Steven Pinker. *Words and Rules: The Ingredients of Language*. New York, Basic Books, 1999, xi + 348 pp.

This is the fifth of Pinker's provocative and well-written books on linguistics and cognition for both linguists and laypeople. The author, of the Psychology of Morphology Group at MIT, is a psycholinguist who concentrates on the ways in which the study of language and the information processing mechanisms of the brain elucidate one another. The current work's major focus is on the English regular and irregular past tense forms.

Pinker is clearly interested in and skilled at making his ideas accessible to the average reader. In the first chapters he brings in linguistic examples from popular movies to Shakespeare to "pigs oinking *boo-boo* in Japan" (p. 2) to introduce basic concepts of linguistics in general and morphology in particular. Once he has defined and exemplified such terms as lexicon, morpheme, affixation, allomorphy, phonological alternation and others necessary to the understanding of the past tense, he presents his words-and-rules theory.

According to Pinker, the language faculty consists (in part) of a memorized lexicon containing all roots, affixes and irregular forms, and a set of rules for combining them. He suggests as a first hypothesis that regular past tenses are formed by rules, while all irregular forms are memorized as items in the lexicon. However, he then shows, through data from child language acquisition and laboratory studies, that rules relating to formation of the irregular past tense are alive and productive, at least in certain arenas. Children continue to produce forms like *brang* as the past tense of *bring*, experimental subjects accept *splang* as the past tense of *spling*, and most people can understand old jokes like the woman asking the taxi driver "'Can you take me someplace where I can get scrod?" He says, "Gee, that's the first time I've heard it in the

pluperfect subjunctive.'" (p. 85). The explanation for the irregular English verbs must therefore be more complex than it at first appears.

At this point Pinker relates the debate on irregular past tense forms to much larger issues of linguistics and the manner in which the mind functions. He discusses how Noam Chomsky and Morris Halle were able to compress all the variety of regular and irregular forms in English into a relatively few rules. On the other hand, connectionists like David Rumelhart and James McClelland believe no rules are needed: speakers store associations between the sounds of stems and the sounds of past-tense forms, and then generalize these to new words. Pinker frames this as part of the centuries-old disagreement between two different ways of viewing the human mind: rationalism, which claims that thinking is essentially the manipulation of symbols by rules, and empiricism, for which thinking is simply the association of items in the mind, that is, memorization. Given this intellectual context, the study of the past tense becomes important not only as a limited, language-specific issue, but as a way to shed light on larger questions about how the mind functions.

Having established the broader context of the past tense issue, Pinker goes on to demonstrate the inadequacy of theories that rely solely on rules or solely on associations in the lexicon. He points out that in the Chomsky-Halle-Monahan rule-based theory, the Lowering Ablaut rule explains the past tense vowel alternations but fails to address the consonantal similarities, apparent to English speakers, in the stems of words like *sting, string, stink, sink and swing*. These similarities are based on "fuzzy" boundaries that are intuitively obvious, but can not be defined in black and white terms. Thus while Chomsky's theory has great explanatory power, it can not fully reveal the patterns in past tense formation.

In order to criticize a strictly associative theory, Pinker describes the artificial neural network model of the past tense created by psychologists David Rumelhart and James McClelland in 1986. The model is a computer program that accepts as input the sound of a verb stem, and produces as output the past tense. It consists of an input layer with 460 neuron-like units, each of which recognizes a short stretch of sound (like "consonant-back vowel-consonant" or "word initial boundary-nasal-high vowel"), and an identical output layer, with every one of the input units connected to each output unit. It works as a pattern associator memory, so that when it is trained on stems matched with correct past tenses, the connections among certain units are strengthened. It matches *drink* with *drank* by associating *dr* with *dr*, *dr* with *rang*, *ring* with *rang*, *ink* with *ank* and so on. When new stems are then fed in, these connections allow the model to output the correct past tense forms. The Rumelhart-McClelland model does in fact produce correct past tense forms approximately 75% of the time.

In spite of this degree of success, Pinker writes that the model clearly handles many facts about human language in ways the brain can not possibly do. It spreads details of pronunciation across 15 different parts of its system, rather than in a single phonology module; it can not differentiate between homonyms such as *break-broke* and *brake-braked* in order to assign them the correct past tense form; and it can easily do things the mind would find impossible, such as producing mirror images of words.

Having rejected the all-rules or all-association models, Pinker presents his modified words-and-rules theory, developed in collaboration with Alan Prince: the past tense forms of regular verbs are computed by a rule, while irregular verbs and their past tense forms are pairs of words retrieved from the lexicon. However, the lexicon is not a simple list of unrelated items, it is associative like the Rumelhart-McClelland pattern associator memory. He posits not only that

words are linked to words, but that other substructures--vowels, consonants, stems, onsets, rimes and features--are linked. He places his theory within the history of morphological theory by noting the acceptance by linguists such as Aronoff, Jackendoff, Lieber and Spencer of models with two sets of rules: true rules that speakers use freely to create words, and lexical redundancy rules that capture similarities among lexical items. The Pinker-Prince model makes a strong prediction: that regular and irregular inflection are psychologically and neurologically distinguishable.

The second half of the book presents the evidence, from areas such as laboratory experiments, child language, cross-linguistic comparisons, language-impaired speakers and brain imaging, for his theory. A less gifted technical writer might make the complex material dry; Pinker continues to use humorous examples from rock songs, cartoons, complaints by language mavens, and recent slang to illustrate his points and keep the reader entertained (example, from a *Zits* cartoon: "This week totally bit!" "Okay, this week bited!" "I hate conjugating irregular vulgarities." (p. 126)).

He also provides more background on various other productive rules in English, such as those related to compounding. Although he makes use of certain theoretical concepts (the Right-handed Head Rule and the Level Ordering Hypothesis), he does not refer to them by name nor does he indicate the degree of acceptance or controversy accorded to them by other morphologists. Noting this failure to place some of his ideas in a theoretical context seems a petty criticism however, of one of the few writers who has ever successfully popularized morphological theory.

Pinker theorizes that irregular forms will only be retained in memory if they are used frequently, whereas regular forms, produced by rules and having no need to be memorized, will

be used correctly even if rare. This is borne out by many laboratory tests, which show that subjects recognize and produce frequent irregular verbs more quickly than infrequent ones, while frequency of use of regular verbs has little effect. The fact that irregular forms are memorized separately from their stems is evidenced by the fact that some past tense forms exist whose stems have been lost to most speakers: *smitten, rent, shod, wrought*. Equally, there are irregular verbs used almost exclusively in the present tense, whose past tense forms are generally unacceptable: *stridden, striven, forwent, throve*.

Data from children's acquisition of language shows that they pass through stages, first simply memorizing all regular and irregular forms, then learning the rule and applying it to all verbs indiscriminately (producing forms such as *goed*, *broked* and *ated*), and eventually sorting out when to use the rule and when to use the memorized forms. This supports another of Pinker's hypotheses, that once irregular forms are stored in the lexicon, they block access to the regular forms that would otherwise be produced.

Studies of language-impaired individuals offer a great deal of illuminating material. Pinker reports on experiments on patients with different forms of aphasia, who, depending on the area of brain damage, can easily produce regularly inflected forms, even of nonsense words, but can not manage irregular forms, or vice versa. He describes a form of retardation known as Williams' syndrome, whose sufferers speak glibly but commit errors of rule overgeneralization, often producing forms such as *catched* and *sleeped* because their rule module is operating more quickly than their ability to access the lexicon. On the other hand, those with Specific Language Impairment (SLI) appear able to use only memorized forms, and have great difficulty with all types of inflection. Pinker recounts that one SLI sufferer had to mutter "add an *s*" over and over to herself to remember how to pluralize nouns during a test.

The new field of cognitive neuroscience and its tools, the electroencephalogram (EEG), Positive Emission Tomography (PET), and Magnetic Resonance Imaging (MRI), can reveal which part of the brain is active during various forms of mental processing. These techniques have produced some evidence that the rules module and the lexicon are handled by different areas of the brain, although the data are somewhat inconsistent. Pinker expresses the hope that a new technique, magnetoencephalography, will have the precision needed to validate his theory. After marshalling all his evidence, Pinker's conclusion is that rational and empirical models of the mind are both correct, and are both required to explain different aspects of the language faculty. Regular and irregular past tense forms coexist in the brain but require different computational mechanisms: symbol manipulation for regular verbs, associative memory for irregular verbs. His words-and-rules theory reflects the interplay of these two mechanisms that together "give rise to the vast expressive power of language, allowing us to share the fruits of the vast creative power of thought" (p. 287). It will be interesting to see whether further laboratory experiments using the newest technologies will validate Pinker's theories, which are after all, similar to some rather old morphological theories. Certainly the clarity and humor which with he presents his ideas make his readers thankful that Steven Pinker has once again shared his creative and expressive powers of thought and language with us.

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