he develops a set of things he wants to talk about. These are the functions that underly the forms of language -- the semantic topography upon which words build their habitats. Lexical acquisition is initially driven by the child's interest in expressing some meaning. As Brown (1973) and MacWhinney (1975, 1978, 1985, 1986) have argued, the child usually develops an interest in the concept expressed by a word before actually acquiring that word. Bates and MacWhinney (1987) refer to the prior learning of the semantics of lexical items as *functional readiness*. The idea behind the notion of functional readiness is that in most cases the child constructs the semantic topography before assigning parts of that topography to words. This is function-driven learning. However, the opposite course of development -- form-driven learning -- can also be observed, particularly in older children. In form-driven learning, the child picks up a word which maps onto parts of the semantic topography that he has not yet constructed or explored. The word then serves as a goad to the exploration of those distinctions that can control its competitions with its neighbors.

In the Competition Model early conceptual development involves the detection of clusters of cues. The one-year-old child may find that there is a set of perceptual features such as hair and 4 legs and activity patterns such as barking, jumping, licking, and sniffing which are fairly tightly intercorrelated. This particular cluster of correlated attributes (Maratsos and Chalkley, 1980) is close to our concept of "dog," although these cues by themselves may not yet make sharp divisions between dogs, cats, racoons, and hyenas. Instead, the child finds clusterings of correlations tending to center around what will later be "cat" and "dog." These clusters of intercorrelations provide the basis of early concepts a can be modeled within the PDP framework.

2.2 Episodic Encoding

Let us imagine that, some months later, the same child has solidified his mappings of the semantic topography in the area of "dog" and "cat." He has also learned enough language to be able to use terms such as "want" and "gimme." Let us then imagine that he sees a small stuffed dog among a collection of other stuffed animals, including a stuffed alligator, a stuffed elephant, and a stuffed seal. The child says "gimme." The mother is not sure which animal he wants and says "doggie?" while handing him the stuffed dog. The child is elated. At the same time, he begins to associate the sound "doggie" with the conceptual clustering that has been developing in the general area of "dog." At first, the strongest linkage is between a particular pronunciation of "doggie" and the actual toy dog figure -- the particular episodic encoding that is fully supported by the input. This first episodic encoding becomes the basis of the "confirmed core" of meanings actually encountered by the child for the new word. The child may also use the new word to cover areas of semantic topography outside the confirmed core. Some children may "hypothesize" that new words refer to the whole territory of the conceptual cluster within which they are located (MacWhinney, 1984; Mervis, 1984). However, this more adventurous and extensional use of new words does not override the continual development of the confirmed core.

If the child is cautious, he will not only limit the range of the new form he will also only attempt to acquire a new form when he is sure that the adult is focusing on a function for which he does not yet have a name. In the case of the "doggie" example, the child recognized that the stuffed dog was present and that the parent was looking at the dog. If the child is uncautious by disposition or if the parent is unclear, the child will end up associating the sound "dog" to the meaning of "alligator." But, even if such overgeneralizations occur, no "learnability problem" arises for the child, since he can learn to map the sound of "alligator" onto parts of the semantic territory occupied by the erroneous mapping and this form will drive out the form "dog" from this part of its habitat. The ability of the form "alligator" to drive out "dog" from part of its habitat is based upon the fact that the main support for each form comes from particular episodic encodings which can be thought of as simple points in the semantic topography. The generalization from the episodic base to new parts of the topography is slow and this allows the two forms to stay in competition for some time during a time of free variation. If the child were to adhere too strictly to Mutual Exclusivity, this period of free variation would be missing and initial mismapping could indeed lead to serious learning problems.

If, instead of handing the child a dog, the parent had given the child a stuffed alligator and named it, the child could still have attempted acquisition of a new form. In this case, however, the function would not have been ready before the form was encountered. The child would then be placed in a position where, having heard a new form, he must search about for a function it might express (MacWhinney, 1978). In both cases, the child makes a first "stab" at a meaning on the basis of his best guess about what the new form might mean. MacWhinney (1988) speaks of this fast mapping of some current referent to the new phonological string as *jumping-in*. If this initial mapping is incorrect, it will be weeded out by the competition. If the child thinks the sound "alligator" means "dog," competition will simply weed out this bad guess. It is not important that this initial fast mapping be completely accurate. Rather, what the child needs to do is to establish a

beachhead to link a form to a function. Eventually, competition will fix up errors in the initial mapping.

What the child does during "jumping in" is simply to establish a first episodic encoding. This encoding is a pairing of a particular actual sound sequence with a particular event or state in the real world. Each time the child hears that same word, he can store a new episodic encoding. We need not assume that each episode is always encoded without fail. Rather, we only need to believe that enough episodes are encoded to provide a rich empirical database for further learning.

2.3 Segmentation

In this particular example, the child did not face a problem in segmenting out the referent word from other verbal material. Things are not always this simple. The mother might have said "the doggie?" In that case, if the child was not familiar with the use of the definite article, he would pick up the whole phrase "the doggie" as a new word, rather than just "doggie." In the connectionist architecture of the Competition Model, this particular association would continue to survive, but would come to require the presence of the semantics of the definite article "the". Support for this association is found not just for the form "doggie" but for all common nouns. In the overall network of projections from meanings to sounds, support for the form "doggie" will be given only by meanings within the specific semantic topography of "dog," whereas support for the article will arise from activation of a quite different part of the topography. In this gradualistic connectionist view, the segmentation of lexical items during acquisition depends not on a one time operation of analysis as in MacWhinney (1978) but on repeated processing of combinations of items against a complex pattern of semantic activation.

2.4 Cue Extraction

Repeated exposure to a word provides the learner with masses of episodic data that can be used to sharpen the borders of lexical items and to sculpt the semantic topography of the lexical habitat. We can think of this sculpting as a process of *cue extraction* whereby highly available and highly reliable cues come to work as the strongest predictors of word assignment. For many words, the extraction and strengthening of cues is based upon the child's increasing his attention to perceptual and experiential cues that he can already detect, but which are somewhat low in salience. In other cases, the cues must be constructed by recombination from more basic cues (MacWhinney, 1987). In yet other cases, the child must actually construct new cues before he can begin to use them (Carey, 1985; Keil and Batterman, 1984). The Competition Model claims that, once detected and acquired, the strengths assigned to various cues will be a function of their "cue validity" which is defined as the product of cue availability (how often is the cue there when you need it) and cue reliability (how often does use of the cue lead you to the correct decision). For details on the Competition Model's use of cue validity as a way of understanding category formation, see MacWhinney and Bates (in press).

2.5 Acquiring Superordinates

The child's acquisition of semantic hierarchies presents a major challenge to all models of semantic development that rely heavily on the principle of contrast. The problem is that, at first blush, superordinate terms such as "animal" and basic level terms such as "dog" seem to show an extreme form of semantic overlap in that a "dog" is always a "animal," although the reverse is not true. If this opposition is looked at without considering the whole of the lexical system, it might appear that acquisition of the word "animal" should be blocked by the Mutual Exclusivity principle. However, the principles of Competition and Contrast fare somewhat better in this area, since they provide the child with more tolerance for free variation, without which the child would have a very difficult time controlling such contrasts. When the child first hears the word "animal" used to refer to a dog, it works in effect as another name for "dog." At the same time, the child is receptive to any data that can distinguish the two forms. In this particular case, the child will also hear "animal" being used to refer to cats, mice, and horses. During this period, the word "animal" is in variation with a variety of forms. However, it is also gaining strength from those features which are shared by cats, mice, dogs, and horses. This then leads to the formation of a concept which expresses the shared features, but which loses out when the child wishes to express more detailed features. In this way, the child uses competition to acquire superordinates (Callanan, 1982; Rosch, 1977).

Conflict can also arise between a subordinate term such as "dachshund" and a basic-level term such as "dog." Again, the child allows the forms to coexist for some time as variants. During this period of probation, the form "dachshund" gains support from features such as "short" and "long-eared." This allows the form to carve out a niche *vis a vis* "dog," so that when the child sees a dog that is clearly a dachshund and wishes to emphasize its exact identity, he uses "dachshund" rather than "dog." However, if the child is talking to a friend, and the friend has only one dog, he asks, "What's your doggie's name?" rather than "What's your dachshund's name?"

The Competition Model views the acquisition of both superordinates and subordinates in terms of the strengthening of particular competitions between lexical items in particular habitats, rather than as the sudden acquisition of a new form of cognition (Inhelder and Piaget, 1964). The literature on this topic (Markman, 1984) indicates that these developments are indeed quite gradual and that they follow different patterns for different words.

3. Polysemy and Homonymy

The notion of a multidimensional semantic topography is a useful way of understanding the way in which words compete for meanings. This topography makes distinctions not just between words, but also within words. Within-word contrasts are brought about by an extremely important and pervasive property of human language called "polysemy."

Most common words in a language illustrate some degree of polysemy. Consider a word like "ball." Looking in Webster's Third, we find three major entries for "ball." The first major entry is for a noun that describes round physical objects; the second is for a verb that involves forming things into balls; the third is for a noun describing a formal gathering for social dancing. The competition between major entries like these is often called "homonymy." For our present purposes, we need to distinguish two types of homonymy. The first involves the use of a single word for two or more different parts of speech. We will call this "syntactic polysemy," since it can be resolved by the use of syntactic cues. The competition between the verbal and nominal readings for "ball" is a case of syntactic polysemy. The second type of competition between major entries involves the use of a single word for two entirely different senses within a given part of speech. We will call this type of homonymy "major polysemy." An example of major polysemy is the competition between the entry of "ball" as "round object" and the entry with "ball" as a "social gathering."

Within each of the major entries, we find a series of minor readings or polysemes. For example, the third entry for "ball" has one polyseme for "a formal gathering" and a second for "a good time." Or the first entry has polysemes for things like "odd ball," "a ballgame," "a fast ball," "testes," or "keep the ball rolling," along with the basic meaning of "a round object." All of these various readings within entries are polysemes and the contrast or competition between these entries is usually referred to as "polysemy." In order to emphasize the continuity between polysemy and homonymy, we will call this type of ambiguity "minor polysemy." Thus, we will use the terms "syntactic polysemy," "major polysemy," and "minor polysemy" to describe the various phenomena in the area of lexical ambiguity. We do this to emphasize the fact that there is no sharp distinction between polysemy and homonymy.

Even within a given minor polyseme, we can find further polysemy. For example, within the basic polyseme for the first entry of "ball," there are 15 minor polysemes. Various types of round objects which we call "balls" include: the ball of the foot, a baseball, the ball of the earth, an eyeball, a ball of fudge, and so on. Even within the minor polyseme for objects that we bounce or roll, there are a long list of types, including baseballs, footballs, golf balls, and so on. Nor does polysemy really end at this level. Within the interpretation of "ball" as "football," we can further distinguish specific object types such as "nerf football," "mini football," and "regulation football."

When we say the word "ball," we may be referring to any one of these many different polysemes. It is the listener's job to try to decide which of the many competing options is the one which is currently intended. If the listener wants to understand the message at all, it is almost always important to pick out the correct major polyseme. If we hear that Cinderella "went to the ball," we would have a very strange idea of what happened if we thought of her as approaching a round object. If we hear "the baby threw the ball," we need to avoid thinking of a baby throwing a wad of hot candy or the bone in someone's foot. We certainly want to focus in on the reading of "round object for throwing or bouncing." However, within this general minor polyseme, it might not yet be possible to distinguish between a beach ball, a soccer ball, a volley ball, or a nerf ball. There may be

no further information in the discourse or in the discourse context that could tell us which of these particular objects is being thrown by the baby. If there is further disambiguating information, we will attempt to use it. A series of studies by Anderson and Ortony (1975), Anderson and Pichert (1976) and Anderson, Reynolds, Schallert, and Goetz (1977) demonstrated the degree to which discourse context influences our final interpretation of lexical items. For example, in a sentence such as "The coca-cola poured all over the table, and then the container was empty," subjects tend to interpret "container" as a "bottle." However, in a sentence such as "The apples rolled all over the table, and then the container was empty," subjects tend to interpret "container" as "basket."

3.1 Polysemic Topography

Major polysemic entries can be seen as corresponding to the valleys of large rivers in this topography, whereas major and minor polysemes correspond to increasingly smaller tributaries. Determining the exact reading for a given word is like tracing a stream back to its source. Some of the decisions are easy and can be made just on the basis of the words in the sentence. Other decisions require rich situational information or prior discourse cues. Even given such additional information, it is unlikely that the listener can trace the referent back to a point which corresponds exactly to what the speaker had in mind. The listener may hear that "the baby was playing with his mother in the sand at the beach when he threw his mother the ball." From this, the listener may tend to interpret the ball as a beachball. It is unlikely that he can imagine a ball with exactly the size and color envisioned by the speaker. Yet, the more cues he has to the resolution of polysemic competitions, the farther he can trace the meaning upstream and the closer he can get to the speaker's intended meaning.

Earlier we noted that the semantic range of words is determined by the particular contrasts in which they are involved. This is also true of the polysemic topography. Major polysemes contrast in so many ways that they can be quickly distinguished during sentence processing. In a sentence like "Bill met Tammy at the ball" the preposition "at" supports the "place" reading of "ball" which matches most readily with the "formal dance" interpretation. In this way, the process of polysemic interpretation supports the contrast between the two major polysemes in terms of the feature of "location or place." Within a major polyseme, the contrasts may not be as sharp. If we say "John stepped on his ball" we may think either of an object for bouncing and rolling or of the ball of his foot. If we go further and say "John rolled off his heel and stepped up on his ball" the choice of "ball of the foot" is clearer. The contrast between these two types of round objects focuses on whether or not they are an actual part of another body. It is this reading that finally dominates in the last sentence.

3.2 Syntactic Polysemy

When a lexical item is detected, it automatically (Swinney, 1979) activates each of its polysemes. These polysemes are then placed into competition. The polyseme which is supported by the strongest cues wins. In English, a large number of words have both nominal and verbal polysemes and these polysemes are always in competition. Fortunately, there are many good cues to help resolve these competitions. When a suffix like -ing or -ed follows the word, it is always a verbal form. Thus, in a sentence like "the sugar balled when it dropped into the cold water," the presence of the -ed after "ball" is a sure cue to the selection of the verbal reading, rather than the nominal reading. To take another example, a single sound form is ambiguous between the locative preposition "to," the infinitive "to," the numeral "two," and the modifier "too." In a sentence such as "I went to the store," all four polysemes are viable candidates up to the beginning of the article. Once the listener hears the article, only the locative polyseme remains viable. The infinitival reading would have required a following verb. The other two readings would have required either a following adjective or a following noun. In terms of cue validity measures (MacWhinney and Bates, in press), these particular cues are extremely reliable. There are many other such cues which, when taken together, are usually enough to resolve the competition between major polysemes.

Many aspects of sentence processing that pose problems to more linear accounts can be seen to follow quite readily from the Competition Model view of polysemes competing on the basis of surface cues. Consider a sentence such as "I know that cats are playful." Up to the point when the listener hears the plural marker on "cat," there is still a competition between two readings for the word "that." One reading is as a complementizer and the other is as a deictic determiner. The crucial cue for the determiner reading is the presence of a following singular noun. The cues for the complementizer reading are the presence of a verb that takes a complement and the presence of a well-formed complement clause following. Here, the determiner reading loses because the following noun is plural. A similar competition occurs with the word "what" as illustrated by the comparison between the sentence "What soldiers did it?" and the sentence "What soldiers did is what he films."

There is also a syntactic polysemic competition between adjectives and their corresponding zero-derivation nominals. Consider a sentence such as "The old can get in for half price." Here, the adjectival reading of "old" requires that the following word be interpreted as a noun. The word "can" is itself ambiguous between a nominal and a verbal reading. However, the nominal reading is blocked by the fact that the verb "get" requires a plural subject. As Milne (1986) shows, agreement cues are often important in resolving such competitions. This leaves the much weaker nominal polyseme of "old" as the remaining competitor. As the nominal reading gains activation, it allows the verbal reading of "can" to gain activation, and finally the correct reading of the sentence surfaces. In a sentence such as "Have the students take the exam" the main verb and auxiliary verb readings of "have" compete up to the end of the verb "take." At that point, the auxiliary reading would require a participle, as in "Have the students taken the exam?"

A very similar chain of events occurs when interpreting "The communist farmers hated died." When "farmers" appears after "communist," the adjectival polyseme dominates strongly. However, when this reading fails to provide a subject for the verb "died," the listener attempts to form a relative clause. In order to do this, the relative clause must have a head that is a non-preverbal noun. A head can be obtained by giving a nominal reading to "communist." However, the adjectival reading has dominated so strongly that, by this point, it is difficult to recover the nominal reading. In a sentence such as "the trash can hit the fence" both the adjectival and nominal readings of "trash" continue in competition up to the point where the listener hears the word "can." Then the nominal and auxiliary verb readings of "can" also compete. Since the adjectival reading of "trash" goes with the nominal reading of "can" and the nominal reading of "trash" goes with the auxiliary reading of "can," both interpretations continue competing and the sentence remains ambiguous up to the end. Similarly, in the sentence "I took her waffles" both the possessive and the indirect readings of "her" yield possible interpretations and the sentence is ambiguous.

Even grammatical markers can be syntactically polysemous. Consider the suffix -s which marks not only the plural of the noun, but also the singular and plural possessive of the noun, and the third person singular present on the verb. If the stem is a proper noun, it cannot be a verb. But part of speech of the stem alone is not enough to decide this competition, since many English nouns can also be verbs. However, the items preceding the stem generally tip the scale in the right direction. If the stem is a common noun, it will be preceded by a determiner. Since determiners cannot precede verbs, the presence of a determiner before the stem is a very strong cue for the possessive and plural polysemes.

3.3 Resolving Non-syntactic Polysemy

Non-syntactic polysemy involves competition between polysemes within the same part-of-speech. This type of polysemy is resolved not by syntactic cues, but by semantic support or spreading activation from other items in the sentence. The spread of activation is much like that postulated in theories of semantic memory (Anderson, 1983). By activating words related to a target polysemic item, we spread activation to that item and help it win out over its competitors (Cottrell, 1985). Forward priming of this type can be illustrated experimentally. If we present subjects with a sentence such as "The world is full of communists" and then flash the word "socialist," we will find that the presence of the previous semantically-related prime speeds the recognition of the probe word "socialist." To illustrate this in a sentence, consider that the word "needle" can refer to a pine needle, a sewing needle or a phonograph needle. In a sentence such as "The gardener had finished raking up the pine cones, when he found some needles stuck in the underbrush" all semantic associations point toward the reading of "needles" as "pine needles." However, if the last word were "pincushion" rather than "underbrush," we would interpret "needle" as meaning "sewing needle." Such an ending to this sentence might make us do a slight double-take, but we would probably derive the correct final interpretation. In this example, the competition occurs toward the end of the sentence

and the double-take is not too severe. If the competition involves a word that occurs earlier in the sentence, the double-take or garden-pathing can be more extreme. Consider Karl Lashley's famous example: "Rapid righting with his uninjured lefthand saved from destruction the contents of the capsized canoe." Here readers sometimes mistake "righting" for "writing" because of the association between "writing" and "hand." The effect is very strong when the sentence is read aloud, thereby removing the orthographic cues supporting "righting" over "writing."

3.4 Anaphora as Polysemy

Some of the most extensive competitive polysemy occurs in the processing of anaphors. Anaphora pushes the use of cues to identify referents in a semantic topography to its ultimate logical limits. A single pronoun in English such as "it" or "that" could conceivably refer to virtually anything. However, given enough discourse, syntactic, and semantic cues, we are often able to use anaphora to identify exactly the referent the speaker has in mind. Anaphors tend to maintain the polysemic pathways followed by previous readings. Consider the following sentences:

11. John put his arm into that of the Atlantic.

12. The curry was hot and so was the coffee.

13. The blade was nicked, but the knight pulled it anyway.

In these sentences, the words "that," "so," and "it" are initially interpreted along the lines of the first clause. We first think of the "arm" of the Atlantic as a human arm and of the "coffee" as "spicy," rather than "warm." Then, under the pressure of the other words in the second clause, we revise our interpretations and see the "arm" of the Atlantic as a body of water and the hotness of the coffee in terms of temperature instead of spiciness. In the third example, it is not the anaphoric pronoun "it" whose interpretation we revise, but that of the antecedent. We first think of the "blade" as a "razor," but then revise our thinking to view it as a "sword."

Cues such as perspective maintenance, gender, number, implicit causality, and action readiness all operate to favor one interpretation of the anaphor over the other. Consider a sentence such as "The fellow praised the busboy, because he was late." We would normally use the implicit causality cue of the combination of the verb "praise" with the conjunction "because" (Au, 1986; Caramazza, Grober, Garvey, & Yates, 1977) to infer that "he" refers to the "busboy." When we use implicit causality in this way, we are overriding the normal effects of perspective maintenance. In a sentence like "the fellow praised the busboy and then he apologized" we tend to identify "he" with the subject "fellow" according to the principle of perspective maintenance. This maintenance of a previous perspective is sensitive to a variety of syntactic cues. Consider these examples:

14. When it was copied, my file disappeared.

15. It disappeared, when my file was copied.

In the first sentence, the presence of the subordinating conjunction licenses a possible following reference for "it." This is not the only possible reading, however, since "it" could also refer to something discussed earlier or perhaps something that is obvious in the situation. In the second sentence, on the other hand, the referent must be something mentioned in earlier discourse, since "it" is a subject of a main clause and must be fully referential at the time of mention. MacWhinney (1984) discusses the many competing ways of interpreting anaphors and the ways in which cues help us decide between these competing readings. For a survey of the polysemes of the definite article, the indefinite article, personal pronouns, and anaphoric gapping the reader should consult that article.

Recently, we have been tracking the time-course of the processing of anaphors against possible referents. Earlier work with anaphoric processing (Corbett and Chang, 1983; Leiman 1982) has suggested that, during the process of identifying a pronoun with its antecedent the availability of the antecedent is increased or primed. MacDonald and MacWhinney (in press) and McDonald and MacWhinney (in press) tested this claim using a cross-modal probe recognition task to measure the speed with which subjects could judge whether a noun had already been mentioned in the sentence. For example, the subject may hear a sentence such as "John pushed Bill and he slipped on the rug." At various points before and after the pronoun "he" we presented either "John," "Bill," or "Frank" as test probes. The subject's task was to decide whether the noun has been mentioned. In both studies we found that subjects were consistently fastest in identifying the subject "John" as present. However, this real-time advantage for the perspective maintenance cue was either limited or amplified by three other cues: gender matching, number, and implicit causality. In general, the strongest cues are the ones which tend to lead to the greatest priming advantages for their referents.

4. Pushy Polysemy

We have now examined a variety of ways in which the concept of competition can enrich our understanding of the relation between word meaning and the semantic topography. However, the notion of a fixed semantic topography is too static to yield a correct view of all that goes on in sentence processing. In general, we need to think of words not just as finding places in a pre-formed landscape, but also of shaping that landscape and of pushing other words around on that landscape. In this section, we will discuss various ways in which this initial simple non-dynamic account of polysemy needs to be replaced by a more general concept of "pushy polysemy." The Competition Model concept of "pushy polysemy" is designed to capture the insights of the fourth major current of categorization theory -- the extensional view of language use.

4.1 Pushing occurs over valence bridges

In sentences, words are always involved in constructions with other words and these constructions force words to assume particular polysemic values. However, it is not the case that every word in a sentence impinges on every other word. In order for one word

to push another word around, the two words have to be involved together in a meaningful relation. Polysemic pushing occurs only across what I will call "valence bridges." The Competition Model notion of a valence bridge derives from Tesnière's concept of valence (1959) as elaborated in the Construction Grammar account of Fillmore (1986). For example, in the sentence "Mary cut up the pie" the particle "up" takes on the meaning of "completive" so that it can successfully combine in a valence relationship with the verb "cut." In this case, a valence bridge exists between "cut" and "up." If the particle were to assume the reading of "direction upwards" it would not be able to function as a particle of the verb and no valence bridge would be formed. However, then the reading of the entire sentence would be rather strange, since the verb "cut" would have no direct object. In this example, we can say that "cut" pushes "up" into a particular polysemic pathway. This is a simple example of pushy polysemy operating across a valence bridge.

In Fillmore's Construction Grammar, every lexical item has a "valence description" which specifies the shapes of its arguments and the semantic relation between those arguments and the head. For example, a verb like "cut" may specify an Agent as its first argument and a Patient as its second object. A preposition like "in" may specify a Location as its first argument and a Located as its second argument. The Competition Model sees the various possible fillers for these valence slots as participating in the formation of possible valence bridges. Each lexical item makes specific requirements on the shape of the items with which it will form valence bridges. For example, the preposition "in" expects its object to be an enclosure. Thus, the phrase "in the store" induces us to view "store" as an enclosure, whereas the phrase "at the store" induces us to view the store as a locational point.

Prepositions also force their arguments to assume particular figure-ground relations. For example, the preposition "near" forces its object to play the role of a fixed reference ground and allows the head of the prepositional phrase to act as the object located. A sentence like "the bicycle is near the house" involves a minimum of polysemic pushing, since "house" is a good stable reference location in its default reading. However, a sentence like "the house is near the bicycle" requires that the word "bicycle" be placed into a reading that sees "bicycle" as a reference location. One way this can be done is by treating both "house" and "bicycle" as toys. In this way, the word "near" pushes both of its arguments into particular polysemic pathways.

In some cases it is the prepositions, rather than the nouns, that get pushed into polysemic pathways. Consider these sentences:

16. I saw the dog in the car.

17. I saw the sun in the car.

18. I saw the dent in the car.

In the first example, the dog is physically enclosed in the car. This is the strongest polyseme of "in." In the second example, the sun is reflected in the body of the car. In both this example and the third, the body of the car is the location and the object being located is incorporated into the location. This is a second reading of "in." In the second

reading, the incorporation is by reflection. In the third reading, the incorporation is physical.

4.2 Reciprocity

So far our examples have all treated the choice between competing polysemes as a unidirectional process. In fact, polysemy works in a far more dynamic and reciprocal way. Consider first an example of pushy polysemy involving major entries as in the sentence "the trash can hit the fence" which we discussed earlier. If we decide to select the nominal reading of "can," we lock in an adjectival reading for "trash." If we decide to select a verbal reading for "can," we lock in a nominal reading for "trash." Here the reciprocal nature of the constraint satisfaction system is fairly obvious, but when we look at minor polysemy, the effects become more subtle. Consider a sentence such as "John drives over the hill." Here the unmarked transitive and punctative meaning of "drive" as "takes a one-time trip to a place" would usually force the word "over" to assume its reading of "path across a gap." In that case, we can say that "drive" is pushing "over" into a marked place in its semantic topography. However, it is also possible to have "over" take on the sense of "position on the other side of a gap." In that case, the preposition "over" forces the verb "drive" to take on the meaning of a generic activity. In that reading, the whole event occurs in some habitual or generic way on the other side of the hill. In one case "drive" pushes "over" into a marked polysemic slot. In the other case "over" pushes "drive" into a marked polysemic slot. The least marked case is the one where the total amount of pushing is the least. In that sense, "over" appears to more easily assume either of these two meanings than does "drive."

Reciprocal pushing can force polysemic variation on still deeper levels. Lakoff (1987) discusses the interesting example of the phrase "a working mother." Given the default interpretation of "working" as describing "engaged in an employment" when the adjective is applied to human beings, we tend to interpret "mother" in terms of the role of "primary caretaker for the child," rather than the polysemic readings of "woman who gave birth to the child" or "woman whose fertilized egg become the child." However, if we decide to focus on the reading of "woman who gave birth to the child," then we force the word "working" to take on a different reading as "functioning," rather than "engaged in an employment."

4.3 Extension and Conversion

One of the most remarkable aspects of human language is the way in which words can assume new meanings right in the middle of a discourse (Clark and Clark, 1979; Lakoff 1987). Sometimes these new meanings are created through processes which operate in fairly well-worn pathways. In other cases, not only the meanings but also the processes deriving the new meanings are more innovative and mark off new territory in the semantic topography. A particularly well-worn extensional path produces "metonymy" or the use of the part to refer to the whole. For example, we can use "hands" to refer

tosailors, "guns" to refer to soldiers, or "wheels" to refer to an automobile. In these three cases, the pathways have been pre-cut into the semantic topography. However, if we refer to men as "ties" or students as "pencils," we would be using this standard extensional pathway in a very innovative way.

A still more productive extensional pathway allows us to refer to tokens of things by the names of the things they are tokens of. For example, we refer to a toy airplane as an "airplane" or a miniature butter churn as a "butterchurn." This pattern is totally productive and there is virtually no miniature or toy that cannot be referred to by using the name of the real object. Along somewhat different lines, we can also refer to any token or written expression of a work of art by the name of the original. So I can say "I lost my Hamlet" and mean that I lost my copy of the book that contains the play Hamlet. There is also a standard extensional path which allows us to use place names like "London" or "Buenos Aires" to stand for governments, radio stations, or soccer teams. For example, we can say "Buenos Aires informed Washington that it would soon withdraw from the Malvinas conflict." Or, to take yet another example, salespeople can refer to customers by the names of the things that they have ordered. So one customer may be "the ham sandwich" and another may be "the banana split" and we can say "The ham sandwich is sitting across from the banana split."

The actual process by which the listener pushes words down these extensional pathways involves the kind of reciprocal interaction we discussed above. For example, when we hear that "Buenos Aires informed Washington that it would soon withdraw from the Malvinas conflict," we know that place names cannot play the roles of first and second argument of a verb like "inform." Indeed this verb has a strong expectation for animate agents in both role slots. However, we can use this extensional pathway to convert both of the place names into names for collections of human beings. In this way pushy polysemy leads directly to attempts to extend the semantic topography.

Pushy polysemy is strong enough to overcome most of the standard categorizations of words into parts of speech and subclasses of the parts of speech. It can easily force a mass noun to assume a reading as a common noun. Often we are told that "sugar" is a mass noun and that phrases such as "another sugar" are ungrammatical (Gordon, 1985). From this we are to assume that the sentence "I'd like another sugar, please" is also ungrammatical. However, if we are asking for a small packet of sugar and using the contents of the packet to refer to the whole (metonymy), the extension is quite reasonable and even conventional. Or we may be working in a chemistry lab analysing the reactions of various sugars such as fructose, sucrose, and glucose. Here we are using an extensional pathway that uses a word to refer to a member of a taxonomic class. One can say that only words like "sugar" can do this because of the special circumstances mentioned. However, even so unlikely a sentence as "I'd like another sand, please" can be interpreted in similar ways. Much like the interpretation of "another sugar" as referring to a packet of sugar, we might interpret "another sand" as referring to a bag of sand used either for construction or for sand-bagging a swollen river. Just as we could imagine a chemist working with various sugars, we could imagine a situation where sedimentary geologists are describing the sand content of a new formation. They have

used sieves to sort out the various types of sand in the formation and then placed these sands into jars. One of them asks the other for "another sand" for testing, meaning either another bottle of sand or another type of sand.

Proper nouns can also be converted into common nouns. Usually, we are told that a determiner such as "a" cannot precede a proper noun such as "Reagan." However, there is nothing wrong with a sentence such as "A wiser Reagan returned from Rejkjavik," if we are thinking of "Reagan" not just as single man, but also as a man who can assume various states or values. Virtually any proper noun can be extended in this way. Another extensional path allows us to convert adjectives into nouns, as in the sentence "the green is nicer than the red." This type of conversion works best if we are able to conceive of the new deadjectival nouns as members of a collection or ensemble.

Prepositions seem to be particularly good at pushing their objects around. When the preposition "in" is combined with a noun that does not have a natural enclosure, that noun is forced into a polysemic reading that allows us to see it as an enclosure. For example, when we say that "the soldier is in the field," we conceptualize the field not as a flat surface, but as an extension with certain perimeters within which the soldier is located. When we say "the soldier parachuted onto the field" we see the field as a flat surface upon which one can alight. When we say that "the truck was in the road," we tend to see the road not as a line connecting two points, but as an expanse of asphalt. When we say "the truck was on the road," we see the road as a line. If we say that we see "the trout under the water," we are focusing on the part of the water that is between us and the trout. If we say that we see "the trout in the water," we are focusing on the entire body of water within which the trout is submerged. Another example is the use of the word "above" to refer to a one-story building whose base is higher up a hill than a 6-story building below it. In this case, we say that the small building is "above" the large building even though the top of the large building is above the top of the small building. However it is reasonable to use "above" to describe this relation, since there is no other single preposition to describe the relation and since we realize that our listener will not imagine that one building is actually suspended in space over the other.

Semantic extension presents us with a great puzzle. How can we predict which word will extend to any given new piece of semantic territory? If there is a well-worn pathway along which many analogous extensions have occurred, a particular extension may be quite predictable. Because we routinely refer to governments as "Buenos Aires" and "Washington," there is nothing too very puzzling about referring to the government of Hungary as "Budapest." When we are dealing with well-worn pathways, we can talk about semantic extension in terms of "inheritance rules." We can formulate specific rules about the conversion of mass nouns into count nouns, the use of the part to refer to the whole under well-defined situations such as the customer who has ordered a particular disk, the use of a capital city name to refer to the government of that city, the use of a common noun to refer to a toy, and so on. These inheritance rules will allow us to characterize the most common types of semantic extension. However, they cannot be used to account for all types of semantic extension.

Extensions that involve more imaginative across-domain analogies require us to think more deeply about the roots of semantic extension. For example, the use of "dog" to refer to an unattractive person is something that is easy to predict only in hindsight. We can say that this extension is based on analogy with the earlier use of "pig" to refer to an unattractive person which in turn was based on a more general use of "pig" to refer to an unkempt person. Or we can talk more generally about pathways for referring to people as animals and ways in which isomorphism is established between the world of animal characteristics and the world of human characteristics. The basic problem with accounting for such extensions is that they involve projections from relations on one semantic plane to relations on another. In order to make such projections, we need to be able to describe the geometry of both planes (Indurkha, 1987). For example, we can project the temporal meanings of prepositions from their locative meanings for words like "at," "before," and "between." We can do this because we have a well-developed system for analogizing the structure of time to the structure of space. However, not all projections are so easy. If they were, riddles would not be so difficult to solve. Whereas most mechanisms controlling the basic competitions between polysemes are extremely well-oiled, the mechanisms computing extensions and projections are fragile and often need to be constructed by inference right on the spot. Despite the rather peripheral nature of some of these projections, they make a major contribution to language development and change. If we can develop a better understanding of the processes of semantic extension we will also be gaining a deeper understanding of the shape of semantic space itself, since it is the shape of that space and the nature of the various planes comprising that space which characterize and predict the various possibilities for semantic extension.

4.4 Extensional Pathways and PDP

We have now sketched out a series of concepts -- semantic range, valence, pushy polysemy, and extension -- which derive from the Competition Model view of language processing. How can we go beyond these verbal formulations to develop a computational model of these semantic processes? An initial step in this direction was taken by McClelland and Kawamoto (1986) in their PDP model of the arguments of verbs. In this model, the semantic features of verbs are used to predict the shape of the arguments with which they cooccur. The model was able to predict the valence descriptions for new verbs and to force nouns to assume semantic features congruent with their argument role. In other words, this PDP architecture behaves in accord with the principles of semantic inheritance, pushy polysemy, and extension that we have discussed. The major limitation on this particular PDP model is that it would not be able to make true extensions into pathways that were not already available from earlier polysemic training. Such extensions require the model to have some kind of theory of representation. Although the actual numbers of such extensions that occur in daily speech is small, they play a crucial role in the development of the language to cover new areas of meaning. Moreover, during language learning, many uses that appear conventionalized to the adult may be understood extensionally by the child. In theory, PDP models can behave in the correct ways once such a theory has been constructed. The problem is that, in order to get

reasonable extensional behavior from a model, one cannot simply model a small domain, since extension needs to range over a large range of possible readings and concepts.

A crucial property of the PDP formalism is that algorithms such as those discussed by Taraban, McDonald, and MacWhinney (this volume) provide a powerful account of how the child can use natural input to induce the adult system. If these algorithms provide us with a good account of what the child is actually doing, all of the phenomena we have been discussing -- semantic range, competition, pushy polysemy, and extension -- should develop in a learning simulation much as they would develop in the child. I say "should" because the work that is needed to back up this claim has not yet been done.

There is a sense in which PDP simulations can be viewed as testing grounds for linguistic analyses. As we go ahead and begin to construct such simulations, we will in effect be testing whether valence descriptions are indeed predictable from some combination of semantic and phonological cues. Linguists continue to debate about the extent to which syntactic patterns can be predicted from semantic facts. For example, some analysts claim that semantic features alone cannot predict whether verbs like "recommend" and "deliver" take double object constructions as in "*we delivered the library the book." Pinker (1988) argues that the semantic features of verbs are indeed powerful enough to predict their valence descriptions. Even if Pinker's analysis fails for a few cases, it is likely that valence descriptions can be predicted on the basis of some combination of possibly idiosyncratic semantic and phonological features of predicates. Allowing phonological features into the equation adds the various stress patterns and derivational types that some linguists believe are important in generating valence descriptions. Finally, connectionist networks can also permit some idiosyncratic variation for high frequency items. Thus, it seems quite likely that connectionist networks have enough power to provide a good account of the prediction of valence descriptions.

Within the valence description network, more detailed features of the predicate may activate more detailed features of the valence description. For example, if the predicate is "big," the feature [+measurable] is activated for the argument. Of course, we can treat virtually any object as measurable, so this is not a restrictive activation. However, it does help us in developing our understanding of the relation between the predicate "big" and its argument.

Consider how an item like "on" activates the valence description network. Along with other words that have the features [+relational] and [+location], it activates two arguments. The first of these two arguments is the object of the preposition. The preposition "on" induces features such as [+entity], [+location], and [+top surface] in its object. The second argument of "on" can be either a verb or a noun. If the verb is transitive it will have an object and that object can be the head of the PP. Alternatively, the verb itself can be the head of the PP. In other words, there are two patterns within the network that are in competition for this second argument. If the verb has features like [+direction] or [+goal-oriented], it will usually be stronger than the object noun as a candidate for the second argument role. Attachment to the verb wins out in sentences such as "John positioned it on the table." However, in that sentence, the fact that the

nominal is a pronoun works against its candidacy. In a sentence such as "the women discussed the dogs on the beach," both attachments are in close competition. In a sentence such as "The boy ate the cake that his mother baked in the oven," the attachment of "in" to "ate" is weakened by a tendency to avoid an oven as a place for eating. Note that this particular association requires that the network encode triplets of relations, such as that between "in," "eat," and "oven."

Making valence descriptions subject to semantic features of the predicate and its arguments has some further interesting consequences for extensional uses of verbs. For example, the first argument of the verb "polish" is usually an animate actor and the second argument is usually an inanimate object. However, when an inanimate occurs as the first argument in pre-predicate position, as in "this table polishes easily," its presence forces the verb to take on the features [+potential] and [+state] and to drop the feature [+activity]. This general change can apply to any action verb. We can say "this phone dials easily" or "this micro programs easily." We can produce and comprehend such forms without having had any prior experience with them, indicating that the valence descriptions involved cannot be frozen forms, but must arise from some general process. In fact, this general process is exactly what is captured by the valence description network.

Nouns have valence descriptions which simply require them to be the argument of other predicates. Thus, all nouns expect to be either the argument of some verb or preposition. However, common nouns have an additional expectation of being the first argument of a modifier with the feature [+delimiting], such as "another," "one," "a," or the plural suffix. Thus, we cannot say "I like dog" without treating "dog" as a mass noun. To treat it as a mass noun, we would have to think in terms of, say, "dog meat."

In the previous section, we asked how we can predict the extension of a word to a new point in the semantic topography. In this section, we have begun to answer this question. To the degree that extensions can be viewed as analogies and to the degree that we can characterize relations such as those between the polysemes of "pig," we should be able to treat these phenomena with PDP formalism, since PDP accounts are particularly good at capturing phenomena based on analogy. The basic principle is this: any particular semantic relation between polysemes can be extended to another item. However, this extension must be based on the same overall activation properties governing all activation in PDP nets. The more words using the particular extensional pathway, the stronger that pathway becomes. At the same time, the closer the new word is to the words using that pathway, the better the spread of the extension to the new case. If the extension does not receive enough cue support, the speaker will avoid making it, using a circumlocution instead, or the listener may fail to properly understand it.

5. Grammatical Entanglement

Grammatical elements often involve the speaker in a complex series of linguistic decisions. For example, in German (Zubin, this volume), whenever a speaker wishes to

note the definiteness of a noun, he must also decide its number, gender, and case. The simple motive of expressing definiteness thus *entangles* the speaker in a variety of future categorizations. Taraban, McDonald, and MacWhinney (this volume) show that there are indeed a good set of cues to guide us in making these further categorizations. Some of these cues are phonological, others involve semantic subclasses of nouns or the presence of derivational markers. Despite the large number of cues, the selection of the gender of a noun is often a particularly difficult matter. Moreover, it is a decision that the speaker would not even have to make in many other languages.

5.1 An example from Hungarian

Hungarian provides us with an example of entanglement that illustrates even more completely the ways in which semantic-relational meanings can become entangled in a network of formal markings. The particular aspect of Hungarian grammar that is most interesting from this point of view is the choice that the speaker must make every time he uses a verb between whether to place that verb in the definite or the indefinite conjugation. My analysis of this system will follow Moravcsik (1983). Moravcsik notes the following paradigm for the present tense of *lát* "see":

		Indefinite	Definite
Sing	1	látok	látom
	2	látsz	látod
	3	lát_	látja
Plu	1	látunk	látjuk
	2	láttok	látjátok
	3	látnek	látják

A similar set of full paradigmatic contrasts exists for the past tense, the conditional mood, and the imperative mood. Intransitive verbs like *megy* "go" only appear in the intransitive paradigm, but every transitive verb can occur in either conjugation.

This choice between the conjugations is a fundamental decision that must be made everytime the speaker uses a verb. The decision to use a verb is a fundamental decision that we make all the time. As we will see, the various factors that govern the choice of one of the two conjugations lead the speaker to become deeply entangled in a fairly complex decision-making process. This decision-making process requires the speaker to pay attention in an on-line fashion to various properties of the object that may be incompletely formulated during the process of sentence planning. As a result, this aspect of Hungarian grammar is the most difficult for non-native speakers. Young Hungarian children also make some errors in conjugation selection (MacWhinney 1986). However, these errors disappear early on. Adult Hungarians report virtually no problems in controlling the basic aspects of this part of their language.

There is one case where the choice of a conjugation is fairly simple. If the verb is intransitive, the indefinite conjugation is obligatory. However, when there is an object,

the decision is based on whether or not the object is "definite." An object is semantically definite whenever it can be uniquely identified by the speaker and the hearer (MacWhinney, 1985). One of the principles governing the categorization of the object as definite or indefinite depends on the overt presence of an article.

1. If the object is modified by the indefinite article, use the indefinite conjugation.
2. If the object is modified by the definite article or the demonstrative adjective, use the definite conjugation.

Because of this strong separation along principles of definiteness, the two conjugations are called "indefinite" and "definite," rather than "intransitive" and "transitive."

In many cases, either these simple article cues are not available or else they conflict with other cues. If the language user were free to either mark or not mark definiteness, he might well leave it at that. However, there is no unmarked conjugation of the verb. Every verb must be either definite or indefinite and this then forces the speaker to classify all objects as either definite or indefinite. This forced choice then entangles the speaker in a variety of further decisions that are less motivated semantically. Here are some of the additional conditions:

1. If the object is a common noun with no article, use the indefinite conjugation. In Hungarian, such nouns tend to take on a meaning of mass or generic quality. They are clearly not definite.
2. If the object is a proper noun used as a proper noun, use the definite conjugation. Although their definiteness is not marked by an article, such nouns are quite clearly definite semantically.
3. If the object is a proper noun used as a common noun as in "I see Hamlet in him," use the indefinite. What is involved here is a process which converts an inherently definite noun into a potentially indefinite noun.
4. If the object has a possessive suffix it is considered definite, even if modified by an indefinite article or has no article at all.

Kati látja egy macskámat.

Kati see-3S_TR a cat-1S_POSS-ACC

"Kati sees a cat of mine."

However, either conjugation can be used with possessed nouns whose possessive meaning has become lost, such as *asvalamennyiünket* "all-our-ACC" which now simply means "all of us." The semantic basis of this treatment of possessed nouns as definite is not entirely clear. It is true that possessives help to delimit the reference, but they seldom provide us with unique identifiability. However, it is interesting to note in this regard that the suffixes of the transitive conjugation actually arose historically from the possessive suffixes, indicating a possible deep semantic relation between possession and the transitive conjugation.

5. If the object is a first or second person accusative pronoun, it is considered indefinite. Third person pronouns are definite.

6. Indefinite pronouns are considered indefinite, unless they end in *-ik*. This suffix tends to select out a particular member of an indefinite collection and thus can be viewed as a definitizer. For example, *melyik* "which" takes the definite conjugation, whereas *mi* "what" takes the indefinite.
7. When indefinite pronouns modify nouns, the nouns are treated as indefinite. When definite pronouns modify nouns, the nouns are treated as definite.

Most of the cues list above have some semantic motivation. But sometimes the cues are quite weak. For example, there is no clear semantic reason why first and second person pronouns should be less definite than third person pronouns. In addition, actual selection of the definite or the indefinite conjugation is variable for pronouns such as *amelyiket* "which" or pronominal adjectives such as *valamennyi* "all" (see Moravcsik for examples). In still other cases, there is no object on the surface at all. This can occur for a variety of reasons:

1. If the verb is truly intransitive and there is no implied definite article, then the indefinite is used.
2. If the object is an "understood" definite noun, the verb should be in the definite, even though there is no definite noun in the surface structure. For example, one can simply say *szeretem* "like-3S_TR" and mean "I like it."
3. If the object of the verb is a complement clause, use the definite, even though there is no single head noun taking accusative marking.

Kati akarja, hogy üljek.
Kati want-3S_TR that sit-1S_IMP
"Kati wants me to sit."
4. If the main verb takes an infinitival complement, the object of that complement is used to determine the definiteness of the main verb.
5. Sometimes the object is missing from the clause because it has been "raised." This can occur when the head of a relative clause plays the role of the object within the relative clause. In such cases, the verb is always indefinite even if the head is actually definite. For example:

A mókus amelyet az egér szeret
The squirrel-(NOM) which-ACC the mouse-(NOM) love-(3S_INTRAN)
eszi a diót.
eat-3S_TRAN the nut-ACC.
"The squirrel the mouse likes eats the nut."

5.2 Extension and Reinterpretation

Although the choice of a conjugation is based on a fundamentally functional attempt to mark the definiteness of the object, this functional motivation runs into two major types of entanglements. Sometimes there is no obvious surface object. The object may be "understood," "raised," attached to an infinitive in a complement clause, or actually missing altogether. In other cases, there may be a conflict between some cues arguing for definiteness and others arguing for indefiniteness. In both cases, the speaker simply tries to extend the notion of definiteness to the new situations. In doing this, he must extend the contrast between definite and indefinite in a way that can be applied to the new situation. Let us take a couple of examples. In the case of an object relative, the principle that is being extended is: when the object is not present in the surface, the verb is intransitive. Thus, this extension is based on analogy with the simple objectless intransitive. In the case of a verb with a complement clause, the whole complement is treated as a definite object on the basis of analogy with sentences in which the complement is an extraposed modifier of a deictic head, as in:

Kati azt akarja, hogyüljek.

Kati that want-3S_TRANS, that sit-1S_IMP

"Kati wants me to sit."

In this example, the pronoun *azt* "that" is clearly definite and serves as the head of the extraposed clause *hogy üjek*.

This view of grammatical extension fits in well with the Competition Model view of language developed in Bates and MacWhinney (1982, 1987). As we noted earlier, that model views grammatical categories as based on a principle of "peaceful coexistence" between naturally confounded principles. Hungarian verbal conjugation is also based on a peaceful coexistence solution. In the prototypical case, the definite conjugation is used when

1. there is a surface object,
2. the object can be given a definite reading as uniquely identifiable by the speaker and the hearer,
3. the object is marked by an article, and
4. the article is definite.

In fact the notion of definiteness itself involves a peaceful coexistence between seven different ways of computing a unique referent. As discussed in MacWhinney (1985), these include exophora, anaphora, cataphora, paraphrase, paronymy, set operation, and genericalness. All of these various aspects of definiteness coexist peacefully in the prototypical definite object. Each is defined by way of contrast with the indefinite conjugation.

When the user is forced to extend the conjugational contrast to non-prototypical cases, he must do so on the basis of the cues that are present in the current situation. This extension is based on the fundamental Competition Model principles of cue availability and cue reliability. Of the various cues for definiteness we have discussed, the one which is most reliable is the cue of underlying semantic definiteness. However, in extending

this cue to complement clauses, the very notion of definiteness has to be extended and "reinterpreted" to now refer not only to a uniquely identifiable object, but also a uniquely identifiable activity. In the case of the use of the indefinite with object relatives the cue that is being extended is the surface absence of an object. By extending this cue to object relatives, the cue itself is being reinterpreted.

Reinterpretation may also be required for cases where cues conflict. For example, the indefiniteness of the stem of *barmelyik* "whatever" may compete with the definiteness implied by the suffix *-ik*. When attached to non-pronominal adjectives, the *-ik* suffix has a very clear definite meaning. For example, *a legszebbik* "the HYPER-pretty-COMP-DEF" means "the prettiest one" and refers to some clearly unique individual. When the *-ik* attaches to an indefinite pronoun, this meaning becomes extended and also somewhat reinterpreted.

The effects of reinterpretation are often seen only in historical perspective. Over the course of the last two millennia the marking of transitivity in Hungarian has undergone several reinterpretations. In the period of early Hungarian, the accusative suffix on the *noun* was a deictic postposition. As this postposition became agglutinated to the stem, it became interpreted as a marker of definiteness. Over time, the marker then became reinterpreted as expressing not definiteness, but object status as in Modern Hungarian. However, this reinterpretation became possible because of the parallel rise of the transitive-intransitive contrast on the verb. The suffixes of the definite conjugation arose from the agglutination of markers of personal possession. So a word like "látom" might originally have had a meaning like "my see" "my seeing." It is possible that such forms were not originally used with overt objects. However, as they then were reinterpreted as verbs and combined with overt surface objects, the marking of definiteness by the suffix on the object became reinterpreted. However, this did not put an end to the marking of definiteness on the noun, since not all nouns are objects. At some point later than the earliest period the definite article arose from a proposed deictic particle. In this way, we see that Hungarian has cycled through two major methods of marking definiteness, first by the suffix on the noun and then by marking on the verb. It appears that there is now some pressure for a major reinterpretation of the system of marking of definiteness on the verb. The marking is now so tightly entangled with every aspect of the conjugational marking of every verb that it cannot be simply dropped. Rather, it is being used to mark a variety of further distinctions such as the structure of the relative clause (MacWhinney and Pléh, 1988), the extended uses of proper nouns, the omission of an understood object (double pro-drop), and the presence of complement clauses. Experimental data on the on-line processing of this cue (MacWhinney and Pléh, 1988) suggests that this marking will undergo a great deal of reinterpretation in the future.

6. Summary

We began our analysis of categorization theories by reviewing the shift from Classical Theory to Prototype Theory. We then pointed out a variety of ways in which the notion of competition can enrich Prototype models. We have shown how competition can help

us understand not only the basic process of word choice and categorization, but also certain crucial aspects of language learning, language extension, and language change. Within the area of language learning, we have seen that competition promotes a growth of correct mappings based on a confirmed core of episodic encodings. Within the area of language extension, we have seen how pushy polysemy can allow us to use language creatively and dynamically and we see how extensional pathways emerge from analogies between lexical forms. Within the area of language change, we have seen how our entanglement with grammatical forms can lead us to reinterpret meanings and forge new uses for old linguistic structures. Together, these concepts based on the ideas of competition and cooperation provide us with vantage points that permit us new insights into category structure, use, and development.

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