CHAPTER 5

A Functionalist Approach to Language and Its Implications for Assessment and Intervention

ELIZABETH BATES, DONNA THAL AND BRIAN MacWHINNEY

There is a constant tension in the field of speech-language pathology between researchers who are wedded to the use of carefully controlled and designed conditions for the study of language and clinicians who need to know how to remediate language disorders in the much more messy real world. The problems created by this tension have been the topic of many discussions, including a recent ASHA Report (Shewan, 1990). Yet, over the past 20 years, a number of approaches to the study of language and language disorders have been developed that provide a better framework for clinician-researcher communication. One of these is Functionalism, an approach to the study of language that Carol Prutting pioneered. Her application of pragmatics to the study of language assessment and intervention was an important step toward bridging the gap between theoretical approaches and clinical applications. This chapter represents our attempt to continue the bridge building that Carol exemplified in her productive career by describing a recent functionalist model and suggesting how insights derived from the model may be applied to real-world clinical situations.

Functionalism can be defined as the belief that the forms of natural languages are created, governed, constrained, acquired and used in the service of communicative functions. So defined, functionalism is the natural alternative to theories of language that postulate a strict separation between structure and function, and/or theories that attempt to describe and explain structural facts *sui generis,* without reference to the constraints on form that are imposed by the goals of communication and the capabilities and limitations of human information processing.

Although this definition seems sensible enough as stated, it has become sadly clear over the years that the term "functionalism" alone does not communicate very well. It means different things to different people, and worst of all there seems to be a "Straw Man" Functionalism that causes trouble wherever we go. In this chapter, the principles of the Straw Man Functionalism are compared and contrasted with an approach that is much more reasonable and much more likely to succeed. Some possible applications of this approach to language assessment and intervention are then suggested.

The straw man form of functionalism can be summarized with the following six beliefs:

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Grammar is a direct reflection of meaning.
Grammar is iconic.
Mappings from meaning to grammar are one to one.
Mappings from meaning to grammar are deterministic.
Functionalism is anti-nativist.
Functionalism is anti-linguistic.

In the next few pages, these six straw man beliefs will be reviewed one at a time, and each will be replaced with a more viable functionalist account. The particular functionalist theory used in this chapter is called *Competition Model.* It is based on two decades of research on more than a dozen languages, including studies of language acquisition in children, language processing in adults, and language breakdown in aphasia (Bates, 1976; Bates & MacWhinney, 1979,1982,1987,1989; Bates, Thal, & Marchman, in press; MacWhinney, 1978, 1987; MacWhinney & Bates, 1989).

FROM STRAW MAN FUNCTIONALISM TO THE COMPETITION MODEL

1. GRAMMAR IS NOT A DIRECT REFLECTION OF MEANING

Instead, grammars reflect the interaction between cognitive content and cognitive process. Grammars carry out important communicative work. Like individual lexical items, specific grammatical devices (word order principles, bound and free morphemes, suprasegmental cues) are associated with meanings and/or communicative goals. But the association is rarely direct. It may be more useful to think of language as a complex traffic control problem, with many different meanings competing for expression in a linear (i.e., time-delimited) channel. The limits imposed by human information processing (limits of perception, articulation, learning, and memory) may ultimately prove more important than meaning itself in elucidating why grammars come to look the way they do.

Figure 5-1 illustrates a two-pronged approach to the explanation of linguistic form, representing an attempt to explain why languages look the way they do. On the one hand, we agree with the proponents of functionalist linguistics and/or cognitive grammar (Chafe, 1971; Dezso, 1972; Dik, 1980; Driven, & Fried, 1987; Fillmore, 1987; Firbas, 1964; Firth, 1951; Foley & Van Valin, 1984; Givon, 1979; Halliday, 1966; Lakoff, 1987; Langacker, 1987) that linguistic forms are associated with and motivated by specific kinds of semantic and/or pragmatic content. In other words, linguistic forms exist to convey messages between human beings. But we disagree with many functionalist linguists who believe that they can explain a given language solely through detailed descriptions of its message constraints (i.e., the restrictions on form-function mappings). That kind of explanation is, we think, only one half of the functionalist story. The other half includes a complex, interacting set of human information processing constraints that operate whenever we use language in real time. These include the opportunities and limitations imposed by memory, perception, planning and articulation of speech movements, and the learning process itself. These message constraints and information processing constraints pose a number of problems that have to be solved together. Hence every natural language can be viewed as a "constraint satisfaction network" (Rumelhart, McClelland, & the PDP Research Group, 1986), a system of converging and (often) competing forms and functions that must be understood to explain how languages evolved in the first place, how they are used by speakers and listeners today, how they are acquired by children, and how they go awry under a range of pathological conditions. We

have called our theory the "Competition Model" to capture the highly interactive nature of the form-function mappings that comprise any natural language.

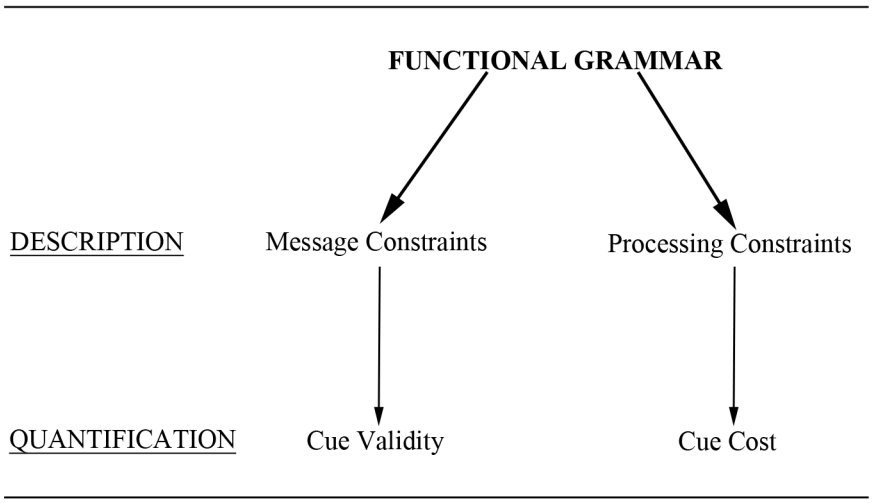

Figure 5-1. Two-pronged view of linguistic form.

In the Competition Model two fundamental principles are used to conceptualize and quantify this traffic control problem: cue validity and cue cost.

The term *cue validity* refers to the information value of a given lexical or grammatical device for any particular meaning or function. The term comes from Gestalt psychology (Brunswik, 1956), where it was broadly used to refer to the information structure of some aspect of the environment for any goal or condition that is of interest to the organism; it is related to (perhaps equivalent to) the better-known term ecological validity, which is widely used in the study of animal behavior (Eibl-Eibesfeldt, 1975) and in the Gibsonian approach to perception (Gibson, 1966,1969). Later on we will talk about how to calculate cue validity from samples of real language use. For present purposes, it is important to emphasize that validity refers to the environment *from the language user's point of view.* Unlike frequency (which really is an objective property of the environment, whether anyone cares about it or not), validity refers to the signal value of some piece of the environment for a goal or event that is important for the organism that we are trying to study. For example, instead of measuring the absolute frequency of a grammatical device like subject-verb agreement, the value of subject-verb agreement can be measured as a cue to the agent role (i.e., who did what to whom?).

The term *cue cost,* also derived from the study of perception, is used to explain why cue validity does not predict behavior perfectly. In an ideal world, an ideal animal would behave in perfect accordance with cue validity. But people do not live in an ideal world, and they are not ideal animals.

The relationship between meaning and form in language cannot be perfect, because of all the constraints imposed by human information processing systems. Our experiments to date have shown that cue validity strongly determines the order of acquisition of cues by children and the extent to which adult speakers rely on those cues during sentence interpretation. Cue validity also plays a major role in the sentence comprehension and production profiles displayed by adults suffering from severe forms of aphasia. However,

there are still many systematic exceptions to this principle. Most of these exceptions can be accounted for by invoking principles of cue cost, that is, the information processing costs associated with the real-time use of any given lexical or grammatical cue. For example, cues that are equally informative can vary in their perceivability (e.g., because two syllables are easier to hear than one, the form of the plural morpheme that follows a voiceless fricative, as in "glasses," is easier to perceive than that in the word "cats"). Cue cost will influence the degree to which adults "trust" this particular cue to meaning, the age at which children come to rely on the cue, and the degree of resistance to impairment associated with this particular cue in sentence processing by adults with brain damage. Similarly, cues can vary in the demands they place on memory. "Local cues" (e.g., a case suffix marked directly on the noun) can be used as soon as they are encountered (providing immediate information about the semantic role that noun is going to play in the sentence). These linguistic forms appear to have an advantage over "long-distance cues" which distribute the same semantic information across a set of discontinuous elements (e.g., subject-verb agreement in a sentence like "The *boys* I told you about *are* coming over tonight"). A full account of how grammars come to look the way they do, and how and when they are acquired by children will require an analysis of the complex interplay between meaning (quantified as cue validity) and information processing (quantified as cue cost). Grammars represent a compromise among these forces, and for this reason, the communicative function of a given grammatical form may be quite opaque.

2. GRAMMAR IS NOT ICONIC

Instead, the relations between form and function are symbolic and indexical. Linguistic forms rarely, if ever, resemble their meanings. There *are* of course a few examples of words that "sound like" the things they stand for (e.g., Bang!), but these are few and far between. It is even more difficult to think of grammatical devices that bear a literal physical resemblance to their meanings. There is of course the apocryphal claim that natural languages prefer basic word orders in which the subject precedes the verb because human beings "naturally" tend to perceive actors before they perceive their actions. This claim is silly enough that it is not worth pursuing. But if grammars do not "look like" their meaning, what kind of natural cause-and-effect relationship could be said to hold between form and function?

C. S. Peirce (1932) provided an analysis of sign-referent relations that may be as useful in the study of grammar as it is in the study of single signs. *Icons* are signs that come to stand for their referents because of a literal physical resemblance (e.g., a stylized picture of a cigarette to indicate a smoking zone). *Indices* are another class of "natural" signs that come to stand for their referents, not because of a physical resemblance but because of their participation in the same event (e.g., contiguity rather than similarity). For example, smoke can serve as an index to fire because the two are commonly associated in real life. *Symbols* are signs that bear no natural relation to their referents (neither iconic nor indexical); instead, they carry meaning only because of an arbitrary convention, an agreement that was reached by a particular community of users. As Langacker (1987) pointed out, most lexical and grammatical signs bear a symbolic relationship to their meanings. Grammatical devices exist to carry out communicative work, but the work they do does not determine their form. However, in the domain of grammar there may well be many cases of indexical causality if we keep in mind that grammars are jointly caused by cognitive content *and* cognitive processing.

To offer just one example, consider the relative clause. This device typically is used to identify referents in discourse, for example, "The man that sold me the car," a clause that picks one particular man out of a range of other possibilities. In principle, the reference specification function could be served by a purely arbitrary (i.e., symbolic) device. However, the reference specification function itself tends to call indexical factors into play that help to determine its shape and position of the relative clause. Bindings between a referent and its modifier are easier to make if the two are in close proximity. Hence the function of referent identification is best served if the relative clause is placed near its governing noun phrase, where other modifiers are located. However, this solution poses another problem: the relative clause must interrupt a main clause. Such interruption is costly for two reasons. First, because relative clauses are longer than most modifiers, the main clause has to be held open for a rather long time. Second, because relative clauses resemble main clauses in many respects, there is a potential for confusion (e.g., which verb goes with which noun). In principle, this problem could be solved by placing a warning signal at the beginning of a sentence to indicate that "a relative clause will be placed within the following sentence at some point; you guess which point." Although this is a logical possibility, it should be obvious why it would not work very well. It makes much more sense to place the marker *at the point of interruption,* to keep the listener from chasing down some garden path and to help him or her construct and attach the clause right where it belongs (i.e., near the element that it modifies). Finally, insofar as an interruption places quite a burden on the processor, the interruption-marking device had best be kept short and sweet. Hence the functions of the relative clause have an effect not only on the existence of certain devices (symbolic determinism), but also on their position and overall shape (indexical determinism). In neither case is it reasonable to say that the resulting grammatical device "looks like" its meaning!

3. MAPPINGS BETWEEN FORM AND FUNCTION ARE NOT ONE TO ONE

Instead, they are many to many. Grammars can be viewed as a class of solutions to the problem of mapping nonlinear meanings onto a highly constrained linear medium. The universal and culture-specific contents of cognition interact with universal constraints on information processing, creating a complex multivectorial problem space with a finite number of solutions. Natural languages exhaust the set of possible solutions to this mapping problem, and because these solutions represent many competing forces, they invariably involve many-to-many mappings between form and function (cf. Karmiloff-Smith, 1979), with correlated meanings riding piggyback on correlated bits of grammar. No single meaning (however abstract) can be allowed a grammatical monopoly.

Figure 5-2 illustrates a network of such form-function mappings, a fragment of the large network that constitutes our knowledge of "subjecthood" in English. The network includes three communicative roles that are usually, but not always, assigned to the same referent in an English sentence: agency (e.g., the actor role for a transitive action verb), topic-hood (the element that we have been talking about so far), and point of view (usually the point of view of the speaker). Because these three important communicative functions go together much of the time, most languages have evolved ways to map them together as a block. The English subject role is a typical example of such a "block assignment." The subject role is referred to as a block or coalition because subjecthood refers to a range of different and potentially separate linguistic devices. In English, the subject tends to be the first noun in the sentence, the noun that comes directly before the verb, and the noun that

agrees with the verb in person and number. If the subject is expressed in a pronominal form, it is usually expressed in nominative case (e.g., "I" rather than "me"; "she" rather than "her"). Interestingly, although it is not usually thought of as a cue to the subject role, across most natural languages statistically the subject is particularly likely to be a first person pronoun *("I")*. Presumably this is because people like to talk about themselves, that is, their point of view and the topic of the sentence tend to be the same.[1] Finally, because the subject coalition is usually mapping topic-hood as well as agency, the subject tends to be "old information," which is in turn likely to be expressed with definite reference (e.g., using the definite article "the" when an article is used at all). All of these correlated surface devices can be used in comprehension as cues to sentence role to help the listener figure out who did what to whom.

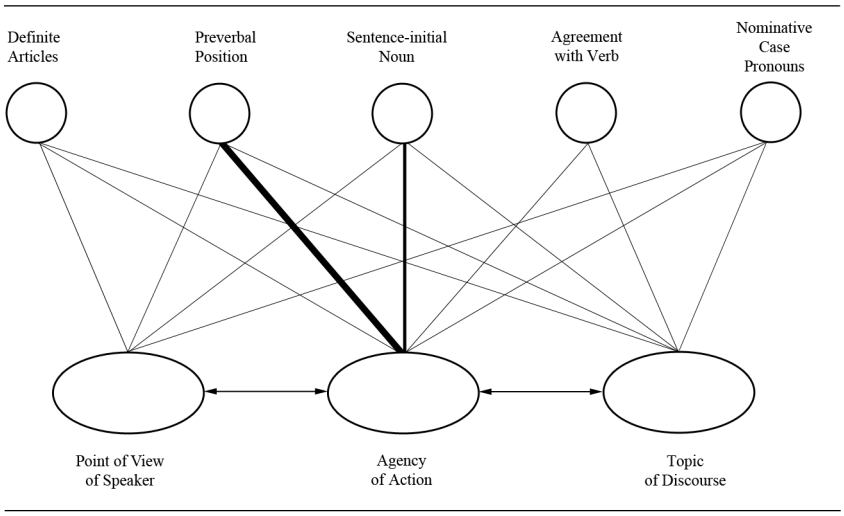

Figure 5-2. Fragment of the sentence role(s) network.

The many-to-many nature of grammatical mapping is both a cause and a result of the instability inherent in linguistic systems. In fact, there may be no stable, perfect pathway through the linguistic problem space. As Slobin (1982) pointed out, many processing constraints stand in direct competition; hence stability in one area may create instability in another. From the listener's point of view, a given linguistic marker will signal its meaning most efficiently if it is consistent, salient, and unique. But from the speaker's point of view, the same linguistic device has to be easy to retrieve and produce. Hence the clear and perceivable markers that evolve for comprehension are often subject to erosion in the service of rapid and efficient speech output. Faced with these competing demands, across the course of history, languages have been known to cycle back and forth from one set of solutions to another. Hence grammars must be viewed as a set of *partial solutions* to the mapping problem, each representing one pathway through the space of constraints imposed by cognitive content and cognitive processing. No solution is perfect, and each is constantly subject to change; but every grammar used by a community of human adults and acquired by their children has to meet certain implicit but implacable limits of tolerance.

[1] Not surprisingly, the next most probable subjects tend to be "you" and "he/she/it," a reflection of how human goals and interests shape the nature of discourse. Indeed, in some human languages the subject role can only be assigned to an animate referent, preferably a human animate referent; there are even some so-called split-ergative languages in which one kind of "special" subject role is reserved for first and second person only; a different treatment is given for third person topics (Silverstein, 1976).

4. MAPPINGS FROM MEANING TO GRAMMAR ARE NOT DETERMINISTIC

Grammatical mappings are inherently probabilistic. Languages differ qualitatively in the presence or absence of certain linguistic devices (e.g., word order constraints, case-marking), but they also differ quantitatively in the extent to which the same linguistic device is used at all and in the range of functional roles it has come to serve. One of the ways in which the Competition Model differs from other functionalist approaches to language lies in its heavy emphasis on the probabilistic nature of linguistic knowledge as well as language use. In a sense, in constructing the Competition Model, we have followed the same path that physicists followed in embracing quantum mechanics: the probabilistic nature of our data is not just a reflection of our imperfect measures; rather, we have been forced to conclude that nature itself is probabilistic at its core. (For a lucid discussion, see Stephen Hawking's *A Brief History of Time,* 1988.) In everyday terms, this means that the relationship between form and meaning is inherently imperfect; when we learn a language, we learn not only *that* a given form and meaning go together, we also learn *how strongly* they go together in our native language. This also means that the "same" mapping from form to meaning (e.g., the relationship the actor role and preverbal position) can vary systematically in strength from one language to another.

We have given a number of examples of such quantitative differences between languages throughout our work (see especially papers in MacWhinney and Bates, 1989). One particularly important example has to do with the relative strength of word order versus subject-verb agreement as cues to sentence meaning. In English, word order is rigidly preserved; in almost all structures, the order that is preserved is Subject-Verb-Object or SVO. In Italian, word order can be varied extensively for pragmatic purposes—a fact that comes as something of a surprise to those who believe that such pragmatic word order variation occurs only in case-inflected languages (i.e., languages with markers on the noun to indicate who did what to whom). The following list (from Bates & MacWhinney, 1989) illustrates some possible variations in the order of major constituents in Italian in a hypothetical restaurant conversation. This short conversation (hypothetical but quite plausible according to our Italian informants) contains all possible orders of Subject, Verb, and Object.

1. SVO:	*Io mangerei un primo.*	I would eat a first course.
2. OSV:	*La pastasciutta Franco la prende sempre qui*	Pasta Franco it orders always here.
3. VSO:	*Allora, mangio anche io la pastasciutta.*	Well then, am eating also I pasta.
4. VOS:	*Ha consigliato la lasagna qui Franco, no?*	Has recommended the lasagna here Franco, no?
5. OVS:	*No. la lasagna l'ha consigliata Elizabeth.*	No, the lasagna (it) has recommended Elizabeth.
6. SOV:	*Allora, io gli spaghetti prendo.*	In that case, I the spaghetti am having.

Some of these require particular intonation patterns to sound exactly right, and some are definitely better with particular grammatical markers like the object clitic. But all of these

orders can be found in a large enough sample of free speech, and all of them occur at some point in the input received by Italian children (Bates, 1976).

At one level, this discourse serves merely to illustrate a well-known qualitative difference between languages: Italian has word order options that do not exist in English at all. However, this quantitative variation also has quantitative implications. In several different experiments it has been demonstrated that Italian listeners "trust" word order—even good old-fashioned Subject-Verb-Object order—less than their English counterparts. Given a sentence like "The pencil hits the cow," English listeners from ages 2 to 80 have a strong tendency to pick the pencil as the agent/subject. Given the Italian equivalent *("La matita colpisce la vacca"),* Italians of all ages are much more likely to choose the cow as the agent/subject. Hence a qualitative difference in the availability of word order types has a quantitative effect even on a subset of grammatical structures that both languages share (e.g., SVO order).

Most of our joint research to date has concentrated on sentence comprehension. But we have also discovered some interesting quantitative differences in the domain of sentence production. For example, Bates and Devescovi (1989) described some robust differences between Italian and English in the use of relative clauses. The structural options available in the two languages are the same, at least for the set of structures studied by these investigators. In both languages, it is perfectly grammatical to describe a picture of a monkey eating a banana by saying either "A monkey is eating a banana" or "There is a monkey that is eating a banana." However, English speakers typically use the first option; Italian speakers describing exactly the same picture, under the same conditions, are three to five times more likely to produce a relative clause. This cross-linguistic difference in relative clause use is already well established in children by the age of three, and it tends to persist even in elderly patients who have suffered left-hemisphere damage. How can we capture a quantitative difference between two structures that are equally grammatical from a traditional grammatical perspective? To be sure, there are some differences between the two languages in the range of functions that control these particular forms. In particular, Italians appear to use the relative clause as a kind of topic marker. But in addition to (and perhaps because of) these differences in function, there are also clear processing differences between English and Italian in the "accessibility" of the relative clause. Similar statistical differences between Italian and English children have been found in rates of article omission (greater in English children well before the age of three) and in rates of subject omission (with much higher rates of subject omission in Italian children even in the stage of first word combinations [Bates, 1976]). Some of these differences (e.g., subject omission) are treated in current linguistic theory in terms of a discrete set of rules or parameters; others (e.g., article omission) receive no treatment at all in current linguistic theory. It may be that these early differences in performance can only be captured by assuming that very small children are sensitive to statistical as well as structural facts about the language they are trying to acquire. Function and frequency co-determine the selection of grammatical forms in sentence production, in language use by adults, and in language acquisition by children.

As noted earlier, physicists have made their peace with the counterintuitive predictions of quantum mechanics, and they now accept the premise that the position of a subatomic particle may be unknowable *in the absolute.* Uncertainty lies at the core of the universe; it is not just a byproduct of man's imperfect measures. We argue that the human language processor is also probabilistic at its core. In the Competition Model, the adult speaker's knowledge of his native language is represented in a probabilistic form, and

probabilities play a fundamental role in the process of language acquisition. The difference between obligatory rules and statistical tendencies is simply a matter of degree. This does not mean that we ignore the powerful laws that separate one language from another. After all, the values "0" and *"1"* do exist even in a probabilistic system, and an adult native speaker thus may come to know with some certainty that a particular structure is impossible in his or her language. The difference between this characterization of adult knowledge (i.e., "competence to perform") and the characterizations offered in most competence models lies in its ability to capture the many values that fall between 0 and 1. Linguistic representations are described in terms of a complex set of *weighted form-function mappings,* a dynamic knowledge base that is constantly subject to change. Returning to the network described in Figure 5-2, a fragment of the English subject system, in principle the weight or strength of the relationship between each form (e.g., preverbal position, subject-verb agreement) and each of the three related functions (agency, topic-hood, point of view) can be calculated. In the Competition Model, these weights would be used to predict the degree to which listeners "trust" each of the subject cues when they are trying to decide who did what to whom. In English, positional cues (e.g., sentence-initial position, preverbal position) are strongly associated with the actor role (i.e., their weights are strong), and they are used quickly and reliably to assign sentence roles during comprehension; in Italian, the same cues are much less reliable (i.e., their weights are small), and as a result, Italian listeners tend to rely more on other, stronger sources of information to assign the actor role (e.g., subject-verb agreement, lexical contrasts, definiteness).

Within this framework, language acquisition can be viewed as a process of *meaning-driven distributional analysis,* similar in spirit to the approach outlined some time ago by Maratsos (1982). However, the Competition Model also furnishes some nonlinear principles that permit the capture of sudden phase transitions, U-shaped functions, and the effect of rare events—all of the phenomena that forced psychologists to abandon the simple linear associative models of American Behaviorism. Many of these discoveries within our model have fallen out of two approaches to the quantification and formalization of language learning: (a) mathematical modeling of the effects of cues on choice behavior in sentence comprehension (McDonald, 1986; McDonald & MacWhinney, 1989) and (b) computer simulations of the learning process (Taraban, McDonald, & MacWhinney, in press). For example, we have discovered that cue validity can be operationalized in two ways: *overall cue validity* (the proportion of all the cases in which an interpretation must be made in which a given cue is available and leads to a correct interpretation) and *conflict validity* (the proportion of cases in which one cue competes with another in which the cue in question "wins"). Both of these metrics can be calculated objectively from texts of real speech, and used to predict the choice behavior of children and adults in sentence comprehension experiments. Interestingly, we have discovered that overall cue validity drives the early stages of language acquisition; conflict validity (affected primarily by rare cases, particularly those that are encountered in complex discourse) drives the late stages of learning in older children and adults. With these two statistical principles, abrupt changes in sentence processing strategies that occur as late as 7 to 10 years of age can be captured.
Although the Competition Model was developed independently (to deal with facts of acquisition and processing across different natural languages), in its current form the model has a great deal in common with a recent movement that is alternatively referred to as *connectionism, neural modeling* and/or *parallel distributed processing* (e.g., Elman, 1990; Rumelhart, et al., 1986). It remains to be seen how strong that relationship will be, but we are at least convinced that the tools we share will prove to be exceptionally important in the next era of language acquisition research. Cognitive psychology has proceeded for more than 30

years without an adequate model of learning. Unfortunately, research in language acquisition has done the same. The new focus on learning in "brain-like systems" is a healthy one, whatever its limits may prove to be. And the new tools (i.e., mathematical modeling, multivariate statistics, computer simulation) are bound to lead to progress. Natural languages are so complex that "eyeball analysis" alone can only take us so far—probably no farther than we have come to date.

5. FUNCTIONALISM IS NOT ANTI-NATIVIST

It is, in fact, based on the unique biological heritage of humans. The innateness issue is one of the major sources of anger and misunderstanding in the field of psycholinguistics. Much of this misunderstanding comes from a failure to distinguish between *innateness* and *domain-specificity.* The innateness issue has to do with the extent to which human language is determined by the unique biological heritage of our species. But this biological heritage may include many capacities that are not unique to language itself: the large and facile brain, particular social organization, and protracted infancy of the human species, and a variety of unknown factors that may contribute in indirect but very important ways to the problem of mapping universal meanings onto a limited channel, and to the particular solutions that we have found to that problem. Hence the human capacity for language could be both innate and species-specific, and yet involve no mechanisms that evolved specifically and uniquely for language itself. Language could be a new machine constructed entirely out of old parts (Bates, 1979). The universal properties of grammar may be *indirectly innate,* based on interactions among innate categories and processes that are not specific to language. In other words, we believe in the innateness of language, but we are skeptical about the degree of domain specificity that is required to account for the structure and acquisition of natural languages.

6. FUNCTIONALISM IS NOT ANTI-LINGUISTIC

Instead, functionalist claims are made at different levels of evidence. Functionalist theories of performance are not in direct competition with any linguistic theory. Different kinds of functionalist claims require different kinds of evidence. This is a point that has been made before in several places (notably Bates & MacWhinney, 1982, 1987, 1989), but it is sufficiently important that it deserves reiterating here. Four different levels of functionalist claims, ordered from weakest to strongest (in the sense that claims at the higher levels presuppose that claims at the lower levels are true) can be distinguished.

Level I focuses on the role of cognitive and communicative functions in the evolution of language proper, and the history of individual languages. Claims at Level 1 constitute a kind of linguistic Darwinism, that is, arguments that functional constraints have played a role in determining the forms that grammars take today. Where did the tiger get his stripes? Why do grammars have relative clause markers? A great deal of work in functionalist linguistics is of this historical sort, in particular studies of "grammaticization" (e.g., Bybee, 1985; Givon, 1979). Although this work is extremely interesting in its own right, claims at the historical level do not necessarily have implications for current language use by adults, language acquisition by children, or the proper characterization of grammatical knowledge. Like the large-scale forces that operate to create mountains and rivers across geological time, the forces that operate across many individuals to bring about historical language change may not be detectable (or even operative) in every individual case.

Level 2 is a synchronic variant of Level 1, focusing on the causal relationship between form and function in real-time language use by adult speakers of the language. Much of our own work with adults is of this sort: We manipulate competing and converging sets of grammatical forms as "causes" to see what interpretations our subjects derive; conversely, we manipulate competing and converging meanings in picture and film description, to see what expressive devices our subjects produce to meet these demands. However, even if we could show a perfect cause-and-effect relation in adults, we could not immediately conclude that children are able to perceive or exploit these relations.

Level 3 presupposes but goes beyond Level 2, focusing on the causal role of cognitive and communicative functions in language acquisition by children. The cause-and-effect work of Level 2 must be repeated at every stage of language acquisition to determine empirically if and when children are sensitive to the form-function correlations available in the adult model. Furthermore (as noted earlier), we need a well-articulated theory of the learning process, one that can adequately describe, predict, and explain the stages that children go through on their way to adult performance.

Finally, *Level 4* is reserved for the claim that facts from Levels 1 through 3 play a direct role in the characterization of adult linguistic competence. A variety of competence models of this sort have been proposed within the functionalist tradition, ranging from *Eastern European functionalism* (i.e., the so-called Prague School—Dezso, 1972; Driven & Fried, 1987; Firbas, 1964; Firth, 1951), *British functionalism* (e.g., Halliday, 1966), the American school of *generative semantics* (e.g., Chafe, 1971; Fillmore, 1968) to more recent proposals that include *cognitive grammar* (Lakoff, 1987; Langacker, 1987), *construction grammar* (Fillmore, 1987), *role and reference grammar* (Foley *&* Van Valin, 1984), and several other approaches that either retain the simple term "functionalism" or elect to avoid labels altogether (e.g., Dik, 1980; Givon, 1979; Kuno, 1986). For the sake of simplicity, these otherwise rather disparate linguistic theories will be referred to with the single term *functional grammar.* Although functional grammars are not designed to account for real-time processing, they are most compatible with highly interactive models of performance, that is, like the Competition Model. For obvious reasons, "modular" theories of performance are instead more compatible with "modular" theories of competence, that is, with linguistic theories that emphasize the autonomy of various components and subcomponents of the grammar (cf. Berwick & Weinberg, 1984; Bresnan, 1982; Pinker, 1984). It is quite possible that ultimately there will be a convergence between some Level 4 versions of functional grammar and the performance model that we have developed to account for data at Levels 1 to 3. But it is also possible, at least in principle, that there may be a rapprochement between a functionalist model of performance and the various rules and representations that have been proposed within the many-times-revised-and-extended school of generative grammar.

In short, we are not anti-linguistic, nor is our work directly relevant to any particular class of competence models. We are consumers of linguistic theory, and we have our own bets about which linguistic theory or class of theories ultimately will prevail. But we are much too preoccupied with problems of a different sort to enter into the linguistic fray. This is an exciting new era in language acquisition research, and time is too precious to be wasted on battles that are best waged elsewhere.

APPLICATIONS OF THE COMPETITION MODEL TO NORMAL ADULTS AND CHILDREN

As summarized in MacWhinney and Bates (1989), the Competition Model has provided a framework for the study of sentence comprehension, sentence production and grammaticality judgments, in child and/or adult speakers of more than a dozen different languages (English, Italian, German, French, Dutch, Spanish, Serbo-Croatian, Hungarian, Turkish, Hebrew, Japanese, Chinese, and Warlpiri). In all of these studies, dramatic cross-linguistic differences in the relative "strength" and timing of grammatical cues have been explained using the twin principles of cue validity and cue cost.

A particularly clear example comes from a recent "on-line" study of grammaticality judgments by Wulfeck, Bates, and Capasso (1991). This study compared American and Italian college students listening to errors of agreement (e.g., "She are selling books down by the river") and to errors of word order involving the same sentence elements (e.g., "She selling is books down by the river"). In both languages, college students were able to detect these errors almost 100% of the time. However, Americans were significantly faster at detecting word order errors; conversely, Italians were significantly faster at detecting errors of agreement. These results follow directly from differences between English and Italian in the cue validity or information value of agreement (high in Italian, low in English) and word order (high in English, lower in Italian). Of course both languages have word order, and both languages have agreement. However, the relative importance of these two sources of information influences the way that native speakers distribute their attention as a sentence comes in.

The Competition Model has also been applied to the acquisition of a second language in normal adults (Kilborn & Ito, 1989; McDonald, 1989). In these studies, cross-linguistic differences in cue validity can be used to predict patterns of transfer from the adult's first language (LI) to the adult's second language (L2). For example, native speakers of German and/or Italian tend to rely primarily on subject-verb agreement when they are asked to interpret English sentences (e.g., given an "odd" sentence like "The dog are kicking the cows," German-English and Italian-English bilinguals tend to choose "the cows" as the subject; monolingual English speakers are much more likely to choose "the dog," rigidly following SVO word order). Conversely, native speakers of English tend to pay more attention to word order than any other cue when they are trying to process a second language. A particularly compelling example of this kind of transfer comes from a study of English-Japanese bilinguals by Harrington (1987), which was described by Kilborn and Ito (1989). In Harrington's study, bilingual subjects were presented with Japanese sentences in which the basic word order of that language (SOV) was placed in competition with semantics (e.g., The pencil the cow is kicking) and/or with morphological cues. Surprisingly, the English subjects actually relied more on SOV word order than their Japanese counterparts (e.g., choosing the pencil as the agent in a sentence like "The pencil the cow is kicking"). Since SOV is not a realistic option in English, Kilborn and Ito interpreted this result as evidence for a kind of "meta-transfer": faced with a new and unfamiliar language like Japanese, these English adults looked for the relevant word order cues in that language and used them as their main source of information. As Kilborn (1987) has shown in other studies, this kind of transfer can be very costly: bilingual listeners may "get the right answer" most of the time with their LI strategies, but they pay a high price in processing efficiency (i.e., slower reaction times, particularly in situations that require rapid and immediate integration of semantic and

grammatical cues). Put somewhat differently, use of the wrong cue validity structure results in high cue cost.

In studies of first language acquisition, the general rule appears to be that children start out by learning the most valid cues in their language (e.g. Turkish children rely on case morphology more than word order from the very beginning; English children rely on word order from the very beginning and make little use of other grammatical cues for several years). However, there are some important exceptions to this general rule which underscore the interaction between cue validity and cue cost. For example, we now know that all forms of agreement (subject-verb, object-pronoun) as primary cues to sentence meaning in comprehension tend to be "postponed" by children until 6 or 7 years of age, even though the same children often know how to produce those forms in their own speech by the age of 2! French, Italian, Spanish, Serbo-Croatian, and Hebrew are all languages in which adults rely heavily on agreement cues in our sentence comprehension task (e.g., given a sentence that is equivalent to "The dog is kicking the cow," they tend to choose "the cow" as the actor); however, in all four languages this adult profile of sentence processing does not show up until 7 years of age (Devescovi, D'Amico, Smith, Mimica, & Bates, 1990; Kail, 1989; Sokolov, 1989). The reason appears to be that use of agreement cues in comprehension (but not production) requires the listener to keep a lot of elements in mind (first listen to and remember the first noun, check it against the verb, but then wait until you hear the next noun because you could be fooled, check it against the verb, and so on). Children appear to operate under memory limits of some kind that are "lifted" around 6 to 7 years of age, when they finally "calibrate" to interpret sentences in an adult mode.

Other cue cost factors that have been studied to date include *perceivability,* that is, differences in phonological salience between cues that are equally high in information value. For example, MacWhinney, Pleh, and Bates (1985) have studied the acquisition and use of the Hungarian accusative case inflection "-t" under two different conditions: after a strong vowel (e.g., "bear-nominative" or *maci*—> "bear-accusative" or *macit)* and after a final consonant (e.g., "squirrel-nominative" or *mokus*—> "squirrel-accusative" or *mokust).* The same inflection is easier to hear in the first condition, and it is in this condition that Hungarian children first demonstrate an ability to use accusative case markings as a cue to sentence meaning.

Another cue cost factor is one that Bates and MacWhinney (1989) have called *functional readiness,* that is, the conceptual difficulty or cognitive cost of the communicative function that underlies a given grammatical cue. For example, some grammatical devices (e.g., the relative clause) bear a very strong and consistent relationship to their primary functions (e.g., specifying the identity of the intended referent for one's listener). However, it may be relatively difficult for young children to understand this reference-specification function (i.e., how much information the listener needs for successful communication to take place) because their cognitive skills are not yet sufficiently developed. In a case like this, a grammatical device may be acquired relatively late despite its high cue validity.

APPLICATIONS OF THE COMPETITION MODEL TO LANGUAGE DISORDERS

During the 1970s and 1980s, many English-speaking aphasiologists were drawn to the notion that grammatical impairment is somehow uniquely associated with nonfluent Broca's aphasia (see especially Caramazza & Berndt, 1985; Heilman & Scholes, 1976; Zurif & Caramazza, 1976). By definition, individuals with Broca's aphasia display reduced syntactic complexity and omission of bound inflections and freestanding grammatical function words

in their expressive language—a form of "expressive agrammatism." The further conclusion that this syndrome reflects a kind of "central agrammatism" was based (at least in part) on the finding that individuals with Broca's aphasia display a form of *receptive agrammatism,* that is, deficits in receptive processing of the same morphosyntactic elements that are missing or impaired in their expressive language. For example, patients who appear to comprehend reasonably well at a conversational level (i.e., in a bedside clinical examination) fail to comprehend the difference between sentences like "He showed her the baby pictures" and "He showed her baby the pictures." From this point of view, the deficits displayed by adults with Wernicke's aphasia could be reinterpreted to reflect a form of "central semantic deficit." If adults with Broca's aphasia are impaired in receptive and expressive processing of grammatical elements, those with Wernicke's aphasia may suffer from a complementary impairment in the receptive and expressive processing of content words. This claim appears to unify several of the behavioral symptoms that define Wernicke's aphasia: moderate to severe problems in language comprehension in patients with fluent but empty speech, marked by moderate to severe word-finding deficits and a tendency toward word substitutions, word blends, and/or neologisms.

Taken together, these complementary forms of aphasia appear to constitute strong evidence for the modularity and dissociability of grammar and semantics—in direct contrast to the most central tenets of the Competition Model. How can a functionalist theory that insists on an intimate relationship between grammar and meaning deal with findings of this kind? As it turns out, our model fits the cross-linguistic evidence on aphasia surprisingly well.

In our cross-linguistic research program, the Competition Model was recently extended to the study of language breakdown in patients with non-fluent Broca's aphasia and fluent Wernicke's aphasia. These two forms of aphasia were chosen because they permit the broadest possible survey of grammatical symptoms across natural languages. This may seem surprising, in view of the above claim that adults with Wernicke's aphasia have "preserved" grammar but "impaired" semantics. However, a more careful examination of speech by fluent aphasics suggests that these patients also suffer from *paragrammatism,* that is, a tendency to substitute one grammatical form for another (a grammatical analogue to the word substitutions and blends that characterize the speech of adults with Wernicke's aphasia at a lexical level). These symptoms are often difficult to see in English. If a patient says, "I went the train to London," has he committed a lexical error (substituting "went" for "took") or a grammatical error (omitting the function word "on")? In richly inflected languages like German or Hungarian, the grammatical problems associated with Wernicke's aphasia are much more obvious, because these patients frequently produce the wrong inflected form for nouns, articles, and other content words. Indeed, the pioneering German aphasiologist Arnold Pick (who invented the term "agrammatism") (Pick, 1913/1973) insisted that there are two forms of agrammatism, frontal and posterior. In fact, Pick argued that the agrammatism associated with fluent (posterior) aphasia may be much more interesting, reflecting deficits at a deeper stage of speech production when grammatical forms are selected for use.

Our cross-linguistic results support Pick's view of agrammatism; in a sense we have merely rediscovered cross-linguistic facts that were known a hundred years ago, but temporarily lost in the 1970s and 1980s when English-language studies dominated the field of aphasiology (see Bates & Wulfeck, 1989a, 1989b, for a detailed discussion). However, the Competition Model has permitted us to take a number of steps beyond Pick's original insights to develop a theory of grammatical processing in aphasia that is compatible with the basic principles of the Competition Model. Briefly summarized, our research to date leads to the

following five conclusions (for reviews, see Bates & Wulfeck, 1988a, 1989b; Bates, Wulfeck, & MacWhinney, in press).

Cross-Linguistic Variation

First, cross-linguistic studies by our research team and by other research groups (see Menn & Obler, 1990) have clearly demonstrated that the "same" aphasic syndromes look very different from one language to another. Indeed, in many of our cross-linguistic experiments to date language differences account for more variance than patient group differences (e.g., Bates, Friederici, & Wulfeck, 1987a, 1987b, 1988; Bates, Friederici, Wulfeck, *&* Juarez, 1988; Vaid *6c* Pandit, in press; Wulfeck, Bates, Juarez, Opie, Friederici, MacWhinney, & Zurif, 1989). English, Italian, and German patients tend to preserve SVO word order—often to a greater extent than normal speakers of the same language. But Turkish aphasics tend to preserve SOV word order—again, to an extent that often exceeds word order usage by normal adults, as though the aphasic patients were sticking with canonical word order as a kind of "safe harbor" for their disturbed sentence planning. Additionally, in all of the languages that have been studied, patients are generally "right more often than they are wrong" at the level of grammatical morphology, producing correct case endings, forms of the article, forms of modifier agreement, and conjugations of the verb at a level that would be impossible to explain if we still believed that grammar had somehow been "disconnected" from the rest of language processing. We conclude that the "shape" of grammatical impairment in aphasia reflects the basic principles of cue validity: strong mappings between form and function tend to "protect" areas of grammar from omission or substitution-weak mappings tend to be "at risk."

Performance Deficits

The existence, strength, and nature of the cross-linguistic differences uncovered in these studies lead to the conclusion that language-specific knowledge (i.e., competence) is largely preserved in Broca's and Wernicke's aphasia, requiring an account of language breakdown based on deficits in the processes by which this preserved knowledge base is accessed and deployed (i.e., performance). In the Competition Model, this means that grammatical deficits in aphasia must be explained by some form of cue cost. This conclusion had led, in turn, to an expanded use of "on-line" or "real-time" experimental procedures that yield information about how patients from different language groups arrive at a correct or incorrect response in receptive and expressive language use (see especially Friederici & Kilborn, 1989; Wulfeck, Bates, & Capasso, in press).

Selective Vulnerability of Morphology

Overlaid on these language differences, there is some evidence for a modified version of the closed-class theory of agrammatism, the idea that grammatical inflections and function words can be selectively impaired in aphasia. In these and other papers by the same research team, evidence has been found for closed-class impairments in production, comprehension, and error detection, although the degree and nature of those impairments vary greatly from one language to another. We have to conclude that closed-class elements are particularly "expensive" to process, that is, they are particularly vulnerable to general or specific deficits in processing capacity (see below). At the same time, these cross-linguistic studies have also helped to distinguish between aspects of morphology that are "at risk" (e.g., case contrasts

that are irregular and/or relatively difficult to perceive) and those that appear to be "protected" (e.g., case contrasts that are regular and/ or relatively easy to perceive) within and across language types (see especially Friederici, Weissenborn, & Kail, in press; MacWhinney, Osman-Sagi, & Slobin, in press).

Patient Group Similarities

The selective vulnerability of morphology described above is apparently not restricted to individuals with agrammatic Broca's aphasia. We have observed equivalent morphological deficits in the expressive language of individuals with fluent Wernicke's aphasia; receptive deficits appear in an even wider range of patient groups, including some patients who are neurologically intact (see especially Bates et al., 1987a; MacWhinney, Osman-Sagi, & Slobin, in press). This suggests that closed-class items might be vulnerable to global forms of cue cost that are only indirectly related to the effects of focal brain injury (e.g., perceptual degradation, cognitive overload). Such findings point to the need for experiments that control for the contribution of a global reduction in perceptual and/or cognitive resources to isolate forms of grammatical impairment that are specific to particular types of aphasia from those that can be induced in normals under stressed or nonoptimal processing conditions (e.g., Kilborn, in press).

Patient Group Differences

Finally, although there are indeed more similarities than differences in the patterns of sparing and impairment observed in patients with Broca's and Wernicke's aphasia, a set of contrasts that holds up across very different language types has been found: differential success in the production of nouns (higher in Broca's) and verbs (higher in Wernicke's) (Bates, Tzeng, & Chen, in press), differences in the ability to exploit both grammatical and lexical redundancy (higher in Broca's) (Bates et al., 1987a, 1987b), and differences in the nature of morpheme substitution errors (patients with Broca's aphasia tend to substitute neutral or high-frequency forms, where as those with Wernicke's aphasia tend toward a more random pattern of substitutions) (Bates, Friederici, & Wulfeck, 1988), Although the reason for these "neurolinguistic universals" is still not understood, the cross-linguistic approach has brought us one step closer to a model of intrahemispheric organization that can handle universal and language-specific differences, between syndromes. Specifically, we have begun to explore processing factors that could produce contrasting forms of grammatical impairment within a single interlocking network of form-function mappings. For example, Dell (1990) showed that variations in the timing and activation of speech forms can produce qualitatively different error patterns: high speed and/or underinhibited patterns of activation result in substitution errors (including low-probability substitutions); low speed and/or underexcited patterns of activation result in omission errors (i.e., failure to reach threshold) or in conservative patterns of substitution (a high-frequency form is substituted for a lower frequency target). Schwartz and Dell (1990) demonstrated that the complementary error patterns displayed by patients with Broca's and Wernicke's aphasia could reflect just such a "speed/accuracy tradeoff" or "fluency/precision tradeoff (see also Bates, Appelbaum, *&* Allard, in press). Although a complete model of the complementarities between fluent and nonfluent aphasia is not yet available, it appears that an interactive, functionalist model can be extended to account for qualitative variations in language impairment.

In short, the Competitive Model is not "defeated" by patterns of language breakdown in aphasia. It contains principles that can account for cross-linguistic variations in the symptoms displayed by patients from the same patient group, and within-language variations in the elements of grammar that are "protected" or "at risk" across patient groups. This kind of variability is difficult to explain in traditional modular or "disconnection" approaches to aphasia. And it appears that by manipulating dimensions of activation and cue cost, the model can also be extended to account for qualitatively different forms of aphasia.

To date, the Competition Model has not been extended to the study of language disorders in children. However, Leonard and his colleagues have begun to carry out cross-linguistic studies of specific language impairment (SLI) in English and Italian (Leonard, 1989; Leonard, Sabbadini, Leonard, & Volterra, 1987; Leonard, Sabbadini, & Volterra, 1988). His results to date are quite compatible with our studies of language breakdown in aphasic adults. For example, he has found that (a) grammatical morphology is generally richer and better preserved in Italian children with SLI, compared with their English counterparts (in line with predictions based on cue validity), but that (b) grammatical morphology is still the most vulnerable area of development *within* each language group (in line with predictions based on cue cost). Furthermore, Leonard, Bartolini, Caselli, McGregor, and Sabbadini (1991) have been able to predict specific patterns of grammatical strength and vulnerability within each language, based on a specific set of cue cost principles that he terms "the surface hypothesis."

What do these findings mean for clinical practice? The Competition Model provides a coherent theoretical framework within which to analyze language disorders and devise intervention strategies in an ecologically sound manner. Since the "pragmatics revolution" of the 1970s and 1980s, clinicians have come to trust their intuitions about "real talk," about evaluating and treating language in valid communication contexts (Gallagher & Prutting, 1983; Lund & Duchan, 1988; Prutting, 1982; Prutting & Kirchner, 1987; Roth & Speckman, 1984). However, it isn't always clear how to proceed to implement this belief. If plain everyday talk were enough, children with communication disorders would have already learned language in its ecological niche. Clearly something else is wrong. For children with mental retardation or autism, one probable factor is lack of "functional readiness." According to Bates and MacWhinney (1987) "Functional readiness means that children will not acquire a complex form until they can assimilate it, directly or indirectly, to an underlying function" (p. 176). Clearly children with mental retardation have cognitive limitations that may prevent development of functional readiness at some levels. Similarly, many children with autism have broad cognitive limitations as well. On the other hand, Wetherby and Prutting (1984) noted heterochronous development of communicative skills in autistic children. They described superior development of skills that can be learned through trial-and-error type problem solving and deficient development of skills that require observational learning. This suggests a potential processing problem which creates higher than normal cue costs for the development of symbolic and social communicative devices such as symbolic play and conventional communicative gestures. Analysis of cue cost factors may also be most appropriate for children with specific language impairment who, by definition, are acquiring linguistic forms at levels below those expected by their development in other areas of cognition. For example, the kinds of auditory processing deficits described by Tallal and her colleagues (Tallal, 1988) would affect the perceivability of critical (and highly valid) cues. Limitations on memory and attention would also affect what is learned. Specific examples from two classes of communication disorders are briefly described below.

One obvious example is the oral language problems associated with hearing loss. In such children cues are reduced or distorted, thus interfering with their usefulness. In the case of severe or profound hearing loss the validity of the auditory cues in the language of the community in which the children are being raised is irrelevant because the cues are not heard and thus are not available for use. This is a major cue cost factor based on a biologically based sensory deficit.

Another interesting example is the language impairment seen in children with autism. A widely recognized characteristic of children who are autistic but not mute is the use of immediate and delayed echolalia. The functional uses of this speech form have been described (Prizant & Duchan, 1981) and attributed to extreme reliance on a "Gestalt" language learning style (Prizant, 1983; Prizant & Wetherby, 1988; Wetherby, 1984). This may create a cue cost by preventing or bypassing perception of the sequential ordering of auditory information and the fact that the speech stream is composed of important individual parts. Thus, the appropriate form to function mapping is missed despite the presence of valid cues. As noted above, another communicative problem of children with autism is the heterochronous development of communicative functions. Wetherby (1986) proposed that children with autism acquire the functions of language one at a time rather than in the parallel manner observed in infants who are developing normally. Functions for regulating behaviors to achieve environmental ends are acquired first, those for achieving social ends considerably later. Wetherby hypothesized that this may be due to delayed or impaired cortical inhibition of the limbic system which would allow continued dominance of limbic-controlled vocal signals which are of low information value and are thought to be emotional or self-stimulatory vocalizations. If form-function mappings occur on a cortical level and if inhibition of the limbic system is necessary for the development of the higher cortical function of communication for social purposes, this could account for the later development of social form-function connections. This then would be another cue cost factor, but at the level of brain development.

The immediately preceding discussion describes how the Competition Model could be used to account for certain observable phenomena in language disorders. Another question remains, however. Can it be a useful guide to assessment and intervention? Again we are just beginning to consider these issues, and again our answer is a tentative yes. Analysis of cue validity for the communication system being learned by individuals who are communicatively impaired will allow us to identify which factors usually work for normal individuals. Assessment of the individual who is communicatively impaired will focus on functional readiness and on perceptual, memory or other information processing difficulties that create cue costs for the individual. Further assessment would include the environments in which the individual must communicate to identify environmental cue cost factors. Most of this is what speech-language pathologists already do. What is new is a coherent theoretical framework that can be used to structure and guide clinical practice from a functionalist point of view. Here are just a few suggestions.

Identify Cue Costs and Manipulate Them Directly

The easiest and most straightforward example of a manageable cue cost factor is oral language delay due to hearing impairment. Amplification will decrease the cue costs associated with hearing impairment, costs that might otherwise have a particularly severe effect on the acquisition of closed-class morphemes, because those morphemes are more difficult to detect and identify in a fluent speech stream. (See Volterra and Bates,1989, for a

discussion of the relationship between hearing impairment and selective deficits in grammatical morphology.) It could also be speculated that amplification of closed-class morphemes might assist children with specific language impairment to overcome the selective vulnerability of morphology (Withee & Tallal, 1989). This is clearly speculative because the cue cost factors that are responsible for the selective vulnerability of morphology are not known. However, it is not far-fetched if one considers the successful use of mild amplification for remediating disorders of phonology (Hodson & Padden, 1991). Hopefully, this will be a productive area of clinical research.

Provide Strong Examples of Form-Function Mapping

In some cases it will not be possible to eliminate or decrease cue costs directly. In such cases therapists need to find a way to get around the cue cost limits by finding and exaggerating "natural" cue validity to make the necessary relationship between form and meaning particularly clear for the child. Cue validity estimation can be used by the clinician to figure out (a) what the ecological niche of a given linguistic device ought to be, (b) which of the network of meanings served by a given device is the most reliable guide to its use (i.e., the best candidate for a therapeutic "caricature" or exaggeration), and (c) the specific items to present in context, providing repeated opportunities to observe "natural" instances of form-function mapping. To some extent, this is exactly what most good clinicians already do. An example comes from a strategy for intervention proposed by Prizant and Wetherby (1988) for children with autism, in which they recommend moving gradually from the existing form-function mappings to the use of more sophisticated forms to map the same functions. The same may be said for the commonly used ecologically and pragmatically sound practices of modeling, expansion, and extension (Duchan & Weirzner-Lin, 1987) and the long known practices of self-talk and parallel talk (Norris & Hoffman, 1990). The key point is that "real talk" alone is probably not sufficient for effective intervention; if it were, children with normal language input would already have the problem solved. Cue validity analysis is a technique that can help clinicians identify specific targets for intervention-in-context, a kind of "amplified pragmatics" that goes beyond normal input but preserves its most essential characteristics.

This "cartoon" approach is not without problems. According to the Competition Model (and to all serious functionalist theories of grammar), the mappings between form and meaning are many to many (see also Karmiloff-Smith, 1979, on "plurifunctionality" in language use). Because cues and functions form a whole network of interlocking relations, an intervention that exaggerates one piece of the mapping could skew the whole system (at least temporarily), presenting the child with an unrealistic picture of the competitions, cooperations, and conspiracies among pieces of the language that characterize real-time language use. The solution to this problem is old-fashioned bootstrapping: if we can help the child to "break into" the most reliable mappings between grammar and meaning, we may start a benign cycle of incidental learning in the child's home and school environment that ultimately will lead to the acquisition of the complete form-function network that underlies a speakers knowledge of what to do and when to do it in his native language.

In short, the Competition Model provides a rigorous and potentially quantifiable framework for doing what speech-language pathologists already know they should be doing: finding out what communicative work language really does and what processing limits prevent the "natural" environment from working in specific cases. This is the approach that

characterized Carol Prutting's work on pragmatics and language processing; these were the key insights that she taught to her students, and conveyed to her friends and colleagues, in a career that illustrated why research and clinical practice belong together.

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