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Science's Compass

Books: Language

Why Do Kids Say Goed and Brang?

James L. McClelland and Mark S. Seidenberg

As Steven Pinker notes in his new book Word's and Rules, kids say the darnedest things. In the late 1950s, language researchers noticed that kids occasionally say odd things like “Daddy goed to work” and “I taked the last cookie.” These past-tense forms were intriguing because children seemed to be generating them without having heard them before. And indeed, when children were tested with nonce verbs such as “glick” and “mott” they often generated novel past-tense forms like “glicked” and “motted.” These forms suggested that the children had discovered a simple rule for forming the past tense: add a variant of “ed” to the base form of the verb. Such actions fit Noam Chomsky’s argument that syntactic rules are the basis of our grammatical ability. Thus the formation of novel past-tense forms came to be taken as the quintessential demonstration that language is produced through the use of a system of rules.

But if language involves the application of rules, why are there so many exceptions? Why is the past tense of take “took” instead of “taked”? Why do we use “stood,” not “st adept”? “sang,” not “singed”? and “went,” not “goed”? Within the rule-based framework, explanations of such apparent exceptions follow two approaches: One tries to construct a more complex set of rules (to cover all the cases). The other introduces a second mechanism, a mental lexicon, to handle cases where the usual rules do not apply.

Perhaps, however, the brain stores language in a way that systems of rules and lists of words can only approximate. The rules of language, such as the past tense, need not be explicitly represented. They could instead stem from the operation of more fundamental underlying processes. In the mid-1980s, a group of psychologists, neuroscientists, and computer scientists began to explore the possibility that lawful performance might reflect the operation of a mechanism that never constructed or consulted a rule per se. For example, in the production of past-tense forms of verbs, the mechanism might simply adjust the connections among the neurons involved in forming past tenses when the network encounters the past-tense form of a word.

David Rumelhart and one of us (McClelland) developed this idea using a computer simulation of a simple neural network (1). The model had two sets of neuron-like units, one for representing the base form of a verb, and one for representing its past tense. The model was trained using repeated presentations of present and past-tense pairs. After each presentation, the connections from the units representing the features of the present tense to the units representing the features of the past tense were adjusted by a small amount to allow the active input units to excite the appropriate output units. The model captured the correct use of both regular and exceptional forms, and it exhibited the capacity to generalize. Thus, within a single network, it accounted for many essential aspects of the past-tense phenomena without a rule or a lexicon.

At this point, Steven Pinker entered the debate. Now well known through his popular science writing, Pinker emerged as a prominent psycholinguist on Chomsky’s home ground at the Massachusetts Institute of Technology. In an influential article (2), Pinker and Alan Prince drew on their broad knowledge of language to develop a blistering critique of the neural network model. After correctly noting several shortcomings of the specific model used by Rumelhart and McClelland, they went on to claim that no neural network could ever adequately capture the generality and aboluteness of the English past-tense system.

In a later paper (3), however, Pinker acknowledged that the neural network model did have some positive properties. Unlike a standard lexical lookup mechanism, it captured another type of generalization based on patterns found among the exceptions. Using the pattern found in pairs like “singsang” and “ring-rang,” children sometimes say “brang” for the past tense of “bring.” Writing rules to capture the fact that some verbs form their past tense by changing “i” to “a” won’t do, said Pinker, because such rules are not fully generative. The pattern only applies to some words with the short vowel “i,” and the ones it does apply to share a “family resemblance” structure of the kind that was well captured by the neu-
ral net. (They often end in ‘-ing,’ but may end in ‘-ing’ as in ‘swim,’ ‘-in’ as in ‘be-’
gin,’” or ‘-ink’ as in ‘drink.’) So, Pinker suggested, we use a rule to form regular
past tenses, but a mechanism very much like the Rumelhart-McClelland network to
formulate irregular past tenses.

Since Pinker proposed these ideas in 1991, he has pursued them in a wide-
ranging series of studies. He and his collaborators have analyzed children’s sponta-
eneous speech to discover whether the use of the regular past tense develops abruptly or
gradually. They have studied adults’ acceptance of such sentences as “the slugger flew
ton center field” versus “the slugger flew out to center field.” They have explored
other putative rule-based systems such as the German plural. And they have exam-
ined people with brain damage to see if they could find one group lacking the abili-
ty to apply the past-tense rule and another group unable to correct-
ly produce exceptions.

In Words and Rules, Pinker offers a very ap-
proachable summary of his ideas and the results of his research. Review-
ing the history we sketch above, he notes the depth of the chal-
lenge that the neural network view poses to
conventional rule-based
approaches, and he provides many amusing
eamples to punctuate his arguments.
Pinker considers two single-mechanism ap-
proaches—using only rules and using only
a neural net—and presents his reasons for
believing that neither approach will do by
itself and that combining positive features
from both is the only plausible approach.
He introduces simple ideas clearly and
complex ideas gradually, so readers with-
out a background in the field will not be
left behind. Along the way, he attempts to
explain many puzzling and amusing quirks
of language, such as the fact that although
we tend to describe someone who eats rats
as a “rat eater” rather than a “rats eater,” we
accept both “mime eater” and “systems an-
alyt.” Similarly, Pinker tries to explain
why we say “ladies in waiting” and not “la-
dy in waitings,” but “major generals” and
not “majors general.” Overall, the book
tells quite an engaging story, one that any-
one who has puzzled over the quirks and
foibles of language is quite likely to enjoy.

While everyone may agree that Pinker’s
story is a pleasure to read, it is important to
realize that Words and Rules hardly reflects
a consensus view. Instead, it represents one
of several positions, each championed by
a band of ardent adherents. Pinker makes no
attempt to hide this; he states his beliefs
and preferences, presents the case for his
point of view, and discusses what he sees as
the shortcomings of the alternatives, partic-
sarily the neural-network approach.

Will this book settle the debate? We do
not think so. In our view, it suffers from
too many serious problems. Pinker sees
the evidence from the empirical studies
through rule-tinted glasses. For example,
he repeatedly refers to abrupt transitions in
children’s use of the regular past tense,
which are consistent with the sudden dis-
covery of a rule. But the relevant data (4)
show much more gradual transitions, as
expected in the neural network framework.
A subtler form of misperception pervades
Pinker’s discussion of studies that rely on
judgments of acceptability of possible
past-tense and plural forms. Many “regu-
lar” past-tense forms receive intermediate
values on a graded acceptability scale.

Such graded judgments appear more
consistent with the effects of continuous-
value connection strengths (found in a
neural net) than with symbolic rules—
which are, as Pinker says, “operations that
apply fully to any instance of a category.”

Nor does Pinker present an explicit
model of the processes by which past
tenses are generated. There are gaps and
inconsistencies in his explanation of how
such items are formed. For example, Pinker
fails to adequately describe how
knowledge of a cluster of similar past-
tense forms gives rise to productive gen-
eralization (such as the production of
“brang” for the past tense of “bring”). He
appeals to broad characteristics of the
Rumelhart-McClelland model to address
such issues, but also to a traditional no-
tion of lexical entries. His presentation
does not demonstrate how these concepts
can be reconciled or how his proposed
system can capture detailed aspects of
the phenomena.

Pinker also mistakenly assimilates all
neural network models into an older theo-
retical tradition called associationism,
which interprets intelligence as the linkage
of “ideas that have been experienced in
close succession or that resemble one an-
other.” After casting the crucial theoretical
issue as a contest between rule-based and
associationist approaches, he argues for a
dual system that uses both, without fully
recognizing how neural network models
erase the distinction between them. Pinker
dismisses a host of newer neural network
models as adding very little beyond the
capabilities of the original Rumelhart-
McClelland net, consistently underrepre-
tsenting their capabilities. Thus, despite
forthrightly acknowledging how revolution-
ar neural network models are, he stops
short of conveying their full potential as the
basis for the productive use of language.

Pinker’s analysis of the formation of the
English past tense is reminiscent of the as-
tronomer Tycho Brahe’s attempt to come to
terms with Copernican theory. Tycho
formulated a compromise that captured some
of the appeal of the Copernican approach,
while maintaining the key Ptolemaic princi-
ples of geocentrism. Correspondingly, Pinker
has seen some of the appeal of the neural
network approach, and he has found ways to incorpo-
rate elements of it in a compromise position
that maintains the key principle that language
knowledge consists (at least in part) of rules.
He relies on the proper-
ties of neural networks to address problems
with the traditional rules-plus-words point
of view. His resistance to the core tenets of
the neural network framework, however,
leaves him—like Tycho—with a comprome-
ise that really deals only partially with the
challenge posed by the emerging system.

Thus it may be fitting that Words and
Rules appears at the end of the old millen-
ia. Written amidst an ongoing research
debate, it captures a transitional mode of
thought that may be typical of a scientific
revolution in progress. Pinker supplies an
engaging treatment of an attempt to find a
middle ground between two incommensu-
rate theoretical frameworks, and he pro-
vides numerous entries to the stream of
ongoing research in which the full poten-
tial of the newer, neural network approach
will eventually become apparent.

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