

Introduction*

Roberta L. Corrigan and Susan D. Lima
University of Wisconsin-Milwaukee

This volume presents a selection of papers from a conference on “the reality of linguistic rules” held in Milwaukee in April, 1992. A striking observation about the papers is that the authors start from very different assumptions about the definition of linguistic rules. Differences in assumptions about rules are certainly not new in linguistic discussions, but authors’ starting points for what constitutes a rule had a major effect on the content of the papers contained within this volume.

Some authors, assuming that rules exist, proceed to describe either particular rule systems or why their rule system is better than an alternative; these authors do not question whether or not the regularities they describe actually constitute rules. Other authors ask about the specific type of evidence that might be useful in detecting regularities. Still others seek to demonstrate the psychological reality of rules by presenting data showing that the rules they suggest are consistent with psychological processing. In addition, there are those who argue about the nature of the mental representation itself and debate whether symbolic entities are manipulated mentally or whether behavioral regularities, that is rule-like behaviors, can emerge *without* any mental representation of symbolic units.

Linguists in the first half of this century were most concerned with distributional patterns that could be observed in the data. Of course, one major departure of Chomsky’s early work in generative syntax (from the Bloomfieldian structuralists that preceded him) was to move beyond mere distributional analyses to the imposition of regularities and the invention of new patterns in order to provide a more comprehensive and systematic framework. That is, rules may function as formal descriptions that go beyond the observable regularities. As formal descriptions, rules may or

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may not directly correspond to psychological mechanisms. Rule-like behavior can emerge without the mental representation of symbolic rules, as in the connectionist models described in Part II of this volume.

Four broad themes emerged from the Milwaukee conference, corresponding to the four parts of this book. Part I centers on arguments for the existence of symbolic rules or principles in linguistic competence and performance. The papers in Part II argue against symbolic rules, presenting connectionist models or other alternatives to the symbolic paradigm. Parts III and IV take up two central issues that are of major concern to a number of language researchers and can be addressed within either a rule-based or a non-rule based perspective: Language acquisition and learnability, and modularity. These four themes are interrelated, of course, and many of the papers are relevant to other sections of the volume besides the one in which they appear.

Part I: For the Existence of Symbolic Rules

Until very recently it was assumed within both linguistic and psychological theories that rules specifying how symbols can be composed and how they can be transformed govern cognitive performance. Part I of the volume begins with a paper by Sanders ("On the typology of grammatical principles"), who assumes the existence of linguistic rules. Sanders' goal is to arrive at a typology of grammatical principles that can be used to evaluate different grammars. His work is based on a sample of phonological, syntactic, and semantic rules and constraints for various languages. He presents a notably systematic investigation of the logical and empirical characteristics of each type of rule, the relationships among the types of rules, and the conditions under which one type of rule may be considered more significant than another.

The nature of hypothesized linguistic rules varies widely both across theories and over time within theories that are direct descendants of one another. For example, transformational grammars of the 1960's had phrase structure rules which, with the lexicon, created deep structure representations that could then be changed to surface structure representations via transformational rules. The rules of transformational grammar turned out to be too powerful, permitting too many different analyses of a given structure (Wasow 1983). The immediate descendent of transformational gram-

mar, government and binding theory (GB), has few or no phrase structure rules and replaces construction-specific transformational rules with a very general rule Move- α , which is restricted by other universal principles and constraints such as the Projection principle and subadjacency. However, GB remains a theory within a symbolic framework. Symbolic alternatives to GB have also developed in the last two decades, such as lexical-functional grammar (LFG) and generalized phrase structure grammar (Gazdar, Klein, Pullum and Sag 1985).

A number of cognitive/functional accounts of grammar developed as alternatives to generative theories. These theories include cognitive grammar (Langacker 1991) and construction grammar (Fillmore 1988) and explain language using cognitive and functional principles rather than universal grammar as their basis. The paper by Barlow and Kemmer (“A schema-based approach to grammatical description”) provides an overview of their cognitive model, which they label *schema theory*. Although we have included this paper in the section of the volume that contains papers arguing in support of symbolic systems, Barlow and Kemmer leave open the possibility that the patterns of language that they call schemas might better be captured within a non-symbolic framework.

Proponents of linguistic rules do not necessarily view them as psychologically real. Part of the question of whether linguistic rules exist in the head of the speaker depends on the level of analysis one is interested in. Most readers will agree there are observable regularities in the linguistic behavior of speakers of particular languages. Sometimes these regularities may exist in speakers of multiple languages and, occasionally, they may be universal. The generalizations that are made about these regularities are often called rules. In this context, rules may simply be a convenient way of describing observable linguistic behaviors. Using examples from domains inside and outside of linguistics, Kac (“A nonpsychological realist conception of linguistic rules”) draws a distinction between having knowledge which permits one to follow rules and having such knowledge represented in a form isomorphic with the rules themselves.

Even psychologists would not describe the rules as we write them as actually existing in a person’s head *in that form*. (See Simon (1992) for an interesting discussion of levels of explanation within the symbolic framework.) A computer analogy may be helpful here: When we are programming in a higher level language, we know that the rules in that form do not exist in the “mind” of the computer — they must be translated into a

form that the computer can understand. However, there is a direct relationship between the higher level language and the machine language. Likewise, many arguing for the reality of linguistic rules assume that there is ultimately a relationship between the rules that the linguist describes and what is stored in the head of the ideal speaker-listener, i.e., his or her competence, in the form of symbols. As with any analysis that goes from observable behaviors, in this case regularities in speech behaviors, to mental constructs, there are multiple ways to derive the same behaviors.

What kinds of converging evidence can be used to support the existence of rules? The traditional tool of the linguist is native speaker intuitions. Using this kind of evidence, Sobin (“An acceptable ungrammatical construction”) describes the psychological implications of an ungrammatical construction involving expletives that is considered by speakers to be acceptable. After describing the principles and parameters treatment of this construction, Sobin argues instead that there is a “monitor” that contains rules that are not purely UG based. He argues that this monitor is critical to the production of certain English agreement forms.

Additional sources of evidence for the psychological reality of rules include child language errors (see, for example, Pinker and Prince, this volume, Part IV) and psycholinguistic experiments (e.g., Goodluck, this volume, Part III). Janda, Joseph, and Jacobs (“Systematic hyperforeignisms as maximally external evidence for linguistic rules”) describe in detail yet another type of evidence, “systematic hyperforeignisms” or “pseudoloan words,” in which perceived regularities from a foreign language are overgeneralized so that a borrowed word is actually mispronounced when it is introduced into the new language. Janda et al. argue that these errors involve both the avoidance of native regularities and the hypercorrect adoption of foreign rules. As such, hyperforeignisms are not to be found in either the native grammar of those who utter them or the grammar of native speakers of the borrowed-from language. In this sense, they are seen as constituting “maximally external” evidence for the psychological reality of linguistic rules.

Part II: Alternatives to rules

Currently, the major theoretical alternative to symbolic rule systems is provided by a class of models variously known as connectionist, parallel distri-

buted processing, or neural network models. These models have generated a great deal of controversy in the cognitive science community, being embraced by some as a major paradigm shift and shunned by others as too associationistic or lacking in predictive power. Connectionist models have a network of elementary units which are interconnected so that active units either excite or inhibit other units. Once it receives its initial input, excitations and inhibitions spread throughout the network. The stable configuration produced at the end of processing is viewed as the system's solution to the problem that has been input. Neither symbols nor rules are stored in the network; activation weights are stored and these change over time as the system learns.

In Part II of this volume, Goldsmith ("Grammar within a neural network") argues for connectionist modeling in phonology. Phonology has seen major changes in the predominant view of rules. Researchers initially focused on the rule systems or derivations that relate underlying phonological structures to phonetic structures. More recently, the focus has changed to the nature of the representations themselves. One of the reasons for this was an increased interest in suprasegmental features and a recognition that earlier descriptions of phonological representations were oversimplified. In the standard theory, phonological representations consist of a linear, nonhierarchical arrangement of segments and boundaries. In contrast, autosegmental theories propose that the representation should be split up into several tiers and that segments should be grouped hierarchically into syllables, feet, phonological words, etc. Although current versions of phonology downplay rules as specific derivational instructions and emphasize constraints, most versions remain within the symbolic tradition. Goldsmith encourages phonologists, and linguists in general, to break out of the symbolic tradition and enter the realm of connectionism. He finds that connectionist systems have the advantage of learning from a simple presentation of data, requiring only modest initial assumptions about the structure of the network.

Corina ("The induction of prosodic constraints: Implications for phonological theory and mental representation") is in basic agreement with Goldsmith. He argues that one of the benefits of modeling with connectionist networks is that it can help researchers understand the structure of language when they analyze how the networks arrive at their solutions. By systematically varying parameters in the network, the contribution of different factors to natural language can be examined. In particular, Corina

manipulated access to sonority within the network and found that sonority was necessary for the network to produce syllable-like behaviors. He concludes that the syllable may not need to be specified in the grammar a priori, but can be derived from other tendencies within a language. In related work, Goldsmith (this volume) found that in order to correctly derive sonority patterns, it was necessary to modify the sonority of each segment by some fraction of the sonority of the segments' neighbors.

Stemberger ("Rule-less morphology at the phonology-lexicon interface") suggests that traditional morphological rules can be entirely replaced by phonological constraints. He suggests a connectionist network in which a form such as *walked* is stored in the lexicon independent of the form *walk*; phonological constraints are also encoded. A subset of the lexicon is activated that imposes constraints on the phonological form of the words within that subset. Morphology emerges automatically, without building in any special procedures, as the network functions.

Schütze ("Towards connectionist lexical semantics") argues that the symbolic framework has had difficulty in accounting for three aspects of semantic processing and representation: the simultaneous coactivation of several distinct readings, deactivation of meaning components, and a natural representation of polysemy. In all these cases, the context-dependencies that exist are variable. Schütze presents data from connectionist networks that can accommodate these phenomena. He concludes that only distributed, continuous representations can account for how people select the best fit among a range of possible semantic readings.

Although connectionist approaches are viewed as alternatives to rules, there are advantages to the symbolic approach that some connectionists want to retain in their systems. MacWhinney (this volume, Part IV), who presents a connectionist model of morphological, lexical, and sentence processing, provides a checklist of symbolic advantages which he would like to see retained in connectionist models. Stone (this volume, Part IV) views productivity as a major advantage of symbolic models and statistical learning as a major advantage of connectionist models. His goal is to develop a hybrid model that incorporates both features.

A theoretical alternative to both rule based systems and connectionist networks is offered by Derwing and Skousen ("Productivity and the English past tense: Testing Skousen's analogical model"). They provide an introduction to Skousen's analogical approach and compare it to both rule based and connectionist approaches. Their test of the the analogical model is based on data on the past tense collected from children.

Part III: Language acquisition and learnability

Theorists working within the frameworks that were direct descendants of Chomsky's transformational grammar have always considered language acquisition data to be of utmost importance. As their theories aimed for explanatory adequacy, learnability became a major issue, with syntactic theories permitting only rules that could be learned on the basis of the data actually available to real children. Wexler and Culicover (1980) attempted to construct a formal model of language development that would achieve learnability. Because it is mathematically impossible to learn natural languages without negative evidence (feedback from the environment when the child produces an ungrammatical utterance) and because children do not appear to receive direct negative evidence, it was suggested that the innate human language faculty must constrain the class of possible hypotheses available to the language learner and thus allow language learning from impoverished input that does not include negative evidence. Likewise, it has been argued that children cannot recover from overgeneralization errors without innate biases (Morgan and Travis 1989). One form of constraint is hardwiring the system with parameters that limit the choices to be made, but still allow some flexibility in switch-setting as the child learns one language compared to another.

Goodluck ("Current grammars vs. rule driven guessing in children's interpretation of some complex sentence types") presents experimental data which she interprets to favor an innate competence model. She studies the development of portions of the grammar of control and movement rules and finds that children's behavior is rule governed, but that it is not fully developed even at the age of 10 years. She concludes that the interaction of principles during language acquisition can produce temporary errors.

In contrast, Van Valin ("Extraction restrictions, competing theories and the argument from the poverty of the stimulus") presents a detailed analysis of island constraints to show that analyzing them from an alternative theoretical perspective can lead to an interpretation that is completely opposite from the interpretation derived from GB theory. From the alternative perspective, there *is* evidence about the constraints available to the child in the language-learning environment, thereby allowing the child to learn something that is unlearnable from a GB perspective. The Van Valin data thus raise serious questions about the validity of the parameter setting model's "argument from the poverty of the stimulus."

Additional questions about the basis for language acquisition can be addressed when physiological constraints are examined. Faber and Best (“The perceptual infrastructure of early phonological development”) examine three possible explanations for the fact that children’s phonological systems are not identical to those of adults. Children’s phonological systems may differ from adults because the underlying phonological representations differ, because their rule systems differ, or because their motor skills are not fully developed. Based on a thorough review of the literature, Faber and Best conclude that it is unnecessary and unparsimonious to appeal to differences in phonological rule systems to account for the phonological inventories produced by young children. They point out that the child is faced not only with learning a formal system but also with perfecting the physical skills needed to use the system.

Part IV: Modularity and related issues

The question of modularity is closely intertwined with the issue of the innate basis of language acquisition. The modular view states that the mind consists of a number of distinct, specialized, informationally encapsulated processors. Language is viewed as a separate, dedicated faculty. Language rules cannot be accounted for by looking to general cognitive principles. In addition, there may be modularity within the language system itself, with, for example, the phonological system and the syntactic system functioning as separate, encapsulated units. Chomsky (1986: 102) views X-bar theory, binding theory, Case theory, theta theory, and bounding theory as separate modules. Those arguing against modularity believe that the mind is a relatively seamless unitary whole operating with a number of general-purpose structures.

This section of the volume opens with MacWhinney (“The dinosaurs and the ring”), who argues that an architecture that separates phonology and semantics is insufficient to produce a model that can be completely successful at learning the morphology of English or German. Kawamoto (“One system or two to handle regulars and exceptions: How time-course of processing can inform this debate”) provides a model that includes phonology and meaning-sound correspondences within the same network, although the model activates each process in a different time course. However, MacWhinney argues that larger scale attempts to deal with meaning

within networks overload them because they cannot store enough distinctions. MacWhinney proposes a solution to this problem by introducing a connectionist model in which lexical categories are extracted from the input and subsequently stored as properties of each lexical item. MacWhinney argues that what distinguishes the Connectionist Competition Model (Concomp) he presents from other connectionist models is the central role the Concomp model assigns to the lexical item.

Closely related to the issue of modularity is the issue of whether regular and irregular forms in language can be handled with the same architecture. Pinker (1991: 533) claims that regular and irregular processes are “encapsulated within different subcomponents”. Pinker and Prince (“Regular and irregular morphology and the psychological status of rules of grammar”) argue that regular and irregular forms in English should differ in frequency, similarity, and impairment effects, as well as in their availability for use in other word formation processes. They use a wide range of data on these effects to argue that regular forms are rule based, while irregular forms are not.

Stemberger (this volume, Part II) describes the following features of irregular and irregular forms that make them qualitatively different: similarity effects on irregulars, lexical frequency effects, u-shaped learning, plurals inside compounds, and disabling generalization. However, in contrast to Pinker and Prince, Stemberger argues that morphological rules are not needed to account for any of these data, but that a local connectionist network that has access only to phonology and the lexicon can generate these effects.

In sum, non-modular theories attempt to handle both rule-like and non-rule like behaviors with a single mechanism. Daugherty and Seidenberg (“Beyond rules and exceptions: A connectionist approach to inflectional morphology”) discuss the history of different theories of the English past tense and the modifications that they have undergone to incorporate new data. They argue that the evidence that Pinker and Prince use to distinguish between network and rule-based approaches is consistent with both approaches. They go on to present results from on-line processing experiments in generating the past tense that are inconsistent with a standard rules-and-exceptions approach and that lead to “conclusions that are precisely the opposite of Pinker’s.” Thus, they argue that network models are preferable to rule-based accounts because they can account for generalizations that are missed by the rule-based approaches.

MacWhinney (this volume) also presents data suggesting that some modular effects can be captured with connectionist architecture. The key to the success of these models is to construct them to allow the storage of lexical information. Stone (“Combining connectionist and symbolic properties in a single process”) presents phonological data to argue for the emergence of rules and exceptions to rules using a single mechanism. Kawamoto (this volume) presents data on the amount of time that it takes to pronounce regular and irregular forms and data from a connectionist simulation that can reproduce these effects. Thymé, Ackerman, and Elman (“Finnish nominal inflection: Paradigmatic patterns and token analogy”) find that a single network can take both paradigm classes and analogies to known tokens into account when learning the Finnish inflectional system. These two strategies had previously been viewed as alternative acquisition strategies (e.g., Maratsos, 1982; Zubin and Köpcke 1981).

Conclusion

Traditional notions of linguistic rules have come under attack from many quarters. Within the generative camp itself, very few rules remain and those that do have become much more abstract. Additional symbolic frameworks have been developed to expand the scope of grammatical description and to account for phenomena that their authors feel have not been adequately handled in the various revisions of transformational grammar. The lexicon has taken on a much more central role in most current syntactic theorizing. In phonology, traditional rules have been replaced by more general principles and constraints. Perhaps the most serious challenge to date to the linguistic and/or cognitive rule is the development of connectionist architecture. Indeed, these systems must be viewed as a serious challenge to the foundations of all of contemporary linguistics. On the other hand, as MacWhinney (this volume, Part IV), points out, connectionist simulations are not yet able to learn language in all its complexity, and symbolic models appear to be superior in a number of different areas. As with symbolic theories, the handling of the lexicon has become a pivotal issue for connectionist implementations. Whatever the outcome of the symbolic/connectionist debate, it is generating remarkable excitement and a great deal of new data that will inform our understanding of the structure of language.

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