WORDS RULES

THE INGREDIENTS OF LANGUAGE

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Bestselling author of

and

WORDS AND RULES

The Ingredients of Language

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PREFACE

This book tries to illuminate the nature of language and mind by choosing a single phenomenon and examining it from every angle imaginable. That phenomenon is regular and irregular verbs, the bane of every language student.

At first glance that approach might seem to lie in the great academic tradition of knowing more and more about less and less until you know everything about nothing. But please don't put the book down just yet. Seeing the world in a grain of sand is often the way of science, as when geneticists agreed to study the lowly fruit fly so that their findings might cumulate into a deep understanding that would have been impossible had each scientist started from scratch with a different organism. Like fruit flies, regular and irregular verbs are small and easy to breed, and they contain, in an easily visible form, the machinery that powers larger phenomena in all their glorious complexity.

Since the dawn of the modern study of the mind in the late 1950s, children's language errors such as *breaked* and *holded*, which could not have been parroted from their parents' speech, have served as a vivid reminder that the mind of the child is not a sponge, but actively assembles words and concepts into new combinations guided by rules and regularities. Every new theory of the mind has tried to account for this feat of childhood creativity, and perhaps the most heated debate in contemporary cognitive science—on whether the mind is more like an artificial neural network or a symbol-manipulating computer—has used it as a benchmark.

The exploration of regular and irregular verbs will take us from the prehistoric tribes that originated our language to the brain-imaging and gene-sequencing technologies of the new millennium. Perhaps best of all, this case study immerses us in that mixture of mathematical beauty and human quirki-

ness called language. Discovering the rationale of a curious word or expression can bring the same blissful intellectual "click" as completing a crossword puzzle or appreciating a witticism.

For the past dozen years my research has concentrated on regular and irregular verbs, and the pleasure of coming to understand one thing really well has been surpassed only by the pleasure of working with extraordinary people who were just as consumed by the topic: the members of the Psychology of Morphology Group at MIT, the Psymorgs. Many of the big ideas in this book originated with my friend and collaborator Alan Prince of Rutgers University, and others were thought up or brought to life by former graduate students, postdoctoral fellows, and research assistants: Chris Collins, Marie Coppola, Jenny Ganger, Greg Hickok, Michelle Hollander, John J. Kim, Gary Marcus, Sandeep Prasada, Jaemin Rhee, Annie Senghas, William Snyder, Karin Stromswold, Michael Ullman, and Fei Xu. Marcus and Ullman in particular had their own big ideas that I could not have dreamed of. This book is dedicated to all of them, with gratitude and affection.

It also has been a pleasure to work with Harald Clahsen, Richard Wiese, and Iris Berent on their ingenious studies of German and Hebrew. Hilary Bromberg and Cyrus Shaoul, former undergraduates at MIT, made important contributions in their senior research projects. Thanks go as well to other collaborators, especially Ursula Brinkmann, Suzanne Corkin, John Growdon, Walter Koroshetz, T. John Rosen, and Joseph Shimron.

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I thank my editors, John Donatich of Basic Books, and Toby Mundy of Weidenfeld and Nicolson, for their invaluable encouragement and advice on every aspect of the book, and Michael Wilde for his excellent copyediting. I am particularly indebted to the friends and colleagues who generously provided detailed comments on an earlier draft: Iris Berent, Alfonso Caramazza, Judith Rich Harris, David Kemmerer, Samuel Jay Keyser, Beth Levin, Gary Marcus, Sandeep Prasada, and Michael Ullman. My agent, John Brockman, conceived the Science Masters series in which this book is published, and I thank him for his advice and his efforts on my behalf.

I am grateful for the constant encouragement and support of my extended family, the Pinkers, Boodmans, and Subbiah-Adams. I am especially grateful to my wife, Ilavenil Subbiah, who designed the illustrations, commented on

the manuscript, offered advice on every aspect, and was always there with love and support.

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THE INFINITE LIBRARY

Language comes so naturally to us that it is easy to forget what a strange and miraculous gift it is. All over the world members of our species fashion their breath into hisses and hums and squeaks and pops and listen to others do the same. We do this, of course, not only because we like the sounds but because details of the sounds contain information about the intentions of the person making them. We humans are fitted with a means of sharing our ideas, in all their unfathomable vastness. When we listen to speech, we can be led to think thoughts that have never been thought before and that never would have occurred to us on our own. Behold, the bush burned with fire, and the bush was not consumed. Man is born free, and everywhere he is in chains. Emma Woodhouse, handsome, clever, and rich, with a comfortable home and happy disposition, seemed to unite some of the best blessings of existence. Energy equals mass times the speed of light squared. I have found it impossible to carry the heavy burden of responsibility and to discharge my duties as King without the help and support of the woman I love.

Language has fascinated people for thousands of years, and linguists have studied every detail, from the number of languages spoken in New Guinea to why we say *razzle-dazzle* instead of *dazzle-razzle*. Yet to me the first and deepest challenge in understanding language is accounting for its boundless expressive power. What is the trick behind our ability to fill one another's heads with so many different ideas?

The premise of this book is that there are two tricks, words and rules. They work by different principles, are learned and used in different ways, and may even reside in different parts of the brain. Their border disputes shape and reshape languages over centuries, and make language not only a tool for communication but also a medium for wordplay and poetry and an heirloom of endless fascination.

The first trick, the word, is based on a memorized arbitrary pairing between a sound and a meaning. "What's in a name?" asks Juliet. "That which we call a rose by any other name would smell as sweet." What's in a name is that everyone in a language community tacitly agrees to use a particular sound to convey a particular idea. Although the word *rose* does not smell sweet or have thorns, we can use it to convey the idea of a rose because all of us have learned, at our mother's knee or in the playground, the same link between a noise and a thought. Now any of us can convey the thought by making the noise.

The theory that words work by a conventional pairing of sound and meaning is not banal or uncontroversial. In the earliest surviving debate on linguistics, Plato has Hermogenes say, "Nothing has its name by nature, but only by usage and custom." Cratylus disagrees: "There is a correctness of name existing by nature for everything: a name is not simply that which a number of people jointly agree to call a thing." Cratylus is a creationist, and suggests that "a power greater than man assigned the first names to things." Today, those who see a correctness of names might attribute it instead to onomatopoeia (words such as *crash* and *oink* that sound like what they mean) or to sound symbolism (words such as *sneer*, *cantankerous*, and *mellifluous* that naturally call to mind the things they mean).

Today this debate has been resolved in favor of Hermogenes' conventional pairing. Early in this century Ferdinand de Saussure, a founder of modern linguistics, called such pairing the *arbitrary sign* and made it a cornerstone of the study of language.[1] Onomatopoeia and sound symbolism certainly exist, but they are asterisks to the far more important principle of the arbitrary sign—or else we would understand the words in every foreign language instinctively, and never need a dictionary for our own! Even the most obviously onomatopoeic words—those for animal sounds—are notoriously unpredictable, with pigs oinking *boo-boo* in Japan and dogs barking *gong-gong* in Indonesia. Sound symbolism, for its part, was no friend of the American woman in the throes of labor who overheard what struck her as the most beautiful word in the English language and named her newborn daughter *Meconium*, the medical term for fetal excrement.[2]

Though simple, the principle of the arbitrary sign is a powerful tool for getting thoughts from head to head. Children begin to learn words before their first birthday, and by their second they hoover them up at a rate of one every two hours. By the time they enter school children command 13,000 words, and then the pace picks up, because new words rain down on them from both speech and print. A typical high-school graduate knows about 60,000 words; a literate adult, perhaps twice that number.[3] People recognize words swiftly. The meaning of a spoken word is accessed by a listener's brain in about a fifth of a second, before the speaker has finished pronouncing it.[4] The meaning of a printed word is registered even more quickly, in about an eighth of a second.[5] People produce words almost as rapidly: It takes the brain about a quarter of a second to find a word to name an object, and about another quarter of a second to program the mouth and tongue to pronounce it.[6]

The arbitrary sign works because a speaker and a listener can call on identical entries in their mental dictionaries. The speaker has a thought, makes a sound, and counts on the listener to hear the sound and recover that thought. To depict an entry in the mental dictionary we need a way of showing the entry itself, as well as its sound and meaning. The entry for a word is simply its address in one's memory, like the location of the boldfaced entry for a word in a real dictionary. It's convenient to use an English letter sequence such as *r-o-s-e* to stand for the entry, as long as we remember this is just a mnemonic tag that allows us to remember which word the entry corresponds to; any symbol, such as *42759*, would do just as well. To depict the word's sound, we can use a phonetic notation, such as [rōz].* The meaning of a word is a link to an entry in the person's mental *encyclopedia*, which captures the person's concept of a rose. For convenience we can symbolize it with a picture, such as ❀. So a mental dictionary entry looks something like this:

rose
  sound: *r*ōz
  meaning: ❀

*This book uses a simplified phonetic notation similar to that found in dictionaries, in which the long vowels *ā* in *bait*, *ē* in *beet*, *ī* in *bite*, *ō* in *boat*, and *ū* in *boot* are distinguished from the short vowels *ă* in *bat*, *ĕ* in *bet*, *ĭ* in *bit*, *ŏ* in *pot*, and *ŭ* in *but*. An unadorned *a* stands for the first vowel in *father* or *papa*. The symbol *ɨ* is used for the neutral vowel in the suffix of *melted* and *Rose's* (e.g., *mĕltɨd*, *rōzɨz*), a version of the vowel sometimes called *schwa*.

"Long vowel," "short vowel," and other technical terms in linguistics, psycholinguistics, and neuroscience are defined in the Glossary.

A final component is the word's part of speech, or grammatical category, which for *rose* is noun (N):

rose
  sound: *rōz*
  meaning: ❀
  part of speech: N

And that brings us to the second trick behind the vast expressive power of language.

People do not just blurt out isolated words but rather *combine* them into phrases and sentences, in which the meaning of the combination can be inferred from the meanings of the words and the way they are arranged. We talk not merely of roses, but of the red rose, proud rose, sad rose of all my days. We can express our feelings about bread and roses, guns and roses, the War of the Roses, or days of wine and roses. We can say that lovely is the rose, roses are red, or a rose is a rose is a rose. When we combine words, their arrangement is crucial: *Violets are red, roses are blue*, though containing all the ingredients of the familiar verse, means something very different. We all know the difference between *young women looking for husbands* and *husbands looking for young women*, and that *looking women husbands young for* doesn't mean anything at all.

Inside everyone's head there must be a code or protocol or set of rules that specifies how words may be arranged into meaningful combinations. Modern linguists call it a *grammar*, sometimes a *generative grammar* to distinguish it from the grammars used to teach foreign languages or to teach the dos and don'ts of formal prose.

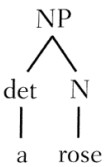
A grammar assembles words into phrases according to the words' part-of-speech categories, such as noun and verb. To highlight a word's category and reduce visual clutter often it is convenient to omit the sound and meaning and put the category label on top:

N
|
rose

Similarly, the word *a*, an article or *determiner*, would look like this:

They can then be joined into the phrase *a rose* by a rule that joins a determiner to a noun to yield a noun phrase (NP). The rule can be shown as a set of connected branches; this one says "a noun phrase may be composed of a determiner followed by a noun":

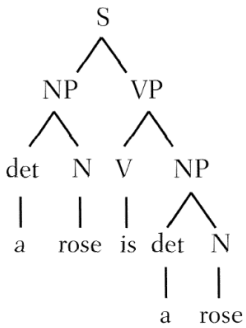
The symbols at the bottom of the branches are like slots into which words may be plugged, as long as the words have the same labels growing out of their tops. Here is the result, the phrase *a rose*:



With just two more rules we can build a complete toy grammar. One rule defines a predicate or verb phrase (VP); the rule says that a verb phrase may consist of a verb followed by its direct object, a noun phrase:

The other rule defines the sentence itself (S). This rule says that a sentence may be composed from a noun phrase (the subject) followed by a verb phrase (the predicate):

When words are plugged into phrases according to these rules, and the phrases are plugged into bigger phrases, we get a complete sentence, such as *A rose is a rose*:



Other parts of the rules, not shown here, specify the meaning of the new combination. For example, the complete NP rule says that the meaning of *the yellow rose of Texas* is based on the meaning of *rose,* which is called the *head* of the phrase, and that the other words modify the head in various ways: *yellow* specifies a distinctive trait, *Texas* its location.

These rules, though crude, illustrate the fantastic expressive power made available by grammar. First, the rules are *productive*. By specifying a string of *kinds* of words rather than a string of *actual* words, the rules allow us to assemble new sentences on the fly and not regurgitate preassembled clichés—and that allows us to convey unprecedented combinations of ideas. Though we often speak of roses being red, we could talk about violets being red if the desire came over us (perhaps to announce a new hybrid), because the rule allows us to insert *violets* into the N slot just as easily as *roses*.

Second, the symbols contained by the rules are *symbolic* and hence *abstract*. The rule doesn't say, "A sentence may begin with a bunch of words referring to a kind of flower"; rather, it says, "A sentence may begin with an NP," where NP is a symbol or variable that can be replaced by any noun, just as x or y in a mathematical formula can be replaced by any number. We can use the rules to talk about flowers and their colors and smells, but we can just as easily use them to talk about karma or quarks or floob-boober-bab-boober-bubs (who, according to Dr. Seuss, bounce in the water like blubbery tubs).

Third, the rules are *combinatorial*. They don't just have a single slot, like a fill-in-the-blank exam question; *every* position in the sentence offers a choice of words from a lengthy menu. Say everyday English has four determiners (*a*, *any*, *one*, and *the*) and ten thousand nouns. Then the rule for a noun phrase allows four choices for the determiner, followed by ten thousand choices for the head noun, yielding $4 \times 10{,}000 = 40{,}000$ ways to utter a noun phrase. The rule

for a sentence allows these forty thousand subjects to be followed by any of four thousand verbs, providing 40,000 × 4,000 = 160,000,000 ways to utter the first three words of a sentence. Then there are four choices for the determiner of the object (640 million four-word beginnings) followed by ten thousand choices for the head noun of the object, or 640,000,000 × 10,000 = 6,400,000,000,000 (6.4 trillion) five-word sentences. Suppose it takes five seconds to produce one of these sentences. To crank them all out, from *The abandonment abased the abbey* and *The abandonment abased the abbot*, through *The abandonment abased the zoologist*, all the way to *The zoologist zoned the zoo*, would take a million years.

Many such combinations are ungrammatical of course, owing to various complications I haven't mentioned—for example, you can't say *The Aaron, a abandonment*, or *The abbot abase the abbey*. And most of the combinations are nonsensical: Abandonments can't abbreviate, and abbeys can't abet. Yet even with these restrictions the expressive range of a grammar is astonishing. The psychologist George Miller once conservatively estimated that if speakers keep a sentence perfectly grammatical and sensible as they choose their words, their menu at each point offers an average of about ten choices (at some points there are many more than ten choices; at others, only one or two).[7] That works out to one hundred thousand five-word sentences, one million six-word sentences, ten million seven-word sentences, and so on. A sentence of twenty words is not at all uncommon (the preceding sentence has twenty words before *and so on*), and there are about one hundred million trillion of them in English. For comparison, that is about a hundred times the number of seconds since the birth of the universe.

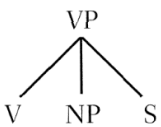
Grammar is an example of a combinatorial system, in which a small inventory of elements can be assembled by rules into an immense set of distinct objects. Combinatorial systems obey what Miller calls the Exponential Principle: The number of possible combinations grows exponentially (geometrically) with the size of the combination.[8] Combinatorial systems can generate inconceivably vast numbers of products. Every kind of molecule in the universe is assembled from a hundred-odd chemical elements; every protein building block and catalyst in the living world is assembled from just twenty amino acids. Even when the number of products is smaller, a combinatorial system can capture them all and provide enormous savings in storage space. Eight bits define $2^8 = 256$ distinct bytes, which is more than enough for all the numerals, punctuation marks, and upper- and lowercase letters in our writing system. This allows computers to be built out of identical specks of silicon that can be

in just two states, instead of the dozens of pieces of type that once filled typesetters' cases. Billions of years ago life on Earth settled on a code in which a string of three bases in a DNA molecule became the instruction for selecting one amino acid when assembling a protein. There are four kinds of bases, so a three-base string allows for $4 \times 4 \times 4 = 64$ possibilities. That is enough to give each of the twenty amino acids its own string, with plenty left over for the start and stop instructions that begin and end the protein. Two bases would have been too few ($4 \times 4 = 16$), four more than needed ($4 \times 4 \times 4 \times 4 = 256$).

Perhaps the most vivid description of the staggering power of a combinatorial system is in Jorge Luis Borges's story "The Library of Babel."[9] The library is a vast network of galleries with books composed of all the combinations of twenty-two letters, the comma, the period, and the space. Somewhere in the library is a book that contains the true history of the future (including the story of your death), a book of prophecy that vindicates the acts of every man in the universe, and a book containing the clarification of the mysteries of humanity. People roamed the galleries in a futile search for those texts from among the untold number of books with false versions of each revelation, the millions of facsimiles of a given book differing by a character, and, of course, the miles and miles of gibberish. The narrator notes that even when the human species goes extinct, the library, that space of combinatorial possibilities, will endure: "illuminated, solitary, infinite, perfectly motionless, equipped with precious volumes, useless, incorruptible, secret."

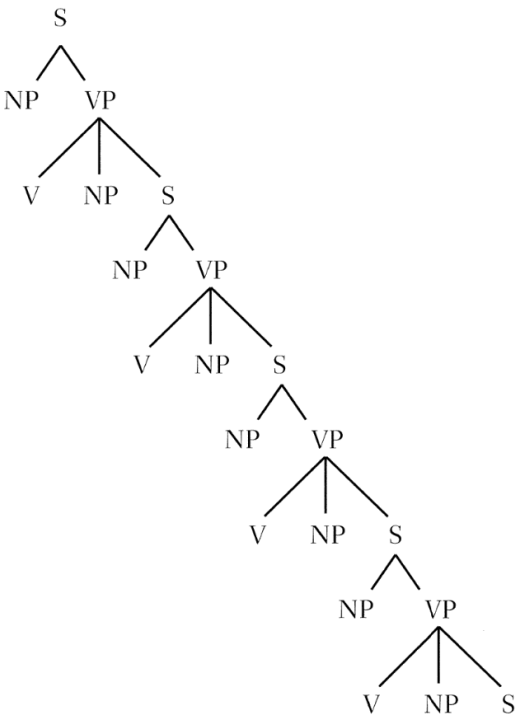
Technically, Borges needn't have described the library as "infinite." At eighty characters a line, forty lines a page, and 410 pages a book, the number of books is around $10^{1,800,000}$, or 1 followed by 1.8 million zeroes. That is, to be sure, a very large number—there are only 10^{70} particles in the visible universe—but it is a finite number.

It is easy to make a toy grammar that is even more powerful than the scheme that generates The Library of Babel. Suppose our rule for the verb phrase is enriched to allow a sentence (S) to appear inside it, as in *I told Mary he was a fool*, in which *he was a fool* comes after the object NP *Mary*:



Now our grammar is *recursive*: The rules create an entity that can contain an example of itself. In this case, a Sentence contains a Verb Phrase which in

turn can contain a Sentence. An entity that contains an example of itself can just as easily contain an example of itself that contains an example of itself that contains an example of itself, and so on:



In this case a sentence can contain a verb phrase, which can contain a sentence, which can contain a verb phrase, which can contain a sentence, ad infinitum. For example, I think I'll tell you that I just read a news story that recounts that Stephen Brill reported that the press uncritically believed Kenneth Starr's announcement that Linda Tripp testified to him that Monica Lewinsky told Tripp that Bill Clinton told Vernon Jordan to advise Lewinsky not to testify to Starr that she had had a sexual relationship with Clinton. That statement is a Russian doll with thirteen sentences inside sentences inside sentences. A recursive grammar can generate sentences of any length, and thus can generate an infinite number of sentences. So a human being possessing a recursive grammar can express or understand an infinite number of distinct thoughts, limited in practice only by stamina and mortality.

The idea that the creativity inherent in language can be explained by a grammar of combinatorial rules is usually associated with the linguist Noam Chomsky. Chomsky traced the idea to Wilhelm von Humboldt, a nineteenth-century pioneer of linguistics, who explained language as "the infinite use of finite media." According to Chomsky, the idea is even older than that; Humboldt was the last in a tradition of "Cartesian linguists" dating back to the Enlightenment.[10]

Enlightenment philosophers were captivated by the dizzying range of thoughts made expressible by a combinatorial grammar. In his book *The Search for the Perfect Language* the semiotician Umberto Eco recounts the many Promethean schemes these philosophers came up with to perfect and harness their power.[11] Descartes noticed that the decimal system allows a person to learn in a day the names of all the quantities to infinity, and he suggested that a universal artificial language built on similar principles could organize all human thoughts. Leibniz, too, dreamed of a universal logical grammar that would generate only valid sequences of ideas, banishing irrationality and error forever.

Three hundred years later we still are fallible, and still take years to learn a Babel of local languages with their tens of thousands of arbitrary signs. Why has no modern language used the horsepower of combinatorial grammar to the fullest and abandoned the unprincipled, parochial, onerous-to-memorize laundry list called vocabulary? The answer becomes clear when we look at the most famous of the combinatorial schemes of the Enlightenment, the philosophical language of Bishop John Wilkins. The arbitrary name was an affront to Wilkins's sense of good design, and he strove for a way to eliminate it. He wrote, "We should, by learning . . . the *Names* of things, be instructed likewise in their *Natures*."

Wilkins's system, laid out in a lengthy 1668 opus, offered the user a *non-arbitrary* name for every thing by dividing the universe into categories and subcategories and sub-subcategories, and assigning a vowel or consonant to every branch in the tree. The first syllable identified one of the forty categories into which Wilkins had sorted all thinkable thoughts. For example, Z stood for "sensitive species" (animals) and could be followed by *i* for "beasts" (quadrupeds). The next consonant picked out a subdivision; *t*, for example, stood for rapacious terrestrial European canines. A final vowel pinpointed the species, yielding *Zita* as the name for dogs. By similar computations one

could deduce another two thousand names for things. *Zana* is a scaly river fish with reddish flesh, in other words, salmon. *Sibα* is a type of public military relation, namely, defense. *Debα* is a portion of the first of the terrestrial elements (fire), to wit, flame. *Coba* is a consanguinous economic relation of direct ascendant, a.k.a. father.

Wilkins's philosophical language has been analyzed insightfully by Borges and Eco, and we can see why no one today speaks Wilkish.[12] For one thing, it forces users to perform a chain of computations in their heads every time they want to refer to a dog. Every vowel and consonant is laden with meaning and acts as a premise in a lengthening deduction. Speakers of the language would have to play a game of Twenty Questions, inferring an entity from a description, for every word in a sentence. They could of course simply memorize the answers, such as that a portion of the first of the terrestrial elements is a flame, but that is not much easier than memorizing that the word for flame is *flame*.

A second problem is that there are more things in heaven and earth than were dreamt of in Wilkins's philosophy, which identified only two thousand concepts. Wilkins understood the exponential principle and tried to cope with the problem by lengthening the words. He provided suffixes and connectors that allowed *calf*, for example, to be expressed as *cow* + *young*, and *astronomer* to be expressed as *artist* + *star*. But eventually he gave up and resorted to using synonyms for concepts his language could not generate, such as *box* for *coffin*. Wilkins's dilemma was that he could either expand his system to embrace all concepts, which would require even longer and more unwieldy strings, or he could force his users to remember the nearest synonym, reintroducing the despised memorization process.

A third problem is that in a logical language words are assembled purely on information-theoretic principles, with no regard to the problems that incarnate creatures might have in pronouncing and understanding the strings. A perfect combinatorial language is always in danger of generating mouthfuls like *mxyzptlk* or *bftsplk*, so Wilkins and other language-designers of the Enlightenment all had to make concessions to pronounceability and euphony. Sometimes they defiled their systems with irregularities, for example, reversing a vowel and consonant to make a word more pronounceable. At other times they hobbled the system with restrictions, such as that consonants and vowels must alternate. Every even-numbered position in a word had to be filled by one of the nine vowels of English, and that restricted many cate-

gories, such as species in a genus, to nine apiece, regardless of how many species exist in the world.

Another problem is that Wilkins's words are packed tight with information and lack the safety factor provided by redundancy. The slightest slip of the tongue or pen guarantees misunderstanding. Eco catches Wilkins himself misusing *Gαde* (barley) for *Gαpe* (tulip).

Finally, all that power is not being put to any sensible use. The beauty of a combinatorial system is that it generates combinations that have never before been considered but that one *might* want to talk about some day. For example, the combinatorial system known as the periodic table of the elements inspired chemists to look for hitherto unknown chemical elements that should have occupied the empty slots in the table. Combinatorial grammar allows us to talk about a combinatorial world, a world in which violets could be red or a man could bite a dog. Yet familiar objects and actions around us often form a *non*combinatorial list of distinctive kinds. When we merely have to single out one of them, a combinatorial system is overkill. We never will have to refer to fish with an enmity to sheep or to military actions with scales and reddish flesh, and that's what a combinatorial system for words like Wilkins's allows us to do. To refer to everyday things it's easier to say *dog* or *fish* than to work through a complicated taxonomy that is just a fancy way of singling out dogs or fish anyway.

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The languages of Wilkins and other Enlightenment thinkers show that combinatorial grammar has disadvantages as well as advantages, and that illuminates our understanding of the design of human language. No language works like Wilkins's contraption, with every word compiled out of meaningful vowels and consonants according to a master formula. All languages force their speakers to memorize thousands of arbitrary words, and now we can see why.[13] Many bodily organ systems are made from several kinds of tissue optimized for jobs with contradictory specifications. Our eyes have rods for night vision and cones for day vision; our muscles have slow-twitch fibers for sustained action and fast-twitch fibers for bursts of speed. The human language system also appears to be built out of two kinds of mental tissue. It has a lexicon of words, which refer to common things such as people, places, objects, and actions, and which are handled by a mechanism for storing and retrieving items in memory. And it has a grammar of rules, which refer to novel relationships

among things, and which is handled by a mechanism for combining and analyzing sequences of symbols.

To a parsimonious scientific mind, however, two mental mechanisms can be one too many. The poet William Empson wrote of the Latin philosopher,

> Lucretius could not credit centaurs;
> Such bicycle he deemed asynchronous.[14]

Today's skeptics also might wonder about a two-part design for language. Perhaps words and rules are two modes of operation of a single faculty. Simple, familiar thoughts need short noises, which we call words, and complicated, unfamiliar thoughts need long noises, which we call phrases and sentences. A single machine might make either short or long noises, depending on the kinds of thoughts it is asked to express. Or perhaps there is a gradual continuum between memory and combination rather than two distinct mechanisms, with words at the memory end of the continuum and sentences at the combination end.

To show that words and rules are handled by different machines we need to hold the input and output of the putative machines constant. We need side-by-side specimens in which the same kind of thought is packed into the same kind of verbiage, but one specimen shows the handiwork of a word regurgitator and the other shows the handiwork of a rule amalgamator. I believe that languages do provide us with such specimens. They are called regular and irregular words.

English verbs come in two flavors. Regular verbs have past tense forms that look like the verb with *-ed* on the end: Today I *jog*, yesterday I *jogged*. They are monotonously predictable: *jog–jogged, walk–walked, play–played, kiss–kissed*, and so on. (Regular nouns, whose plurals end in *-s*, such as *cats* and *dogs*, are similar.) The list of regular verbs is also open-ended. There are thousands, perhaps tens of thousands, of regular verbs in English (depending on how big a dictionary you consult), and new ones are being added to the language all the time. When *fax* came into common parlance a decade or so ago, no one had to inquire about its past-tense form; everyone knew it was *faxed*. Similarly, when other words enter the language such as *spam* (flood with E-mail), *snarf* (download a file), *mung* (damage something), *mosh* (dance in roughhouse fashion), and *Bork* (challenge a political nominee for partisan reasons), the past-tense forms do not need separate introductions: We all deduce that they are *spammed, snarfed, munged, moshed*, and *Borked*.

Even young children do it. In 1958 the psychologist Jean Berko Gleason tested four- to seven-year-old children with the following procedure, now known as the *wug*-test:

This is a wug.

Now there is another one.
There are two of them.
These are two _____.

The children could have refused to answer on the grounds that they had never heard of a wug and had never been told how to talk about more than one of them. Instead, Berko Gleason wrote, "Answers were willingly, and often insistently, given." Three-quarters of the preschoolers and 99 percent of the first-graders filled in the blank with *wugs*. Similarly, when shown a picture of a man who knows how to *rick* or *bing* or *gling* and did the same thing yesterday, most children said that he *ricked* or *binged* or *glinged*.

The children could not have heard their parents say *wugs* or *binged* before entering the lab, because these words had been coined especially for the experiment. Children therefore are not parrots who just play back what they hear. And the children could not have been previously rewarded by parents for uttering those forms, because the children did not know the words before entering the lab. Children therefore are not like pigeons in a Skinner box, who increase or decrease the frequency of responses in reaction to the contingencies of reinforcement. Noam Chomsky and Eric Lenneberg, pioneers of the modern study

of language and contemporaries of Berko Gleason in the Harvard-MIT community, pointed to children's ability to generalize constructions such as the regular past tense in support of their theory that language is actively acquired by a special rule-forming mechanism in the mind of the child.[15]

As it happens, all children are subjects in a version of Berko Gleason's experiment. Children often make up words or mangle them and are happy to put their new verbs in the past tense. Here are some examples:

spidered
lightninged
smunched
poonked
speeched
broomed
byed (went by)
eat lunched
cut-upped egg[16]

All children also make creative errors in their speech like these:

I buyed a fire dog for a grillion dollars.
Hey, Horton heared a Who.
My teacher holded the baby rabbits and we patted them.
Daddy, I stealed some of the people out of the boat.
Once upon a time a alligator was eating a dinosaur and the dinosaur was eating the alligator and the dinosaur was eaten by the alligator and the alligator goed kerplunk.[17]

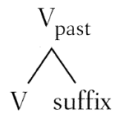
Such errors bring us to the second flavor of a verb in English: irregular. The past-tense form of an irregular verb is not simply the verb decorated with an *-ed* ending. For example, the past tense of *buy* is not *buyed*, but *bought*. Similarly, the past tense of *hear*, *hold*, *steal*, and *go* are *heard*, *held*, *stole*, and *went*.

Irregular verbs contrast with regular verbs in almost every way. Whereas regulars are orderly and predictable, irregulars are chaotic and idiosyncratic. The past tense of *sink* is *sank*, and the past tense of *ring* is *rang*. But the past tense of *cling* is not *clang*, but *clung*. The past tense of *think* is neither *thank* nor *thunk*, but *thought*. And the past tense of *blink* is neither *blank* nor *blunk* nor *blought*, but a regular form, *blinked*. The language maven Richard Lederer wrote a poem, "Tense Times with Verbs," that begins:

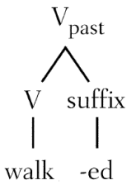
The verbs in English are a fright.
How can we learn to read and write?
Today we speak, but first we spoke;
Some faucets leak, but never loke.
Today we write, but first we wrote;
We bite our tongues, but never bote.
Each day I teach, for years I taught,
And preachers preach, but never praught.
This tale I tell; this tale I told;
I smell the flowers, but never smold.
If knights still slay, as once they slew,
Then do we play, as once we plew?
If I still do as once I did,
Then do cows moo, as they once mid?[18]

Also in contrast to the regulars, irregular verbs form a closed list. There are only about 150 to 180 irregular verbs in modern English (depending on how you count), and there have been no recent additions.[19] The youngest irregular is probably *snuck*, which sneaked into the language over a century ago and is still not accepted by purists.[20] And the freewheeling children in Berko Gleason's study were downright stodgy when it came to irregular forms: Only one out of eighty-six turned *bing* into *bang*, and one other turned *gling* into *glang*.[21]

These differences suggest a simple theory. Regular past-tense forms are predictable in sound and generated freely because they are products of a rule that lives in the minds of children and adults: "The past tense of a verb may be formed from the verb followed by the suffix *-ed*." The rule would look just like the rules of syntax in the toy grammar we played with earlier,



and would generate a similar inverted-tree-like structure:



Irregular verbs, in contrast, are unpredictable in form and restricted to a list because they are memorized and retrieved as individual words. An irregular form would look just like the lexical entry we saw when considering the name of the rose. It would be linked with the entry for the plain form of the same verb and labeled as its past tense:

hold	held
sound: *hōld*	sound: *hĕld*
meaning: ✍	meaning: ✍
part of speech: V	part of speech: V
	tense: past

Two mechanisms trying to do the same job would get in each other's way unless something adjudicated between them, and there is indeed a simple principle: If a word can provide its own past tense from memory, the rule is blocked; elsewhere (by default), the rule applies.[22] The first part explains why we adults don't say *holded* and *stealed*; our knowledge of *held* and *stole* blocks the rule that would have added *-ed*. The second part explains why both children and adults say *Borked* and *moshed* and *ricked* and *broomed*; as long as a verb does *not* have a form in memory, the rule may be applied. The ability of a rule to apply *elsewhere* or by default—that is, to any word that does not already have a specified form in memory—is the source of its power. A speaker who needs to express a past tense or plural is never left speechless, even when a search in memory comes up emptyhanded.

The theory that regular forms are generated by rule and irregular forms are retrieved by rote is pleasing not only because it explains the differences in productivity between the two patterns but also because it fits nicely into the larger picture of the design of language.

At first glance irregular verbs would seem to have no reason to live. Why should language have forms that are just cussed exceptions to a rule? What are they good for, besides giving children a way to make cute errors, providing material for humorous verse, and making life miserable for foreign language students? In Woody Allen's story "The Kugelmass Episode" a humanities professor in a midlife crisis finds a magic cabinet that projects him into any book he takes in with him. After a tempestuous affair with Madame Bovary, Kugelmass tries again with another novel, but this time the cabinet malfunctioned, and the professor "was projected into an old textbook, *Remedial Spanish*, and was running for his life over a barren, rocky terrain as the word *tener* ('to have')—a large and hairy irregular verb—raced after him on its spindly legs."[23]

But under the word-and-rule theory we need not suppose that evolution fitted us with a special gadget for irregularity. Irregular forms are just words. If our language faculty has a knack for memorizing words, it should have no inhibitions about memorizing past-tense forms at the same time. These are the verbs we call irregular, and they are a mere 180 additions to a mental lexicon that already numbers in the tens or hundreds of thousands. Irregular and regular forms therefore would be the inevitable outcome of two mental subsystems, words and rules, trying to do the same thing, namely, express an event or state that took place in the past.

Regular and irregular forms throw a spotlight on the advantages and disadvantages of words and rules, because everything else about them is the same: They both are one word long, and both convey the same meaning, past tense. The advantage of a rule is that a vast number of forms are generated by a compact mechanism. In English the savings are significant: The rules for *-ed*, *-s*, and *-ing* (the three regular forms of the verb) cut our mental storage needs to a quarter of what they would be if each form had to be stored separately. In other languages, such as Turkish, Bantu, and many Native American languages, there can be hundreds, thousands, or even millions of conjugated forms for every verb (for different combinations of tense, person, number, gender, mood, case, and so on), and the savings are indispensable. The rule also allows new words like *mosh*, rare words like *abase*, and abstract words like *abet* to be supplied with a past tense (*moshed*, *abased*, *abetted*), even if there were no previous opportunities for the speaker and hearer to have committed the form to memory. On the other hand, a rule is more powerful than needed for words we hear so often that retrieval from memory is easy. As we shall see, it is the most common verbs, such as *be*, *have*, *do*, *go*, and *say*, that turn out to be irregular in language after language.

Rules have another shortcoming that invites the word system to memorize irregulars. Recall that one of the nuisances plaguing John Wilkins as he designed his perfect language was that flesh-and-blood humans had to pronounce and understand the products of the rules. A sequence of sounds that encodes a concept precisely and efficiently may be unresolvable by the ear or unpronounceable by the tongue. So it is with the rule for the past tense in English. The delicate tongue-tap that graces the end of a regular form may escape a listener and be omitted when he reproduces it, resulting in a solecism such as *suppose to*, *use to*, or *cut and dry*, or in signs and inscriptions like these:

Broil Cod
Use Books

Whip Cream
Blacken redfish
Can Vegetables
Box sets
Handicap Facilities Available

In certain older expressions *-ed* was omitted so often that the expression eventually lost the *-ed* altogether, even among careful speakers and listeners. That's how we ended up with *ice cream* (originally *iced cream*), *sour cream*, *mince meat*, and *Damn Yankees*.[24] Irregular verbs, in contrast, tend to use vowel changes such as *ring–rang*, *strike–struck*, and *blow–blew*, which are as clear as a bell.

Similarly, the very obliviousness to the details of the verb that makes a rule so powerful (it applies across the board to all verbs, whether they are familiar sounding or not) can let it blindly jam a suffix onto the end of an inhospitable sound. The result can be an uneuphonious tongue-twister such as *edited* or *sixths*. Monstrosities like these are never found among the irregulars, which all have standard Anglo-Saxon word sounds such as *grew* and *strode* and *clung*, which please the ear and roll off the tongue.[25]

Language works by words and rules, each with strengths and weaknesses. Irregular and regular verbs are contrasting specimens of words and rules in action. These are the themes of this book, but with many twists to come. It would be too good to be true if we reached a major conclusion about the most complicated object in the known universe, the human brain, simply by seeing how children name pictures of little birds. The word-and-rule theory for regular and irregular verbs is an opening statement in the latest round of a debate on how the mind works that has raged for centuries. It has inspired two alternative theories that are equally ingenious but diametrically opposed, and intensive research showing what is right and wrong about each of them—perhaps resolving the debate for good. The theory has solved many puzzles about the English language, and has illuminated the ways that children learn to talk, the forces that make languages diverge and the forces that make them alike, the way that language is processed in the brain, and even the nature of our concepts about things and people. But to reach those conclusions we first must put regular and irregular verbs under a more powerful magnifying glass, where we will find some unexpected fingerprints.

2

DISSECTION BY LINGUISTICS

Regular and irregular words have long served as metaphors for the law-abiding and the quirky. Psychology textbooks point to children's errors like *breaked* and *goed* as evidence that we are a pattern-loving, exception-hating species, explaining everything from why children have trouble learning simple laws of physics to why adults make errors when using computers or diagnosing diseases. In *1984* George Orwell has the state banning irregular verbs as a sign of its determination to crush the human spirit; in 1989 the writer of a personal ad in the *New York Review of Books* asked, "Are you an irregular verb?" as a sign of her determination to exalt it.

Science is not always kind to folklore from the natural world. Elephants do forget, lemmings don't commit mass suicide, two snowflakes can be alike, we use more than 5 percent of our brains, and Eskimos don't have a hundred words for snow. We had better give irregular and regular verbs a closer look before using them as evidence for a language faculty that works by words and rules, or more generally, a mind that works by lookup and computation.

Regular and irregular forms do not work in isolation; they are part of the integrated living system we call a language. This chapter will tease out regular inflection from the linguistic organs and tissues in which it is embedded. The next chapter, on irregular verbs, will have a different feel. Living creatures can be dissected, but creatures dead so long that only a trace of the living organs

remain must be excavated. Our tour of the irregular verbs will uncover them from layers of historical sediment laid down over thousands of years.

Does language even *have* an anatomy? Many people think about language in the following way: We need to communicate, and language is the fulfillment of that need. For every idea there is a word and vice-versa, and we utter the words in an order that reflects the connections among ideas. If this commonsense view is true, there would be little need to speak of language being a complex system. The complexity would reside in the meanings, and language would reflect that complexity directly.

The point of this chapter is to show that this view is mistaken. I will put regular verbs under a microscope to reveal the delicate anatomy that makes them work. Language does express meaning as sound, of course, but not in a single step. Sentences are put together on an assembly line composed of mental modules, shown on the following page. One is a storehouse of memorized words, the mental lexicon. Another is a team of rules that combine words and parts of words into bigger words, a component called *morphology*. A third is a team of rules that combine words into phrases and sentences, a component called *syntax*. The three components pass messages about meaning back and forth with the rest of the mind so that the words correspond to what the speaker wants to say. This interface between language and mind is called *semantics*. Finally, the assembled words, phrases, and sentences are massaged by a set of rules into a sound pattern that we can pronounce when speaking or extract from the stream of noise when listening. This interface between language and the mouth and ear is called *phonology*.

Many people are suspicious of box-and-arrow diagrams of the mind. The walls of the boxes and the paths of the arrows often seem arbitrary, and could just as easily have been drawn differently. In the case of language, however, these components pop out as we tease apart the phenomena, and at least some of the divisions are now becoming visible in the living brain, as we will see in chapter 9.[1] This chapter will explore the kinds of discoveries that have led linguists to divide language into parts, using only the facts of regular and irregular words. First, we will see why the lexicon is different from the two boxes of rules to the right, then why morphology is in a different box from syntax, and finally, why phonology and semantics each gets a box.

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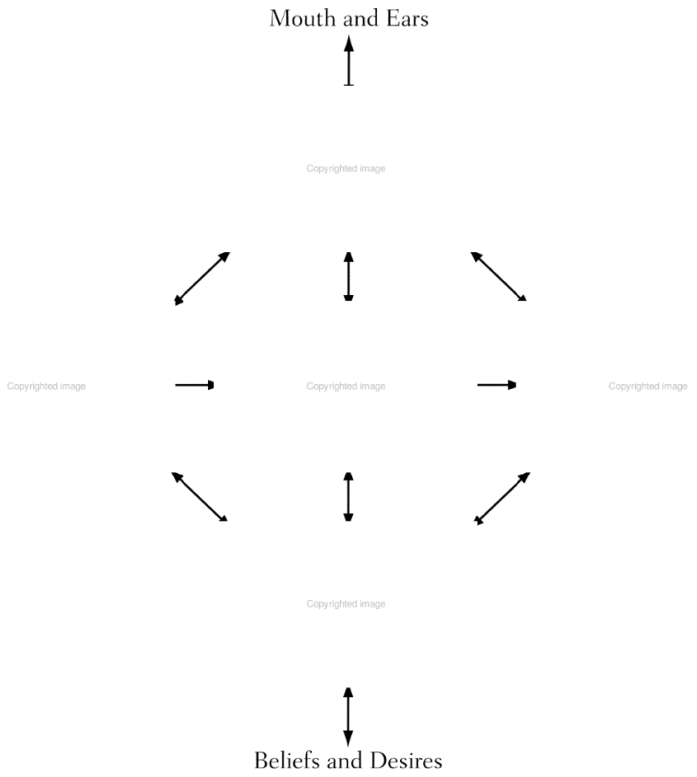
The easiest boxes to keep separate ought to be the boxes containing words and rules. From the discussion in the preceding chapter, it should be clear that a



simple word like *duck* belongs in the lexicon to the left in the diagram. Just as clearly, a sentence like *Daffy is a duck* is assembled by the rules of syntax in the box on the right. According to the words-and-rules theory, irregular forms such as *swam* are also words that come from the lexicon, because they are as arbitrary as *duck*. What do we do then with regular forms like *quacked*? They look like words and sound like words, but I have been insisting they don't have to be stored in the lexicon. They don't seem like words, but they don't seem like sentences either, which are the clearest products of rules.

The problem is that the terms *word* and *rule* come from everyday parlance and are as scientifically fuzzy as other vernacular terms, like *bug* and *rock*. On closer examination, the word *word* has two very different senses.[2] The first sense matches the everyday notion of a word: a stretch of sound that expresses a concept, that is printed as a string of letters between white spaces, and that may be combined with other words to form phrases and sentences. Some of these words are stored whole in the lexicon, like *duck* and *swam*; others are assembled out of

smaller bits by rules of morphology such as *quacked* and *duck-billed platypus*. A technical term for a word in this sense is a *morphological object*, to be distinguished from phrases and sentences, which are syntactic objects.

The second sense of *word* is a stretch of sound that has to be memorized because it cannot be generated by rules. Some memorized chunks are smaller than a word in the first sense, such as prefixes like *un-* and *re-* and suffixes like *-able* and *-ed*. Others are larger than a word in the first sense, such as idioms, clichés, and collocations. Idioms are phrases whose meanings cannot be computed out of their parts, such as *eat your heart out* and *beat around the bush*. Collocations and clichés are strings of words that are remembered as wholes and often used together, such as *gone with the wind* or *like two peas in a pod*. People know tens of thousands of these expressions; the linguist Ray Jackendoff refers to them as "the Wheel of Fortune lexicon," after the game show in which contestants guess a familiar expression from a few fragments. A chunk of any size that has to be memorized—prefix, suffix, whole word, idiom, collocation—is the second sense of *word*. It is the sense of *word* that contrasts with *rule*, and the sense I had in mind when choosing the title of this book. A memorized chunk is sometimes called a *listeme*, that is, an item that has to be memorized as part of a list; one could argue that this book ought to have been called *Listemes and Rules*.

So *walked* is a word in the first sense (a morphological object) and not a word in the second sense (a listeme); its listemes are *walk* and *-ed*. These one-part listemes—prefixes, suffixes, and the stems they attach to, such as *walk*—are called morphemes, a term coined by the nineteenth-century linguist Baudouin de Courtenay to refer to "that part of a word which is endowed with psychological autonomy and is for the very same reasons not further divisible."[3]

What about the rules? Why divide the rules of morphology, which build complex words (including regular plurals and past-tense forms), from the rules of syntax, which build phrases and sentences? Both are productive, recursive, combinatorial systems, and some linguists see them as two parts of a larger system.[4] Yet all linguists recognize that they are not identical. This may seem of no interest to anyone but a student cramming for a Linguistics 101 final, but in fact it has been a source of countless barroom arguments, late-night dorm-room debates, and irreconcilable differences.

What is the correct word for people who pass by: *passerbys* or *passersby*? Do nervous fiancées dread the first meeting of the *mother-in-laws* or the *mothers-in-law*? Who did Richard Nixon force to resign: a series of *Attorney Generals*, or a series of *Attorneys General*? Here are a few real-life examples:

> Dear Ms. Grammar,
> A member of the Friday Night Couples League . . . had a *hole in one* on the third hole and another on the fifth. Did he have two *holes in one* or two *hole in ones*? One of us believes that the pattern should be the same as in *attorneys general* and *passersby*. The other disagrees, believing that *holes in one* would indicate that the golfer gained multiple holes in one shot. A Diet Coke has been wagered on this, and we have agreed that Ms. Grammar shall be the final authority.[5]

> **Spoonfuls**
> From a recipe: "Now throw in two tablespoons full of chopped parsley and cook ten minutes more. The quail ought to be tender by then." Never mind the quail; how are we ever going to get those tablespoons tender? The word, of course, is *tablespoonfuls*, no matter how illogical it seems. One dictionary contains the entry *spoonsful*, but this is not generally accepted.[6]

> Gin and tonic season (no hyphens, please) is just about finished, but Joe Galeota of West Roxbury would still like to know how to order when he's having more than one. "Friends advised me that the answer is 'gins and tonic' because alcohol is the main ingredient," he writes.[7]

> Never has the U.S. faced a worse crisis than in 1887, after the invention of the Jack-in-the-Box. It had become a fad overnight, and everyone was having a whale of a time when someone asked, "What is its plural?" "Jack-in-the-Boxes!" claimed some. Others hotly insisted, "Jacks-in-the-Box!" Civil war seemed inevitable, when Zeke Kelp's Crusade won a compromise on "Jacks-in-the-Boxes." Unthanked for forty-three years, Kelp will be honored next week when N. Y. City unveils a hydrant in his name.[8]

All right, the last example isn't from real life; it's from the *Early Cartoons and Writings of Dr. Seuss*. The others are from well-known language columnists. *Hole-in-one* is from Ms. Grammar, the nom de plume of Barbara Walraff when presiding over "Word Court" in the *Atlantic Monthly*. *Spoonful* is from Theodore Bernstein, the late *New York Times* editor who wrote the syndicated

column "Bernstein on Words." *Gin and tonic* is from Jan Freeman, who dispenses "The Word" in the *Boston Globe*.

People disagree on how to pluralize nouns, and they care about who is correct. Purists insist that the *-s* belongs on the noun in the middle of the expression (*notaries public, runners-up*), and those with the common touch are content to leave it at the end (*notary publics, runner-ups*). "Ms. Grammar" advised her beseechers that *holes in one* is technically correct, but added, "to say 'two holes in one' is to ask to be misunderstood." Her Solomonic suggestion was to say *a hole in one twice*, and to buy two Diet Cokes.

For my purpose—figuring out how the human mind deals with language—there is no correct answer. Most disputes about "correct" usage are questions of custom and authority rather than grammatical logic (see "The Language Mavens" in my book *The Language Instinct*), and in these disputes in particular, both parties have grammatical logic on their side. Their agony highlights the distinctions among lexicon, morphology, and syntax, and illustrates the theme of this book: that the mind analyzes every stretch of language as some mixture of memorized chunks and rule-governed assemblies. How people pluralize an expression depends on how they tacitly analyze it: as a word or as a phrase.

With a simple word the plural suffix goes at the end: one *girl*, two *girls*. Now what happens in a compound word composed of two simple words, such as *cowgirl*? The plural still goes on the end: *two cowgirls*, not *two cowsgirl* or *two cowsgirls*. That is because the word *girl* inside *cowgirl* is special. It is called the *head* of the word, and it stands for the word as a whole in determining its meaning (a cowgirl is a kind of girl) and in determining its plural: The *-s* goes on *girl*. A *phrase* also has a head, and it too determines the meaning and gets the plural. But now we discover the major difference between a word, the product of morphology, and a phrase, the product of syntax: In the phrase, the head is on the *left*, not the right. If you meet more than one girl from Ipanema (head = *girl*), they are *girls from Ipanema*, not *girl from Ipanemas*. With a word the plural is on the end (*cowgirls*); with a phrase the plural can be in the middle (*girls from Ipanema*).[9]

The seeds of the *mother-in-law* dispute were sown by a special option of English: Occasionally a phrase gets repackaged into a long word. For example, a hangover victim may complain of a *bottom-of-the-birdcage taste* in her mouth; the phrase *bottom of the birdcage* has been packaged as a word that modifies *taste*. When a word-made-from-a-phrase is new and fresh, speakers still can perceive the anatomy of the phrase inside the word. For example, we parse the modifier *bottom-of-the-birdcage* to understand that it means something as foul as the bottom of a birdcage.

But when the phrase is used as a word repeatedly, the original meaning can recede from collective memory. The phrase boundaries melt into a glob, and speakers no longer sense its parts. No one thinks of *Thursday* as *Thor's Day* anymore, or of *breakfast* as *breaking a fast*. Modern English has thousands of former phrases and complex words that have congealed into what people now perceive as simple words, such as *business* (busyness), *Christmas* (Christ's Mass), and *spinster* (one who spins). The meltdown, of course, does not happen overnight or in all speakers at once; there must have been a time when some English speakers still heard *Christmas* as *Christ's Mass* and others heard it as the arbitrary name of the holiday, just as today's older speakers hear the *awe* in *awesome* where younger speakers hear the whole word as a synonym for *good*.

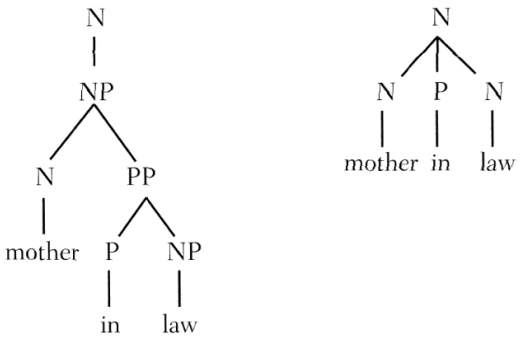
Most of our disputed plurals originated as phrases and then became words. Long ago people might have thought, "she is not my *mother in reality*; she is only my *mother in law*" (that is, according to canon or Church law). But the concept of a spouse's mother needs a word, and eventually the phrase got reanalyzed as that word: "She is my *mother-in-law*." Similar meltdowns occurred in these phrases:

Jack is in the box → That is a *Jack-in-the-box*.
Phyllis completed that hole in one shot → She got a *hole-in-one*.
Barry passed by → He is a *passerby*.
I set aside a spoon full of parsley → I set aside a *spoonful*.

If some speakers still hear the phrase inside the word, they will be tempted to put the plural marker on the head of the phrase: two *mother* + *s in law, Jack* + *s in a box, hole* + *s in one, passer* + *s by, spoon* + *s full*. But if speakers glom the words together in their minds, they will be tempted to put the plural marker at the end: *motherinlaw* + *s*, *jackinthebox* + *es*, *passerby* + *s*, *holeinone* + *s*, *spoonful* + *s*.

It's not that phrase hearers interpret these expressions literally (for example, that a mother-in-law is a mother as recognized by the law), or that the phrase-deaf treat them as any old string of consonants and vowels; both surely recognize them as complex words built out of familiar words. It's just that they grow different kinds of connective tissue when piecing these expressions together. Those who would describe themselves as *sons-in-law* hear *mother* as the head of a phrase inside the word (shown in the left tree in the diagram); those who

would describe themselves as *son-in-laws* hear a string of little words inside the big word (right tree):



A proof that the *in-law* expressions have congealed into words may be found in the umbrella word *in-law*, which can stand alone and be pluralized in the usual way: *The in-laws are coming over*. It is a good bet that many of today's commonly used phrases will also become opaque some day and turn into words; the giveaway will be a plural at the end. Don't be surprised if one day you hear about *grant-in-aids*, *bill of ladings*, or *work of arts*.

This ambiguity—one stretch of sound, two ways of building a tree in the mind—also started the controversy raised by reports such as the following:

> While Mo Vaughn should finish well over .300 with close to 40 home runs and more than 100 RBIs, Mike Piazza has not been producing anywhere close to what he did last season, when he hit .362 with 40 homers and 124 RBIs.[10]

Baseball purists who deplore artificial turf and the designated hitter get equally incensed by the plural form *RBIs*. *RBI* is an acronym for *run batted in*, a run scored by a teammate as a consequence of one's batting the ball. An RBI and then another RBI are two runs batted in, and the acronym for *runs batted in* is just *RBI*—so it should be *124 RBI*, not *124 RBIs*. (The purists are not mollified by the sportscasters' common alternative, *ribbies*.) But the purists fail to recognize that acronyms, like phrases, can turn into bona fide words as a language evolves, as in *TV*, *VCR*, *UFO*, *SOB*, and *PC*. Once an acronym has become a word there is no reason not to treat it as a word, including adding a plural suffix to it. Would anyone really talk about *three JP* (justices of the peace), *five POW* (prisoners of war), or nine *SOB* (sons of bitches)?

An additional puzzle surrounds *governors-general, solicitors-general*, and *attorneys-general*. The speakers who bequeathed the plurals to us must have

analyzed the words as phrases, which have their heads on the left. Indeed, a governor-general is a general governor, namely, one who has several governors under him. The puzzle is, why didn't they simply call him a *general governor*? After all, the adjective comes before the head noun in English, not after it. The answer is that these words, together with many other terms related to government, were borrowed from French when England was ruled by the Normans in the centuries after the invasion of William the Conqueror in 1066. In French, the adjective can come *after* the head noun, as in *États-Unis* (United States) and *chaise longue* (long chair, garbled into the English *chaise lounge*). The earliest citation in the *Oxford English Dictionary* is from 1292: "Tous attorneyz general purrount lever fins et cirrographer" (All general attorneys may levy fines and make legal documents). Anyone who insists that we eternally analyze (hence pluralize) these words as they were analyzed in the minds of the original speakers of Norman French also should insist that we refer to more than one major general as *majors general*, because a *major-general* was once a general major (from the French *major-général*). Long ago our linguistic foreparents forgot the French connection and reanalyzed *general* from a modifying adjective to a modified noun.

So if you are ever challenged for saying *attorney-generals, mother-in-laws, passerbys, RBIs*, or *hole-in-ones*, you can reply, "They are the very model of the modern *major general*." They come from reanalyzing a phrase into a word, a common development in the history of English, and a nice demonstration that we treat stretches of language not as sounds linked directly to meanings but as structured trees. People who put different trees on the same sound will use the sound in different ways, even if the meaning is the same.

Let's now peer into the morphology box. Morphology may be divided into *derivation*—rules that form a new word out of old words, like *duckfeathers* and *unkissable*—and *inflection*—rules that modify a word to fit its role in a sentence, what language teachers call conjugation and declension. The past tense and plural forms are examples of inflection.

English inflection is famous among linguists for being so boring. Other languages exploit the combinatorial power of grammar to generate impressive numbers of forms for each noun and verb. The verb in Spanish or Italian comes in about fifty forms: first, second, and third persons, each singular and plural, each in present, past, and future tenses, each in indicative, subjunctive and conditional moods, plus some imperative, participle, and infinitive forms.

Languages outside the Indo-European family, such as those spoken in Africa or the Americas, can be even more prolific. In the Bantu language Kivunjo, for example, a verb is encrusted with prefixes and suffixes that multiply out to half a million combinations per verb.[11] But English speakers subsist on only four:

open
opens
opened
opening

Strangely enough, English grammar does not have only four roles for verbs to play. It has at least thirteen different roles, but it shares the four forms among them, as if suffixes were expensive and the designers of the language wanted to economize.

The first suffix is a silent bit of nothing, -∅, which when added to the stem *open* turns it into the inflected form *open*. You may wonder: Why say that speakers hallucinate an imaginary suffix at the end of a word? The reason is that it distinguishes the root or stem—the irreducible nugget found in the mental dictionary that captures the essence of a verb and upon which suffixes are hung—from a particular incarnation of that verb with a particular person, number, and tense. In English they can sound the same—*to open* and *I open*—which disguises the fact that they are different versions of the verb. In other languages the form of the verb that you look up in a dictionary cannot be pronounced. For example, in Spanish you can say *canto, cantéis, canten*, and so on, leaving *cant-* as the stem, but you can never say *cant-* by itself. Stems are therefore not the same things as pronounceable verb forms, and that distinction is useful to preserve in English—*to open* versus *open*∅—even though the two forms sometimes sound the same.

The suffix, -∅ is used in four variations of the verb in English:

Present tense, all but third-person singular: I, you, we, they *open* it.
Infinitive: They may *open* it, They tried to *open* it.
Imperative: *Open!*
Subjunctive: They insisted that it *open*.

The suffix *-s* is used for only one purpose:

Present tense, third-person singular: He, she, it *opens* the door.

The suffix -ing is used in at least four ways:

Progressive participle: He is *opening* it.
Present participle: He tried *opening* the door.
Verbal noun (gerund): His incessant *opening* of the boxes.
Verbal adjective: A quietly-*opening* door.

Finally we come to our friend *-ed*, which has four jobs:

Past tense: It *opened*.
Perfect Participle: It has *opened*.
Passive Participle: It was being *opened*.
Verbal adjective: A recently-*opened* box.[12]

Why make all these distinctions among verb forms that sound the same? One reason is that the list of phrases calling for a form such as *opened* have nothing in common: To capture the behavior of *-ed*, we have no choice but to list four phrase types separately. Another reason is that some distinctions that are inaudible for regular verbs are audible for irregular ones, and this shows that English speakers register these distinctions as they speak. About a third of the irregular verbs have different forms for the stem, the past tense, and the perfect participle: *I sing, I sang, I have sung; I eat, I ate, I have eaten*. A few make a further distinction and have a special form for the verbal adjective—*a newly wedded couple; a drunken sailor; a shrunken head; rotten eggs*—which is not used for the participle: people say *They have wed*, not *wedded*; *He has drunk*, not *drunken*; *It has shrunk*, not *shrunken*; *The eggs have rotted*, not *rotten*. And one verb comes in *eight* different forms:

Infinitive; subjunctive; imperative: To *be* or not to *be*; Let it *be*; *Be* prepared.
Present tense, first-person singular: I *am* the walrus.
Present tense, second-person singular, all persons plural: You/we/they *are* family.
Present tense, third-person singular: He/she/it *is* the rock.
Past tense, first- and third-person singular: I/he/she/it *was* born by the river.
Past tense, second-person singular, all persons plural; subjunctive: The way we/you/they *were*; If I *were* a rich man.

Progressive and present participle; gerund: You're *being* silly; It's not easy *being* green; *Being* and Nothingness.
Perfect participle: I've *been* a puppet, a pauper, a pirate, a poet, a pawn and a king.

With nouns, too, different grammatical forms have to dip into the same small pool of suffixes. The naked stem *dog* must be distinguished from the singular *dog* + Ø because a *dogcatcher* doesn't catch just one dog and a *dog lover* doesn't love just one. The *dog* inside these compounds refers to dogs in general and thus differs in meaning from the singular form in *a dog*. The plural *dogs* uses *-s*, which we have already met in the verb system in *She opens the door*. The possessive forms *dog's* (singular) and *dogs'* (plural) use it too; the three noun forms *dogs, dog's,* and *dogs'* differ only in punctuation.

All this redundancy suggests that regular inflection in English is remarkably simple. All the inflections are suffixes; none of the grammatical roles call for a prefix or some other way of decorating or tinkering with a word. And every word has at most one inflectional suffix. We never get *opensed* or *opensing*, nor do the plural *-s* and possessive *'s* stack up when several owners own something: *the dogs' blanket*, not *the dogs's* (dogzez) *blanket*. Finally, each niblet of sound making up a suffix has a life of its own and combines with several verb forms, noun forms, or both, rather than being a slave to only one role. This suggests that instead of crediting English speakers with seventeen verbose rules like "To form the past tense, add *-ed* to the end of the verb," we can credit them with just *one* rule:[13] "A word may be composed of a stem followed by a suffix," like the simple rule shown on page 16. All the other details can be handled by assuming that suffixes are stored in the mental lexicon with entries like those for words, perhaps something like this:

-ed
sound: *d*
part of speech: suffix
use 1: past tense of a verb
use 2: perfect participle of a verb
use 3: passive participle of a verb
use 4: adjective formed from a verb

By factoring seventeen verbose rules into one austere rule and four lexical entries, one per suffix, we not only save ink but get some insight into the men-

tal organization of language. English *could* have used seventeen different forms for its seventeen slots in the noun declension and verb conjugation: prefixes such as *ib-, tra-*, and *ka-*, suffixes such as *-og, -ig*, and *-ab*, and so on. Instead the slots share a few sounds (*-Ø, -ed, -s, -ing*) and one position (immediately following the verb). This miserliness, called syncretism, is found in language after language. Syncretism suggests that the mind keeps separate accounts for the templates that build words (for example, "word = stem + suffix"), for the scraps of sound that may be added to words (*-s, -ed*, and *-ing*), and for the roles these additions can play (for example, plural, participle, imperative).[14] A particular construction like the English past tense is a mix-and-match affair, assembled by hooking together parts also used in other constructions. No one knows why languages like to recycle their suffixes and other ways of modifying words. It's certainly not to save memory space, because the savings are trivial. Perhaps the reason is to help listeners recognize when a word is composed of a stem and a suffix rather than being a simple stem. Whatever its purpose, syncretism shows that in the language system, combination is in the blood; even the tiniest suffixes are combinations of smaller parts.

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Syncretism—one form, several roles—is one kind of violation of the simplest conceivable system in which every sound has one meaning and vice-versa. The other kind of violation—one role, several forms—is rampant in languages as well; linguists call it allomorphy.[15] Take the regular past-tense suffix—or is it suffixes? Though always spelled *-ed*, it is pronounced in three different ways. In *walked*, it is pronounced *t*. In *jogged*, it is pronounced *d*. And in *patted*, it is pronounced *id*, where *i* is a neutral vowel called "schwa." We also find allomorphy in the regular plural: The suffix *-s* has three different forms in *cats, dogs*, and *horses*.

Are there in fact three past-tense suffixes and three plural suffixes? In some languages, we are forced to this messy conclusion. Dutch speakers, for example, select either *-en* or *-s* as the regular plural, depending on the sound of the end of the noun. But in English the three-way variation has a simpler explanation, worked out by the linguists Arnold Zwicky and Alan Prince. *One* past tense suffix is stored in the lexicon, not three, and a separate module fiddles with its pronunciation: the rules of phonology, which define the sound pattern or accent of a language.[16]

Why do we pronounce the past tense suffix as *t* in *walked*, *d* in *jogged*, and ~~*id*~~ in *patted*? The choice is completely predictable, and can be stated as a list of rules:

1. Use ~~*id*~~ if the verb ends in *t* or *d* (for example, in *patted* and *padded*).
2. If it doesn't, use *t* if the verb ends in an unvoiced consonant—that is, a consonant in which the vocal cords don't buzz, namely *p, k, f, s, sh, ch,* and *th* (for example, *tapped, walked, sniffed, passed, bashed, touched,* and *frothed*).
3. Use *d* for all other verbs: those ending in vowels, such as *played* and *glowed*, and those ending in the voiced consonants *l, r, m, n, b, g, v, z, j, zh,* and *th* (for example, *smelled, marred, slammed, planned, scrubbed, pegged, saved, buzzed, urged, camouflaged*, and *bathed*).

This sounds like something out of the tax code. Let's see if we can do better.

The first thing to notice is that nothing in these rules is specific to the past tense. Other constructions that use *-ed* work the same way:

	t	*d*	~~*id*~~
Past tense:	kicked	flogged	patted
Perfect participle:	has kicked	has flogged	has patted
Passive participle:	was kicked	was flogged	was patted
Verbal adjective:	a kicked dog	a flogged horse	a patted cat

Outside the verb system entirely is yet another *-ed* construction that comes in the three variations; it turns a noun that means "X" into an adjective that means "having *X*":

	t	*d*	~~*id*~~
Nominal adjective:	hooked	long-nosed	one-handed
	saber-toothed	horned	talented
	pimple-faced	winged	kindhearted
	foulmouthed	moneyed	warm-blooded
	thick-necked	bad-tempered	bareheaded

The regular plural *-s* also comes in three forms, which you can hear in *hawks*, *dogs*, and *horses*. The variation mirrors the past tense uncannily. Use *ɨz* when the noun ends in a sibilant sound: *s, z, sh, zh, j,* or *ch*. If it doesn't, use *s* if the noun ends in an unvoiced consonant. Use *z* for all other nouns. In fact, not only does this pattern appear with the plural, it appears with the other *-s* suffixes as well:

	s	*z*	*ɨz*
Plural:	hawks	dogs	horses
3rd person singular:	hits	sheds	chooses
Possessive:	Pat's	Fred's	George's

The variation even appears in versions of *-s* that aren't genuine suffixes. English speakers commonly contract the verbs *has*, *is*, and *does* to their final consonant and glue it onto the end of the subject, as in *Mom's left* or *Dad's home*. Sure enough, the contraction is pronounced in three ways, depending on how the noun ends:

	s	*z*	*ɨz*
has:	Pat's eaten.	Fred's eaten.	George's eaten.
is:	Pat's eating.	Fred's eating.	George's eating.
does:	What's he want?	Where's he live?	

That's not all. English has an *affective -s* that can be used to form nicknames in some dialects and argots, as in *Pops*, *Moms*, *Fats*, *Pats*, and *Wills* (the prince second in line to the British throne). That *-s* can also show up in emotionally colored slang such as *bonkers* and *nuts*, similar to the *-y* and *-o* that give us *batty* and *wacko*. (Sometimes the two suffixes are even used together, as in *Patsy*, *Bugsy*, *Mugsy*, *footsie*, *fatso*, and *Ratso*.) Still another version of *-s* appears in adverbial forms such as *unawares, nowadays, besides, backwards, thereabouts*, and *amidships*. A final use for *s* is as a meaningless link joining the words in compounds such as *huntsman, statesman, kinsman, bondsman, Scotsman*, and *grantsmanship*. And yes, all of these *-s*'s can be pronounced either as *s* or as *z*, depending on the preceding consonant (it's hard to come up with examples for the third column):

	s	*z*	*ɨz*
Affective:	Pops, Patsy	Wills, bonkers	

Adverbial:	thereabouts	towards, nowadays
Link in compound:	huntsman	landsman

So we have *fifteen* suffixes that show the same three-way or two-way variation. Forty-one suffixes that happen to fall into fifteen parallel sets of alternatives is too much of a coincidence to stomach. More likely, *one* set of rules creates the three-way variation, and the set applies in at least fifteen situations.

There is a second, equally striking set of coincidences that runs across the suffixes. If the variation came from any old set of *if . . . then* rules, we would expect to find all kinds of pairings between stems and suffixes: for example, "Use *s* after the vowels *a* and *e* or after the consonants *th* and *g*," "Use *d* after a *k*," and so on. But the rules are far more lawful than that. The *t* sound comes after unvoiced consonants, and the *t* itself is unvoiced. The *d* sound comes after voiced sounds, and the *d* itself is voiced. The *-s* suffixes show the same chameleonlike behavior: We find unvoiced *s* after unvoiced consonants, and voiced *z* after voiced consonants. It looks as if something is trying to keep the consonants at the end of a word consistent: All of them are voiced, or all of them are unvoiced.

Indeed, something is—the sound pattern of the English language. English never forces speakers to turn their vocal cords on for one consonant then off for the next, or vice-versa. We see the restriction in force in one-piece words that end in a cluster of consonants. These words never received a suffix; they just happen to be built that way, so any sound pattern they display cannot have come from a suffix rule, but rather from the way English speakers like to pronounce words in general. In all but one of these words, the vocal cord switch can be left in the "off" position:

After *k* (unvoiced):	*s* can occur	*z* cannot occur
	ax, fix, box	—
	t can occur	*d* cannot occur
	act, fact, product	—
After *p* (unvoiced):	*s* can occur	*z* cannot occur
	traipse, lapse, corpse	—
	t can occur	*d* cannot occur
	apt, opt, abrupt	—
After *t* (unvoiced):	*s* can occur	*z* cannot occur
	blitz, kibitz, Potts	—
After *s* (unvoiced):	*t* can occur	*d* cannot occur
	post, ghost, list	—

In one English word, *adze*, the vocal cord switch is left in the "on" position:

After *d* (voiced):	*s* cannot occur	*z* can occur
	—	*adze*

In *no* English word is the voicing switch toggled on and off, in an ending like *zt*, *gs*, *kz*, or *sd*.

These difficult-to-pronounce clusters *can*, however, be created by a dumb rule of morphology that pins a suffix onto the end of a word without regard for how the resulting train of consonants is to be pronounced. That is what happens when a rule adds a *d* sound to *walk* or an *s* sound to *dog*. English cleans up these awkward mismatches with a different kind of rule. The rule says, "When there is a cluster of consonants at the end of a syllable, adjust the voicing setting of the last consonant to make it consistent with its neighbor on the left." (In other words, change *kz* to *ks*, *pd* to *pt*, and so on.) The rule does not care whether the syllable was formed by a past-tense suffix, a plural suffix, a contracted *has*, a nickname with *-s*, or anything else. It kicks in *after* the syllable has been assembled, in the cleanup module we call phonology.

Can we now tell whether the suffix stored in the lexicon is *-d*, and is converted to a *t* when it finds itself at the end of *walk*, or whether it is *-t* and is converted to *d* when it finds itself at the end of *jog*? A little detective work can settle the question. Not every sound cares about the consonant that follows it. Those that do are consonants in which the airstream is obstructed, namely *p, b, t, d, k, g, s, sh, ch, z, zh*, and *th*. But the vowels, and the vowel-like consonants *r, l, n*, and *m*, are indifferent to what comes after them; they tolerate either *s* or *z*, either *t* or *d*, as we see in these one-piece words:

After *n*:	*s* can occur	*z* can also occur
	fence	*lens*
	t can occur	*d* can also occur
	lent	*lend*
After *r*:	*s* can occur	*z* can also occur
	force	*furze*
	t can occur	*d* can also occur
	fort	*ford*
After *l*:	*s* can occur	*z* can also occur
	pulse	*Stolz*
	t can occur	*d* can also occur
	guilt	*guild*

After a vowel:	*s* can occur	*z* can also occur
	niece	*sneeze*
	t can occur	*d* can also occur
	goat	*goad*

Here we have laissez-faire environments in which the suffixes can show their true colors, untouched by rules of phonology. What do we find? That the virgin suffixes are pronounced *-d* and *-z*, not *-t* and *-s*:

After *n*:	we don't say *s*	we say *z*
	—	*grins* (grĭnz), *pins* (pĭnz)
	we don't say *t*	we say *d*
	—	*grinned*
After *r*:	we don't say *s*	we say *z*
	—	*wears* (wĕrz), *cores* (kōrz)
	we don't say *t*	we say *d*
	—	*feared*
After *l*:	we don't say *s*	we say *z*
	—	*calls* (kŏlz), *balls* (bŏlz)
	we don't say *t*	we say *d*
	—	*smiled*, *well-heeled*
After a vowel:	we don't say *s*	we say *z*
	—	*flees* (flēz), *fleas* (flēz)
	we don't say *t*	we say *d*
	—	*flowed*

The *-t* and *-s* we hear in words with choosy sounds such as *walked* and *cats* must be the aftermath of the rule.

Finally, what about the funny extra vowel in *patted* and *horses*? Here again the change in sound is not some random act of vandalism. The vowel appears when *d* follows *t* or *d*, and when *z* follows *s* or *z*. The word endings that trigger the extra vowel are similar in pronunciation to the suffixes themselves, and that can't be a coincidence. Apparently a rule is trying to separate too-similar adjacent consonants by pushing a vowel between them: between *t* and *d*, *d* and *d*, *s* and *z*, *z* and *z*, *sh* and *z*, and so on. In many languages the rules of phonology do *something* when a rule of morphology leaves two identical or near-identical consonants in a row, presumably because there's no natural way to pronounce them. Some languages drop the second consonant, others merge the two into

one long consonant, and still others, like English, wedge a vowel between them. As with the rule that fiddles with voicing, the rule that inserts a vowel must live in a phonology module separate from rules that stick on the various suffixes, because the rule is oblivious to what kind of suffix it manipulates.

We even can deduce which of the two rules applies first, the one that changes the voicing setting or the one that inserts the vowel. The devoicing rule is triggered by adjacent consonants; the vowel rule breaks up adjacent consonants. If the voicing rule came first, it would convert *pat* + *d* to *pat* + *t*, and only then would the vowel be inserted, yielding *pătɨt*:

Morphology: *păt* + *d*
↓
Devoicing: *păt* + *t*
↓
Vowel insertion: *păt* + *ɨ* + *t*

But that is not how we pronounce it; we say *pătɨd*. This means that the vowel rule must have come first, creating *patted*; now the voicing rule is no longer compelled to do anything, because the *td* sequence that would trigger it has been broken up:

Morphology: *păt* + *d*
↓
Vowel insertion: *păt* + *ɨ* + *d*
↓
Devoicing: not triggered

The ordering makes sense when you think about how the phonology module should be organized. It has some rules that edit the string of vowels and consonants composing a word (phonology proper), and other rules that convert the string into actual sounds or muscle movements (phonetics). The vowel-insertion rule makes a major change in the stuff that makes up a word, and belongs in the first subcomponent; the voicing rule does a last-minute adjustment of pronunciation for the benefit of the muscles, and belongs in the second.[17]

This completes the analysis of the three versions of the past-tense suffix. When we started, we needed forty-odd rules, each stipulating that some suffix be placed next to some word ending. We have ended up with just two rules. Best of all, what the rules do, why they do it, and in what order they do it all