THE FIRST WORD

The search for the origins of language

CONTENTS

Index

1. Noam Chomsky

Housed in the modern, gabled, jarringly chrome, brick, and mustard yellow Stata Center at MIT is the Department of Linguistics and Philosophy. Noam Chomsky has had an office in the department for forty-five years. His room is full of shelves with books, five rubbery office plants, and a small table in the center facing a poster of Bertrand Russell. Under Russell's looming face is the quotation: "Three passions, simple but overwhelmingly strong, have governed my life: the longing for love, the search for knowledge, and unbearable pity for the suffering of mankind." Across Chomsky's desk stretch piles and piles of books and unbound manuscripts. They look like a small mountain range.

Prior to an office interview, Chomsky spoke at the 2005 Morris Symposium on the Evolution of Language at Stony Brook, New York. There, his speech seemed flat, almost without affect. He stood at a lectern and read directly from a paper, speaking in such low tones that it was sometimes hard to make out what he was saying. Today, in person, he accompanies his greeting with a puckish grin but is otherwise grave. He takes a seat at the table and sits very still, talking in such a forceful stream that it is virtually impossible to get a word in edgewise. The sense that he cares deeply about what he is saying is unmistakable and compelling.

Chomsky's style of exposition in person is almost exactly the same as in his writings—he takes no prisoners. Depending on whether you disagree or agree with him, you will probably experience his manner as one of airless conviction or the just impatience of a man who knows the truth and is weary of waiting for others to get it. Debating him is a high-stakes venture—he shows little respect for the intelligence of those who don't accept his views.

Chomsky has served as a geographical constant in the minds of generations of scientists and linguists since the early 1960s. It was as if, on the publication of his first book, he thumped down a flag and said, "This is the North Pole," and the rest of the scientific world mapped itself accordingly.

Anyone who has studied language or the mind since then has had to engage at some level with Chomsky's definition of language. Chomsky's signature claim is that all humans share a "universal grammar," otherwise known as UG, a set of rules that can generate the syntax of every human language. This means that apart from the difference in a few mental settings, English and Mohawk, for example, are essentially the same language. Traditionally researchers committed to Chomskyan linguistics believed that universal grammar exists in some part of our brain in a language organ that all humans possess but no other animals have. For Chomsky, syntactic structure is the core of human language, and a decades-long quest for the universal grammar—the linguistic holy grail—has shaped linguistics since he first presented his ideas.

Around the time of the Stony Brook conference, the British magazine *Prospect* published the results of a poll in which Chomsky was voted the world's top intellectual. (He beat Umberto Eco, who took second place, and Richard Dawkins, in third.) Twenty thousand voters, mainly from Britain and the United States, had been canvassed, and a flurry of media about Chomsky had accompanied the poll's announcement. *Prospect* published two articles about the world's top intellectual: a "for" and an "against" Chomsky. On the "for" side Robin Blackburn wrote that Chomsky had transformed an entire field of inquiry and likened him to the child who pointed out that the emperor had no clothes. On the "against" side Oliver Kamm spoke of Chomsky's "dubious arguments leavened with extravagant rhetoric."[1]

This latest burst of attention is merely one of many. Chomsky has been famous in several worlds for a long time. Within the university there are apocryphal Chomsky stories. It's said that graduate students would sometimes come to their meetings with him in pairs, so they could take turns, trying to keep up. His weekly seminars are legendary. Over the decades, they have been attended not just by MIT graduates but also by an ever-changing cast of unfamiliar students, whom none of the regulars knew. Time and again, so the story goes, the outsiders would try to beard the lion in his den, and Chomsky would swat them one by one. By now, it has to have become tiresome.

Until 2002, and in some ways even since then, Chomsky's exact position on the evolution of language was hotly contested, but both sides in the debate would at least agree on this: for many years Chomsky deemed language evolution unworthy of investigation, and given the extraordinary nature of his influence, his pronouncement was as deadening as any formal ban. Now, he has decided, it is feasible to study the topic.

Before Chomsky, most linguists were field linguists, researchers who journeyed into uncharted territory and broke bread with the inhabitants. They had no dictionary or phrase book but learned the local language, working out how verbs connect with objects and subjects, and how all types of meaning are conveyed. They have always been seen as adventurers, but the soul of a field linguist is really that of a botanist. When they transcribe a language for the first time, they create a rigorous catalog of sounds, words, and parts of speech, called the grammar of the language. Once this is completed, they match one catalog to another—finding evidence of family relationships between languages. Grammar writers are meticulous and diligent, arranging and rearranging the specimens of language into a lucid system.[2]

In the early 1950s, Chomsky submitted a grammar of Hebrew for his master's thesis at MIT. At the same time he was also at work on a huge manuscript titled *The Logical Structure of Linguistic Theory,* in which he wrote about grammar in the abstract.[3] Instead of describing an actual language, Chomsky discussed the different ways that a language *can* be described. He submitted one chapter of this effort for his Ph.D. thesis, but it was so different from the way linguists typically thought and worked that many academics who read it didn't really know what to do with it.[4] In 1954 Morris Halle, an MIT professor famous for his work on the sounds of language, wrote to Roman Jakobson, another famous linguist: "I am very impressed with Noam's ability as a linguist; he has a wonderful head on his shoulders, if only he did not want to do all things in the most difficult way possible."[5]

With his next project Chomsky moved even further away from the concerns of his colleagues. After receiving his doctorate, he got a part-time job at the Research Laboratory of Electronics at MIT.[6] He carried on with his work, taught linguistics, and, in order to make enough money, also taught German, French, philosophy, and logic. In 1957 Chomsky published the notes from his first linguistics course as *Syntactic Structures*.

In that book he continued his examination of language in the abstract, discussing the grammars of languages in a wholly new way. Instead of simply being a catalog of all the words and sounds in a language, with instructions for how to put them together, a grammar, he argued, was really a theory of that language.

As a theory, a grammar should be judged in the same way all scientific theories are: it should explain as much as it can with as little as possible. It should be simple and elegant. Viewed this way, possible grammars of a language can be compared in the same way that different theories in science are: the successful one more fully explains the phenomena in question in as economical terms as possible.

Syntactic Structures, for example, contrasted two methods for writing a grammar. The best method, said Chomsky, collapsed all of language into a set of rules. And in much the same way that software generates output in a computer, those rules can generate an entire language. For example, an English sentence can be described as "S goes to NP VP," meaning that a sentence (S) consists of a noun phrase (NP) and a verb phrase (VP). "NP goes to Det N" means that a noun phrase consists of an "a," the determiner (Det), and a noun (N).[7]

Chomsky also pointed out that the set of language rules could be made smaller and simpler if you included ways to relate certain sentences to each other. "The man read the book" and "The book was read by the man," for example, have a striking similarity. Instead of having separate rules for each of them, Chomsky suggested that the more complicated second sentence was derived from the first. He called this a transformation.[8]

If the phrase structure analysis of "The man read the book" is "S goes to NP_1 VP NP_2," then "The book was read by the man" can be represented as "S goes to NP_2 VP by NP_1." In this way, the relationship between all the simple active sentences of English and their passive versions can be described by just these two simple structures and the transformational rule that links them.

Language, in this view, is basically a set of sentences. And the job of a grammar, or theory of language, is to generate all of the language's allowable sentences ("The cat sat on the mat"; "The plane was rocked by turbulence") but none of the bad ones ("Cat mat the on sat"; "Turbulence plane by the rocked was"). A grammar generates all possible utterances of a language, Chomsky said, "in the same way that chemical theory generates all possible compounds."[9]

Syntactic Structures got Chomsky some attention, but at the time of publication it wasn't especially well known. Two years later Chomsky made a much larger splash when he published a review of B. F. Skinner's *Verbal Behavior*. The review appeared in what was at the time the premier journal of linguistics, *Language*. Skinner, a psychologist, was already well known for his theory of behaviorism. In its simplest form, behaviorism says that all animals, humans included, are like machines—if you press their buttons in the right way, they'll respond automatically. The appearance of emotion or thought is irrelevant, because everything can be reduced to behavior. As long as you know what kind of machine you are dealing with—human, feline, avian—you can control its behavior. Even very complicated behavior can be reduced to a series of depressed buttons.

At the time, people spoke about Skinner in the terms they would later use to describe Chomsky. In her book *Animals in Translation,* Temple Grandin wrote about the behaviorist's influence when she was a college student. "Dr. Skinner was so famous," she remembered, "just about every college kid in the country had a copy of *Beyond Freedom and Dignity* on his bookshelf." Of behaviorism she added, "It's probably hard for people to imagine [the power] this idea had back then. It was almost a religion. To me—to lots of people—B. F. Skinner was a god. He was a god of psychology."[10]

Chomsky's review was published two years after Skinner's book came out, oddly late in the day for a book review, even in academia. Nevertheless, it had an immediate impact. Skinner suggested that language was a simple behavior, a notion Chomsky dismissed as absurd. Skinner was used to dealing with lab rats, but pressing a pellet for food is no analogy for producing language. In order to speak, people use great creativity while obeying many complicated rules.

Chomsky argued: "A typical example of stimulus control for Skinner would be the response to a piece of music with the utterance *Mozart* or to a painting with the response *Dutch*. These responses are asserted to be 'under the control of extremely subtle properties' of the physical object or event." But, argued Chomsky, what if we don't say "*Dutch*"? What if we say, "*Clashes with the wallpaper*, *I thought you liked abstract work*, *Never saw it before*, *Tilted*, *Hanging too low*, *Beautiful*, *Hideous*, *Remember our camping trip last summer?* or whatever else might come into our minds when looking at a picture"? People are not controlled by some unknown aspect of a painting, he said. Their response comes from inside them and is facilitated by the infinite creativity of language.[11]

The key idea in Skinner's behaviorism—if you push someone or something in the right way, it will respond in a predictable manner—was called stimulus-response. But when it comes to language, Chomsky said, particularly when children learn language for the first time, stimulus-response is not a relevant model. What is fundamentally interesting about language is the incredible speed with which children learn thousands and thousands of words and the many rules that combine them. In fact, there just isn't enough information in the language children hear in their day-to-day lives for them to divine all the rules that they come to know how to use. Chomsky called this phenomenon "poverty of stimulus." So how do children learn how to speak if language is so incredibly complicated? They must come to the task somehow prepared, he concluded. They must be born with a mental component that helps them learn language.

It was as if Chomsky had delivered unto Skinner and behaviorism a knockout punch.[12] The review garnered enormous amounts of attention from people in all sorts of disciplines. For many academics, this was the moment at which Chomsky seized their attention and would hold them riveted from then on.

The young professor was propelled into the limelight, and even though his review was widely criticized as glib, biting, and angry, it was these very qualities that seemed to thrill people. As much a polemic as a review, the article was described as "devastating," "electric," and a superb job of "constructive destruction." Chomsky the linguistic freedom fighter was born.[13]

Skinner responded that Chomsky hadn't understood what he was saying, that in some respects it seemed that Chomsky had intentionally misinterpreted him, but the damage was done. From that point on, the obvious influence of behaviorism seemed to fade.

It took a few years for the impact of Chomsky's first book to be felt, but by 1964 Charles Hockett, one of the most eminent

linguists of the time, described *Syntactic Structures* as among the field's few "major breakthroughs."[14] Howard Maclay wrote: "The extraordinary and traumatic impact of the publication of *Syntactic Structures* by Noam Chomsky in 1957 can hardly be appreciated by one who did not live through this upheaval."[15] Ray Jackendoff remembers that in 1965, when he began his graduate studies (with Chomsky), "generative linguistics was the toast of the intellectual world."[16] Daniel Dennett, the well-known philosophy professor at Tufts, wrote in *Darwin's Dangerous Idea* that he could "vividly remember the shockwave that rolled through philosophy when Chomsky's work first came to our attention."[17] Looking back, Chris Knight of the University of East London wrote that Chomsky may as well have thrown a bomb.[18]

In less than a decade, people were proclaiming a psycholinguistic revolution.[19] Many young scholars flocked to MIT to work with Chomsky on his new generative linguistics, and in many other universities researchers began to search for the mental component containing the basic, innate generative rules of language with which children are born.

Chomsky's theory was expanded and his reputation solidified with *Aspects of the Theory of Syntax,* published in 1965. A slim but extremely difficult book, *Aspects* further explained key Chomskyan concepts like deep structure and surface structure, and has since become a classic text.

All the ideas in *Aspects* rest on the notion that language can be divided into, on the one hand, everything that goes along with actually speaking in a given situation and, on the other, all that is stable and universal. Chomsky called this the difference between competence and performance. Competence, which includes syntax (a perfect, mathematical system), is the innate basis of language and is the same from speaker to speaker. Performance includes whatever is individual or context-specific in language: the myriad differences in the way we pronounce "ketchup," the use of gesture, the "ums" and the "ahs."

Even though he imagined an idealized speaker and hearer as the subjects of his research, language in the Chomskyan sense had little to do with the fact that it overwhelmingly takes place between people. For the Chomskyan linguist, to study what was interesting about language was to discard any variation, the way any given speaker actually speaks, and to focus instead on the skeleton that remains.

The role of the language specialist was fundamentally changed by these ideas. Linguists were no longer mere catalogers but scholars who were perfectly positioned to unearth the deepest mysteries of their subject. What mattered about a language was not that it came from a particular region like the plains of the Midwest, the villages of Mexico, or the beaches of Asia but that it came from our heads. With generative linguistics, the terrain that the linguist explored shifted from the corners of the planet to the depths of the human mind. Universal grammar specified every rule for every language, and that controlled a child's ability to develop the correct rules of syntax of each language. It was believed in the early days that universal grammar, or the language organ, was hardwired into people's brains. Anyone born with UG, which is to say everyone, was born with the potential to learn any language.

Even though searching for the universal principles of language was hugely different from the way scholars had previously thought about language, early generative linguistics still divided language in the brain in much the same way that linguists of the 1950s had divided languages in the field. Field linguists wrote a grammar by analyzing its structure, sound, and meaning in separate sections. They also believed that when you were learning a language from scratch and assembling its grammar, you should keep these parts of language completely separate—you should never mix levels.

Generative linguists began to divide language in the brain in the same way. They looked for evidence of a module that controlled syntax, a module that controlled meaning, and a module that processed sound. It was thought that these modules were independent of one another and that language was produced by a coarse-grained interaction between them. Additionally, the separate systems of language had their own subsystems. For example, the syntactic module was made up of a set of smaller modules, each dealing with a different part of syntax, each autonomous.

In this model, when someone heard speech, the separate modules divided up the signal. The syntactic module extracted from the sound wave all the information regarding syntax, the intonation module analyzed all the pitch variation, and so on. Once each module had sufficiently analyzed the component for which it was responsible, the brain put them all back together as language. One implication of this theory is that when you heard someone else speak, the grammar part of your brain somehow extracted the grammatical information from the sound waves but ignored any other information in those waves that might help interpret it.

The workings of the language organ were also thought to be completely separate from other parts of the brain. They were separate from the context of spoken language, and they were also completely different from similar systems, like music. Gesture was peripheral and uninteresting. Moreover, human language was entirely distinct from the communication that takes place between other animals. This model of language was consistent with general theories at the time about how the brain functioned—namely, as a series of separate boxes, each of which computes different parts of the world.

Critics said the model was merely a new version of phrenology, a nineteenth-century "science" that held that for every tendency in an individual, there was a corresponding spot on the brain that controlled it. The brain would bulge or recede in these areas, depending on how developed a given trait was. (Phrenologists even believed that the skull would echo the shape of the brain, so that a person's character could be read by the bumps and pits of his or her head. For example, someone with a great deal of self-esteem would have a big bump right at the top and back of her head. Phrenology is now the iconic example of silly science.)

The Chomskyan deconstruction of language was, on the one hand, counterintuitive. The average person who hadn't taken a university course in linguistics and been rigorously trained to force these elements of language apart would probably consider context crucial to understanding language. He would count intonation as important, and he would be unlikely to completely separate structure from meaning.

Yet Chomsky's approach satisfied another kind of intuition: to divide an object into its essential and incidental parts. With language, generative linguists tried to strip away everything peripheral, anything that *could* be stripped. The hope was to expose the bare bones, discover what was indivisible, and unearth the core.

Another key insight that Chomsky brought to language studies was the infinitude of language. While so much of language is rote, consisting of things that you have heard before, you don't have to go far to find words assembled in a way you've never

heard them put together. Chomsky described this as the infinite use of finite means, calling it "discrete infinity."

With discrete infinity, "Kate read the book that Bill wrote" can be embedded in "Ally saw," becoming "Ally saw that Kate read the book that Bill wrote." It can be further embedded into something like "Andrew explained how Ally saw that Kate read the book that Bill wrote," and so on, ad infinitum.

Ten years after *Syntactic Structures* was published and two years after *Aspects,* most papers presented at the 1967 meeting of the Linguistic Society of America discussed Chomsky's transformations.[20] A few years later Chomsky's growing reputation within linguistics and philosophy had spread into many other fields. In 1970 a Chomsky monograph was published in the Viking Press Modern Masters series, putting him in the company of Einstein and Freud.

Of course, Chomsky had detractors at this time as well, and the louder his supporters became, the more his critics grew in number. In 1967 Charles Hockett, who had just three years earlier hailed Chomsky's genius, called him a "neo-medieval philosopher." Another prominent linguist, George Trager, described him a year later as "the leader of [a] cult…with evil side-effects."[21]

Chomsky's skirmish with B.F. Skinner turned out to be merely the first in a long line of infamous, bitter conflicts. The next took place in the late 1960s and early 1970s, when a group of linguists calling themselves generative semanticists argued that separating language from the way it was used was ridiculous.[22] This group believed that the most fundamental organizing principle of language was its meaning (semantics), not the way it was structured (syntax), as Chomsky's transformational theorists believed.

The generative semanticists defined themselves in opposition to the Chomskyan juggernaut, and as Randy Allen Harris (the main historian of this period) recounted it, that opposition took on all the flavor of the 1960s counterculture—irreverent, exuberant, and combative. Their criticisms of Chomsky extended from the way that he divided up language to his ascetic style. One running joke of the era was inventing a title for the world's shortest book, like *"Problems of the Obese" by Twiggy*; a popular candidate among linguists was *The Bawdy Humor of Noam Chomsky*.[23] In turn, the generative semanticists were caricatured as unthinking followers of a fad. Chomsky repeatedly insisted that they didn't actually understand the theories with which they took issue.

There is a clear pattern in these different conflicts. Again and again, Chomsky's critics claimed that he chose data to support his theories but then discarded it when it no longer suited, and that he intentionally misinterpreted his adversaries and then launched an attack against his own misunderstanding. People also accused him of abandoning ideas that he once promoted without acknowledging that he had changed his position. Another complaint was about the way Chomsky dealt with counterevidence to his theories, most of which he insisted could be simply disregarded.

When Chomsky put forth his ideas, he typically dictated the terms with which people could reasonably disagree with him. Academics objected to the fact that he laid out his argument and the rules for argumentation at the same time. For instance, he said, "Counterexamples to a grammatical rule are of interest only if they lead to the construction of a new grammar of even greater generality or if they show some underlying principle is fallacious or misformulated."[24] That is, critics could not simply point out that something didn't work; they had to come up with a new theory in its place that did.

As relentless as the expansion of Chomsky's vision seemed to be, it deflated unexpectedly in the 1970s. Part of the appeal of generative linguistics was the way it rendered sentence analysis into mathematical-looking algorithms. Rules like "S goes to NP VP" gave language study a scientific veneer. It turned out, however, that this was not what actually happened in the brain as it processed language.

If deep structures really existed, it was reasoned at the time, you'd expect people to take longer to understand the more complicated, transformed structure of a given sentence than its simpler basic form. But when psycholinguists tested this in experiments, it did not pan out: the derived sentence took the same amount of time as the basic sentence.

Soon the voices that had criticized Chomskyan linguistics from the beginning grew to a din. As researchers found that the notion of an innate language organ was not supported by real-world evidence, they became interested instead in the idea of general foundations for language and thought. Even the popular press ran articles about the Chomskyan revolution and declared it over.[25]

For his part, Chomsky continued to dismiss objections to generative linguistics as being either uninteresting or not serious, and to assert that he had been misunderstood. And indeed, the history of modern linguistics is densely populated by straw men who look a lot like Noam Chomsky.

He was regularly accused of making statements that he had not. When he was charged with changing his mind or abandoning ideas that he once championed, he explained that he hadn't changed his mind but that he meant something else all along. While careful rereading of Chomsky's writing often bears out his claims, his great influence often worked against him. Chomsky's casual hunches and suppositions were often treated—and debated—as though he had made a fully defended argument.[26]

Certainly, Chomsky's terminology changed considerably over the years, and this must have contributed to his being misunderstood. In 1972 he referred to his developing ideas about language and the mind as the standard theory. In 1977 the standard theory became the extended standard theory, and later it became the revised extended standard theory. In the early 1980s Chomskyan linguistics was called principles and parameters theory, and then later government-binding theory. Over time, transformations were transformed into T-markers; phrase structure representations became P-markers. Instead of deep structure, surface structure, and logical form, linguists had D-structure, S-structure, and LF. Theta-theory described the assignment of roles like agent to noun phrases.

Some of the name changes marked big shifts in ideas. For example, in the earliest theories of UG, children were born with innate, very specific rules for languages. In the principles and parameters theory, children are born with a finite set of parameters for language that their experience of a particular language then modifies. So the differences in the syntax of

different languages can be reduced to this collection of settings. Overall, though the many shifts make it hard to imagine that more than a few syntacticians can really track all the distinctions between them, a vision of language has remained consistent for all this time. Chomsky emphasized repeatedly both the complex nature of language and the fact that the human brain was especially designed to acquire and to implement it. As he wrote in 1975: "A human language is a system of remarkable complexity. To come to know a human language would be an extraordinary achievement for a creature not specifically designed to accomplish this task. A normal child acquires this knowledge on relatively slight exposure and without specific training. He can then quite effortlessly make use of an intricate structure of specific rules and guiding principles to convey his thoughts and feelings to others, arousing in them novel ideas and subtle perceptions and judgments.[27]

Declaring the revolution over turned out to be premature, and the downturn in the fortunes of generative linguistics was merely a blip. Just a few years after Chomskyan linguistics was supposed to be over, barely anyone remembered that it had been in peril. People continued to wax superlative at the mention of Chomsky's name, and comparisons to the great men of intellectual history kept rolling out: He was the Newton, the Einstein, of language. He was an intellectual colossus, a special kind of genius that made the merely normal geniuses look dim-witted. Not only did Chomsky's influence reassert itself, but in 1980 Charles Hockett complained of his "eclipsing stance." By now people didn't just think Chomsky's ideas were the most important thing in linguistics; they had begun to believe that nothing important had ever happened before Chomsky.

Writing about the many problems for Chomskyan theory in the 1980s that were simply ignored, the linguist and historian Peter Matthews likened the advance of generative linguistics in that period to the German army's march across France in World War II. (After World War I, the French built a huge fortification on the French-German border called the Maginot Line. When the Germans invaded France in World War II, they basically went around the fortification by going through Belgium, and from there they entered France unimpeded.)[28] Students continued to be attracted to Chomsky's work. One way of measuring the power of an academic is to count his intellectual children, the students he influences who leave the university, get jobs on other campuses and in other countries, and continue to teach the ideas of the teacher. These students' students become teachers and in turn influence their students. In this way, an academic lineage is created. Chomsky has been a prolific father; his heirs have gone forth and multiplied. The 1988 four-volume Cambridge survey of linguistics describes, for the most part, Chomskyan linguistics.

Says Steven Pinker, "The bulk of modern linguistic work has dealt with problems or phenomena that Chomsky noted." Still, even though Chomsky has had a powerful influence on other sciences, they have had a notorious lack of influence on him. All theories of language evolution in the last decade, as well as most ideas about language and the brain, are usually characterized as for or against him.

It's ironic that Chomsky, who began his career striking a blow against totalitarian ideas in the form of Skinner and who also happens to be one of the best-known radical-left figures in politics, is now himself a figure of totemic power. For decades, his name appeared in the synopses of conferences, the papers of students, and the articles of academics with all the frequency and duty that portraits of the leader appear in the classrooms of third-world dictatorships.[29]

How does one man inspire both blistering rage and religious devotion? There is little evidence to suggest that Chomsky has sought to create the sociological marvel that is his career. Academics who are familiar with him will—without exception—describe the way he insists that he is a minor figure with little real influence.

It is Chomsky's legend rather than any rationale that he advanced that stifled language evolution research during the latter half of the twentieth century. His public comments on the topic have mostly been cryptic. In his book *Language and Mind* he wrote, "It is perfectly safe to attribute this development [of innate mental structure] to 'natural selection,' so long as we realize that there is no substance to this assertion, that it amounts to nothing more than a belief that there is some naturalistic explanation for these phenomena."[30]

In the same book, Chomsky went on to wonder how many possible alternatives to transformational, generative grammar exist for an animal that evolved in the way humans did. Perhaps none exist, or only a few. If this were the case, he said, "talk about the evolution of language capacity is beside the point."[31]

In the 1980s Chomsky acknowledged that language must have given us some kind of evolutionary advantage but its origins were more likely to have been accidental than the result of slow evolutionary change. "We have no idea, at present," he said, "how physical laws apply when neurons are placed in an object the size of a basketball, under the special conditions that arose during human evolution."[32]

Certainly no one knew whether language was a function more of physics than of behavior or biology. Instead of resulting from adaptation and selection, language may have arisen as a by-product of a very complex mental machine. But at the time, few people engaged in any meaningful way with the idea. As a result, when confronted with this kind of Chomskyan koan, almost no one took the question of adaptation any further.[33]

Having stripped away all of the untidy bits of language as "performance," Chomsky defined language as an idealized, perfect, and elegant system. The brain, on the other hand, he said, was messy. How did something so messy develop something so perfect? It was a mystery, he said, one that was, for the time being, insoluble.

If it were true that language was perfect and that it simply emerged from our highly complex mental organization, Chomsky has also said, such a development does not make much sense with what we know about physical systems. Biology just doesn't work like that. Indeed, biological evolution is a haphazard, junkyard kind of process where traits are not intelligently designed from scratch, but rather, new tools are built over old ones. This conundrum was, in Chomsky's view, a problem for biology, not for linguistics. "What followed in theories of language acquisition," said A. Charles Catania, a professor of psychology at the University of Maryland, Baltimore County, "was closer to creationism than any other part of psychological research."

So, while Chomsky did publicly discuss the utility of language, whenever he mentioned evolutionary theory, it was mostly to discourage its value as a solution to the origins of language. He said, reasonably enough, that you can't assume that all traits are selected for. In one of his most concrete statements on the topic, he wondered aloud whether a genetic mutation might have been responsible for the property of discrete infinity, which he considered fundamental to language.

As far back as 1973 critics had complained that "the notion advanced by Chomsky among others, that a language system could have come into existence suddenly, as the result of a 'mutation,' seems simplistic and hardly more plausible than the idea that language is a gift of the gods."[34] Yet Chomsky in no sense advanced this argument; he merely suggested it. His most

damning evaluation of the idea that language was an adaptation was that it was “hard to imagine a course of selection that could have resulted in language.”

Such was his eminence that when Chomsky said things like it’s “hard to imagine,” it was taken to be a truth about the intractable nature of the problem rather than the limits of imagination. It is a testament to his rhetorical skills and the depth of his influence that a strong case could be so widely inferred from his highly qualified statements on the topic.

Against the backdrop of Chomsky’s rather pointed lack of interest, the problem of language evolution remained for most of the twentieth century the domain of the occasional crackpot and a few brilliant and determined mavericks. Sue Savage-Rumbaugh belongs to the second group. While the consensus in linguistics and most of psychology was that language was a monolithic trait that only humans possessed, Sue Savage-Rumbaugh was busy trying to teach another species how to use it.

2. Sue Savage-Rumbaugh

It's no exaggeration to say that Chomsky entered the academic scene with a crash, announcing his interests in such a compelling way that generations of scholars fell into lockstep with him. Yet despite his dominance, islands of research have sprung up independent of his school of thought. For the last few decades, ape language research has been one such island.

Social, affectionate, emotional, and smart, apes need other apes, just as humans need other humans. This seems obvious enough in the twenty-first century, but it is relatively recent knowledge, the fruit of painstaking observation by primatologists like Jane Goodall.[1] The notion that human intelligence was a unique phenomenon started to break down in a very small way with the birth of primatology. The field's findings have become so ingrained in popular consciousness that it's now very hard to believe that as recently as fifty years ago we knew virtually nothing about apes and other primates. The years that Goodall and her colleagues spent patiently watching them in the wild yielded powerful insights, not just into the lives of other primates but also into how like them we are.

Robert Sapolsky, a longtime observer of baboons (which are in the monkey family and therefore more distantly related to humans than apes are), draws attention to the similarity of our emotional and cognitive lives in his description of a mother baboon's mishap:

> One day, as she leapt from one branch to another in a tree with the kid in that precarious position, he lost his grip and dropped ten feet to the ground. We various primates observing proved our close kinship, proved how we probably utilized the exact same number of synapses in our brains in watching and responding to this event, by doing exactly the same thing in unison. Five female baboons in the tree and this one human all gasped as one. And then fell silent, eyes trained on the kid. A moment passed, he righted himself, looked up in the tree at his mother, and then scampered off after some nearby friends. And as a chorus, we all started clucking to each other in relief.[2]

The intelligence, the shared attention, and the intense sociability that Sapolsky noted cannot help but remind us of our own species. Such similarities, according to Darwin, were likely inherited from a common ancestor. Indeed, he argued that the traits we have in common with a closely related species are a matter of shared inheritance rather than independent, parallel evolution. So if we want to look at early stages of linguistic development, it makes sense to examine our tree-dwelling and generally less-inhibited cousins.

Sue Savage-Rumbaugh's name may not be as familiar as Noam Chomsky's, but her place in history is assured. She is the researcher who has most successfully bridged the species gap by teaching an ape to produce and understand aspects of language. She and her colleague Duane Rumbaugh take raw material like a chimpanzee or bonobo, with its familiar neural architecture, and see to what extent they can bypass a few million years of evolution.

Before Savage-Rumbaugh began work with Kanzi, a bonobo, other ape studies had successfully taught chimpanzees to comprehend language. The problem was, as Savage-Rumbaugh pointed out, that even though creatures like Washoe could successfully use language to request food or obtain other objects of desire, they weren't any good at taking on the other role in the communication process. For Washoe, Sarah, and Lana, the first generation of language-trained apes, wrote Savage-Rumbaugh, language was a one-way street. It only functioned as a tool for getting what they wanted; there was no listening.

One of the first and most important discoveries for ape language research (ALR) was that trying to teach language directly was not the way to go about it. ALR, which began in the 1970s, made an evolutionary leap when Savage-Rumbaugh realized that apes were best taught indirectly rather than explicitly. Savage-Rumbaugh had been trying to teach language to Kanzi's mother, Matata, for a number of years. During this time, Kanzi had simply observed the two in their lessons. On the first day that Savage-Rumbaugh turned her attention specifically to Kanzi, he spontaneously used the picture keyboard to combine symbols and communicate to her what he wanted her to do and what he wanted to do next. Kanzi had been learning language all along. "I was in a state of disbelief," wrote Savage-Rumbaugh.[3] (The same process applies for human children. Even though they typically receive some explicit instruction, such as leafing through a picture book with a parent and associating animals with their names, children primarily acquire language by hearing it around them and by interacting with creatures who speak.)

Thereafter, instead of being formally instructed in the value and use of a language system (imagine trying to introduce the concept of verb tense to a classroom of apes), the bonobos were raised in a language-rich environment. While Washoe had never learned a sign without being taught with hundreds and hundreds of repetitions, Kanzi, and soon another bonobo called Panbanisha, picked up words by being regularly spoken to during feeding, playing, and grooming; having symbols on the picture keyboard pointed out to them with the spoken word; and even watching television. Such activities were all that was required to outfit Kanzi and Panbanisha with some language skills.

Over many years, these two apes learned how to manipulate keyboards that contained visual images, of milk or a dog, say, instead of letters. They also learned how to comprehend spoken English, coming to understand hundreds of single words and longer constructions. (Unlike other experiments in which monkeys perform for food rewards, these apes have free access to food all day.) Kanzi and Panbanisha are able to participate in two-, three-, and four-way conversations. They can converse about objects as well as intentions and actions, and state of mind. Testing has shown that Kanzi in particular is capable of correctly understanding hundreds of sentences that he's never heard before, sentences like "Show me the ball," "Get me the snake picture," and "Can I tickle your butt?"

As well as developing comprehension abilities at the level of a three-to-four-year-old child, the bonobos demonstrate creativity in their manipulation of language. They spontaneously combine single words they already know to create new words, like linking "water" and "bird" as "waterbird" to mean a duck. They've also been known to make up sentences in response to novel situations. The ape Sherman, who was raised in a different experiment, once rushed into his lab in order to tell the scientists inside, "Scare outdoors." Sherman had just seen a partially anesthetized ape being carried past in a stretcher.

Still, sometimes even the cleverest primates have difficulty with comprehension. At the March 2002 Evolution of Language conference at Harvard, Heidi Lyn, who was working at the time in the Language Research Center at Georgia State University, recounted what happened the day that Savage-Rumbaugh told Kanzi to put water on a carrot. The ape threw the carrot outdoors. Thinking he had misunderstood, Savage-Rumbaugh repeated the request. In response, Kanzi pointed vigorously

outside. It was raining.

Lyn is now at the University of St. Andrews in Scotland, where she is involved in a dolphin research project. She is also writing a book that brings together the findings from all of the animal language studies. She has worked with Kanzi, with language-trained dolphins under Lou Herman in Hawaii, and with Diana Reiss in New York on a dolphin keyboard project. The earliest animal language experiments, Lyn explained in an interview, began in the 1890s, with documented cases of people raising apes in human homes, and in some instances raising them side by side with human children. It wasn't until the 1960s through the late 1970s, however, that scientific animal language research really boomed.

The early attempts to get apes to communicate like humans were failures, primarily because researchers were trying to induce apes to talk. This focus changed when Allan and Beatrix Gardner, a husband-and-wife team at the University of Nevada in Reno, perceived that apes seemed to find gesture easier than vocal communication. The Gardners reared Washoe, a female chimpanzee, in their home, teaching her a modified version of American Sign Language. Washoe was extremely successful and learned hundreds of different symbols. She was rigorously tested again and again, and her learning stood up. In 1972 Penny Patterson, a Stanford Ph.D. in developmental psychology, began her lifelong experiments teaching sign to Koko the gorilla. Duane Rumbaugh also began to work with the chimpanzees Lana, Sherman, and Austin, seeing how well they could communicate with picture symbols, called lexigrams. There was enormous interest in this work and many interesting results, said Lyn.

In the 1970s a young academic named Herb Terrace heard about the Washoe work. He was excited by the results and wanted to replicate them, so he obtained a chimpanzee and called him Nim Chimpsky. Terrace followed the Gardners' work closely, although he had many more people interact with Nim than had ever interacted with Washoe. Initially, it looked as if he had successfully taught Nim to use words and some syntax. But when he did a frame-by-frame video analysis, he realized that what Nim was doing was less symbolic than imitative: Nim wasn't using language independently but instead responding to cues that Terrace or other caretakers were giving him. At the same time Terrace also did a video analysis of Washoe and Koko and concluded they, too, were being inadvertently cued by their handlers and neither thinking nor communicating. He published the results of his investigation in the journal *Science* in 1979.

The damage from Terrace's findings was immediate and devastating. His article was picked up by the press, and a popular and scientific consensus quickly developed that the apes weren't doing anything their caretakers hadn't cued them to do. Funding for animal language research very rapidly dried up. The Gardners were effectively shut down, and one of their graduate students, Roger Fouts, took over and was for a long time only able to maintain but not expand the Washoe project.

From that point on, said Lyn, it became very hard to get any animal language data published. After the Nim Chimpsky publication, Lou Herman started his studies with the dolphins Akeakamai and Phoenix, using an artificial language and focusing on comprehension (his funding for the project was secured before 1979). The fact that he was concerned with comprehension, rather than production of language, was probably what saved his work, said Lyn. People found it easier to consider the possibility of animals' understanding versus producing language. Still, Herman didn't publish his first paper until 1984. As soon as the paper came out, he was criticized intensely for using linguistic terms like "sentence," and "noun," and "verb" to describe what the dolphins were doing. That response was unjustified, said Lyn. In fact, she said, Herman has the best data on syntax for any animal, anywhere. Akeakamai and Phoenix have mastered a complex grammatical system. If Herman gives the dolphins nongrammatical sentences, they will either refuse them or make grammatical sentences out of them.

A year after Terrace's *Science* article was published, Martin Gardner reviewed a number of books about animal language training in the *New York Review of Books*. He began by tracing a direct line from crackpot claims that dolphins communicated through ESP to ape language research. His first pass at evaluating Penny Patterson's work with Koko and the attention it received had more to do with Patterson herself than with her science. "It is not hard to understand why Penny—young, pretty, with long blond hair—has received such enormous publicity," he wrote. "What could be more dramatic than color photographs of Beauty and the Beast, heads together, raptly chattering to one another?"

It is hard to understand how comments like Gardner's become part of the debate: the same would never have happened had the scholar in question been, say, Chomsky, who has likely never had his physical appearance assessed in reference to his work and its public appeal or been called "Noam" in similar circumstances.

Apes might have a "feeble talent" for putting together signs in meaningful ways, but it was more likely, Gardner concluded, that ape language research amounted to little more than an unconscious collusion between a cooperative animal and a hopeful human. As he wrote: "There is no solid evidence that an ape has ever invented a composite sign by understanding its parts. In the course of several years an ape will put together signs in thousands of random ways. It would be surprising if it did not frequently hit on happy combinations that would elicit an immediate Clever Hans response." (Clever Hans was a famous horse who could allegedly perform mathematical computation. He would indicate the answer to a problem by pawing at the ground the correct number of times. A 1907 study showed that Hans's owner gave him subtle and unconscious cues when to stop pawing at the ground.)[4]

Terrace did make some important contributions, explained Lyn, by pointing out that there had been no scientific controls in the studies assessing the apes' syntactic ability. Mostly, the claims for syntax were based on naturalistic observations and had not been rigorously tested. But because Terrace found instances of cuing, the scientific community and the public decided that all of the behavior was cued. There were, in fact, numerous examples of solid, double-blind experiments, such as one where Washoe was placed alone in a room. A camera was trained on her, and pictures were flashed up on a screen before her. The chimpanzee made the signs for every object in the pictures, and because she was by herself, cuing was impossible.

Luckily for Savage-Rumbaugh, her funding had been renewed for five years just before the Terrace article appeared. She spent those years producing valuable findings. For example, Kanzi and Panbanisha have spent time with other apes in different experimental situations. For a while, they were raised with another bonobo, Tamuli. But while Kanzi and Panbanisha were exposed to language from the time they were just a few weeks old, Tamuli's exposure began much later in life. She was

initially reared by her mother, but at three and a half years of age she was allowed to accompany Kanzi and Panbanisha in their daily activities, like taking trips to the forest. Kanzi and Panbanisha's human caretakers also spoke to Tamuli while pointing at the picture keyboard and describing their daily activities.

Tamuli never developed language skills comparable to those of the other apes. In this respect she is like human children who, for whatever reason (for example, undiagnosed deafness or abuse), are not exposed to language at an early age. There is a crucial learning period for humans when they must be exposed to language. Even if they are neurologically normal, they will never fully acquire language if its foundations are not laid in this early period of brain development. Genie, the most famous of these cases, was kept locked in a room, denied normal human communication, and never taught language, and by the time she was rescued, she was unable to acquire much more than basic language skills. Her experience shows that if you are denied language, you don't spontaneously produce it. Since Genie's case was studied, it has become fairly well established that language is not innate in the same way as, say, our instinct to breathe or cry. Tamuli's experience suggests that apes have a similar window of opportunity.

Even though Tamuli could not relate at the sophisticated level that Kanzi and Panbanisha did, she at least seemed to understand that the keyboard was intended for communication. While the apes often tried to use it to relay messages, Tamuli's usage was a bit like that of a young child banging away on a piano or a keyboard. She made no sense.

One thing that Tamuli lacked was the ability to recognize that her interlocutors had separate minds and that communication with them could alter their perceptions. Kanzi and Panbanisha, on the other hand, seemed to have acquired a theory of mind along with language. When Panbanisha saw her trainer remove candy from a box, replace it with a bug, and then give the box —supposedly still with candy—to Kanzi, she called her "bad." The chimp demonstrated that she could understand what was going on in her trainer's mind independent of the reality and apply language to the situation. She herself scared Kanzi when she used language to tell him there was a snake nearby, when in fact there was no snake. Panbanisha used language to manipulate the contents of Kanzi's mind, just as her trainer had manipulated the contents of the box.

The ape experiments indicate how memory is a vital component of language use, even at this rudimentary level. A chimpanzee, Panpanzee, who was raised with Kanzi and Panbanisha, would sometimes make language mistakes that demonstrated a limited memory, such as when she was asked to put a sweet potato in the microwave. Typically in an experiment like this, an object, like the potato, would be made readily available for Panpanzee, placed right before her eyes. But in this example, the chimpanzee had to retrieve one from the refrigerator in order to complete the request. This she did. But instead of putting the vegetable in the microwave, she took it to the sink and proceeded to wash it. Somewhere between the retrieval process and the end task, the request became scrambled for the chimp. In similar situations, Panpanzee's incorrect response suggested she was falling back on her knowledge of routines, rather than correctly remembering a novel request (something people occasionally find themselves doing as well).

Sometimes language mistakes can be as useful as correct responses. Eliciting errors in human speech is one of the main methods that psycholinguists use to expose the mental strategies that underpin language use. Spoonerisms, for example, aren't just sound swaps: "pea tot" (teapot), "dood gog" (good dog), and "band hag" (handbag) suggest that speech is not entirely spontaneous. If a speaker accidentally begins a word with the first sound of the next word, he must be planning what he is about to say, even if he is not aware of it.

Lyn analyzed eleven years' worth of Kanzi's and Panbanisha's language error data and found that when the apes accidentally pressed one keyboard picture instead of another, or when they misunderstood a spoken word, their errors usually revealed an underlying connection between the intended word and the mistaken one. Just like humans, the apes made category substitutions, like mistaking colors, such as red for black. They made word association errors, confusing the names of locations with items that were found in those locations. And they made phonological (sound) errors, like using a word because it rhymed with the intended word.

Lyn and colleagues found that Panbanisha and Panpanzee have more symbol ordering rules in common with each other than with their caretaker. It's possible, even probable, that the last common ancestor between these apes and humans had the ability to understand meaning-based ordering strategies. Lyn also found that these apes have a gesture-last rule: they always touch the lexigram, and then gesture in the real world.

Bonobos acquire language up to the level of human children. For example, they can understand sentences that contain one verb and a three-noun phrase ("Will you carry the M&M's to the middle test room?"), but they have trouble with conjoined sentences that require two separate actions ("Bring me the ball and the orange"). They do not speak English words, though they attempt to do so. Their short-term memory seems to be only half the capacity of human children's, so they are not as good at imitating a series of utterances without a lot of repetition.[5] The more complicated syntax gets, the more trouble they have with it.

The ape language research led Savage-Rumbaugh and her colleagues to conclude that language consists of "a large number of component parts and interacting functions."[6] Even though their work has not had the impact of Chomsky's, most researchers in language evolution would today think about language in these terms.

What's most striking about the older criticism of ape language research is its basic attitude, which is more motivated to discredit than evaluate. In much ALR commentary, there is a strong sense that the critics have already made up their minds before arguing or offering reasons why ape language couldn't work. There are claims of falsifying data and even of people being out to get each other. In the 1980s the debate was rarely conducted without tones of disdain and contempt.

Even now, scholars who work with animal language are often characterized as daft idealists or outright frauds, believing that beneath the fur or behind the beak are creatures with souls. Yet if you speak to these researchers, you won't find anyone downplaying the enormous differences between humans and other animals, despite the fact that they happen to be interested in the commonalities.

One legacy of the Terrace paper has been an ongoing difficulty getting funding for this kind of work. Researchers often have to go outside the typical funding bodies of academia to keep their studies going, turning to special interest groups and private individuals. The promotional literature for the Koko research mentions visits from Sting and Robin Williams, for example, a

gambit that gives animal language research a weird profile. Such marketing gives the impression that it is not solid, straightforward science.

Still, the basic tenor of the commentary has begun to shift over the years. Critics used to dismiss the research by saying, "All that the animals have is a few words, and they don't have any syntax whatsoever." Now the fact that apes can acquire words is treated as an interesting phenomenon.

Frans de Waal, a professor of primate behavior at Emory University and the author of *The Ape and the Sushi Master,* says:

> I think the trend is clearly towards poking holes in the wall that exists between us and animals, and increasingly people embrace the comparison, so to speak. In the 1970s, when I had to give a lecture on chimpanzees, some people would say, "How can you use the term 'reconciliation'?" They would have strong objections. Or let's say it was about sex differences, and they would say, "How can you compare chimpanzees and humans?" Because obviously, we are cultural beings and we can change our behavior.
>
> When I give lectures on these topics today, that never happens anymore. It's because there's a gene on the cover of *Time* or *Newsweek* almost every week, a gene for this or a gene for that, so people are getting very used to the idea that genes add something to behavior. So the climate is totally different, and there's a much greater openness to seeing us as animals, as Darwin always wanted and as many other people wanted.
>
> I was recently invited to give a talk for business ethicists. Now, business ethicists are basically philosophers who teach at business schools. Even there, there is an enormous openness for these comparisons, whereas I'm sure twenty years ago they would not want to even touch a monkey. So I think the trend is clearly towards more comparisons. More comparisons doesn't necessarily mean that we fully accept the similarities. Usually they'll want to keep something like, "This is typically human" or "This is unique to humans"—they want to keep this to some degree.

One of the most important contributions of ape language research is its challenge to the traditional idea that other animals have a fixed mental bag of tricks, and humans are different because we have language and that makes us mentally flexible. If that were the case, Kanzi would have been unable to learn the language skills he has. Clearly, these apes who have the rudiments of language can also be flexible and creative with their communication.

Ape language research, and Kanzi in particular, opened one fascinating window into the problems of language evolution. Steven Pinker and Paul Bloom opened another in 1990 when they published a paper in which they sidestepped the question of how much animal language training can teach us about language evolution and instead argued directly that not only could language evolution be studied but it *should* be studied. The two scholars—one a rising academic star, the other a graduate student with a brilliant idea—inflamed hearts and minds because their proposal was clever, innovative, and engaging. And even though they weren't the first to propose that language evolution was a valid topic of inquiry, their paper ignited a small blaze that quickly grew and spread.

3. Steven Pinker and Paul Bloom

In 1989 Paul Bloom, a twenty-five-year-old graduate student in the psychology department at MIT, was doing research in child language development. He was interested in word learning in young children, which had nothing to do with evolution, but he was increasingly bothered by the general agreement that language could not have evolved.

"Two things happened at once," he recalled in an interview.

> One was that Leda Cosmides, who is now at the University of California, Santa Barbara, came to give a talk at MIT. She's a prominent evolutionary psychologist, and she started talking about the mind and language from an adaptive point of view. When we met later, I said,
>
> "This is ridiculous!" I responded to her with the Stephen Jay Gould line, which I had totally been persuaded by years before. There was no reason to favor an adaptionist account of language (as opposed to the view that it was an evolutionary accident).
>
> She was very civil and intelligent, and she said, "No, no, you're mistaken." And she convinced me that it made sense to apply an evolutionary analysis to mental life. Some things may be artifacts of biology, but there are good reasons to believe that something as rich and as complicated as language could have evolved by natural selection.
>
> It was one of the rare case where an academic changes his mind. After thinking about it for a while, I realized that it made sense.
>
> And then, at the same time, Massimo Piatelli-Palmarini, a colleague and friend of mine in the Department of Linguistics and Philosophy, published an article in *Cognition* on the evolution of cognition and language. His article presented in this very sharp, cogent fashion the Chomskyan view on evolution—basically he said that there was very little interesting to make of the connection between natural selection and cognition and that language has features that simply cannot be explained in terms of adaptation. I strongly disagreed with it.

At the time that the *Cognition* article appeared, it looked to Bloom as if everyone else agreed with Piatelli-Palmarini. "Back then if you didn't independently have an interest in evolutionary biology or evolutionary theory, the arguments of Chomsky, on the one hand, and Gould, on the other, were very persuasive. Chomsky is the smartest guy in the world and the dominant figure in linguistics, and Gould is this lay saint, this wonderful writer and brilliant synthesizer. And they're both telling you the same thing—that language didn't evolve as a result of natural selection.

"You can't underestimate the influence that Chomsky had," said Bloom. "People believed this line partly because of the force of Chomsky's personality. A linguistics friend of mine told me in all seriousness about what he called the C-principle. The idea is that if Chomsky believes something, then it makes sense to agree with him in the absence of other knowledge. Because, you know, he is a really smart guy.

"There was also something of an ideological taint about adaptionist explanations," remembered Bloom. "It was a sort of a dark association with racism and sexism and the evils of biological determinism, and people were wary of being associated with that.

"So I approached Steve Pinker." Bloom was acquainted with Pinker as a young professor in the psychology department who studied language.

> I don't know whose idea it was originally, but we discussed writing a response to Massimo's article. We did not disagree with Massimo about his characterization of language. We did buy the Chomskyan party line that there was an innate, mental language organ. But we disagreed about evolution.
>
> So I wrote up this little thing. It was five pages long, something like that. It was very drafty. And I gave it to Steve, and he came back to me with this thirty-page thing. It was monolithic and far more ambitious than the paper I had written. At that time neither of us knew much about evolutionary biology or the issues in detail, and so we were both reading up on it. Trying to keep up with Steve when he's acquiring new knowledge was a difficult task. At that point, it definitely became "Pinker and Bloom," not "Bloom and Pinker." Steve was the dominating intellectual force here.

Stephen Jay Gould, whose line Bloom had taken with Leda Cosmides, was at the time an intellectually flamboyant and highly influential evolutionary biologist. He was based at Harvard as the Alexander Agassiz Professor of Zoology, and he believed passionately in spreading the word about evolution. For years he wrote essays for *Natural History* magazine, many of which had been collected into popular books like *Bully for Brontosaurus* and *The Lying Stones of Marrakech*.

Gould's *Natural History* column was widely read within the academic community, and his books sold extremely well to both specialist and popular audiences. He wrote with enormous verve about the lessons and mysteries of evolution, ranging from the subtleties of natural selection, "the wriggles of a million little might-have-beens," to faked fossils, racism in science, and the most singular minds of scientific history.

The "Stephen Jay Gould line" was that scientists were too quick to apply evolutionary explanations to everything. Some features of our lives did not result from adaptation, he argued, but are just accidental by-products of other evolutionary changes. Gould called these biological artifacts "spandrels." As he explained:

> Since organisms are complex and highly integrated entities, any adaptive change must automatically "throw off" a series of structural by-products—like the mold marks on an old bottle or, in the case of an architectural spandrel itself, the triangular space "left over" between a rounded arch and the rectangular frame of wall and ceiling. Such by-products may later be co-opted for useful purposes, but they didn't arise as adaptations. Reading and writing are now highly adaptive for humans, but the mental machinery for these crucial capacities must have originated as spandrels that were co-opted later, for the brain reached its current size and conformation tens of thousands of years before any human invented reading or writing.[1]

Throughout his career, Gould stressed the ways in which the human species was a glorious accident. The wonder of evolution, he emphasized over and over, was that it was "an unpredictable process with no drive to complexity."[2] In life, there is only forward motion, just the drive to keep driving. At some point in the past, Gould believed, our brains evolved to a level of complexity that would enable us to reason our way through certain situations, and at that level we had the structures for language already in place. In a sense, language simply "happens" when you have a machine complex enough to accommodate it. So rather than language being selected, we lucked into it, and it wasn't part of what initially made us successful as a species—even though now it's essential to our existence.

In 1997 Gould gave a talk at Iowa State University. It was one of probably hundreds he presented as one of the century's most ardent popularizers of evolutionary theory. And it went, no doubt, as most of those talks did. Gould, short and remarkably loud, spoke with vigor about evolution. After his speech, he spent a lot of time answering questions about evolution and equal amounts of time batting away the creationists who had come to bait him. When someone asked about the evolution of language, he was uninterested, even a little annoyed by the question. He waved his hands about and said, "It's probably a spandrel."

Steven Pinker was thirty-five years old in 1990. A decade earlier he had completed his Ph.D. thesis in an unusually short amount of time. He was hired by Harvard in 1980, and was lured to Stanford in 1981, only to be lured to MIT in 1982. Pinker began to work there on regular and past-tense forms of verbs and how children acquire them. When Paul Bloom approached him, he had not thought a lot about evolution, but he eagerly dove into the research. "I was motivated," he said, "by the feeling that there was a premature consensus from two charismatic figures who did not have a sensible argument."

"On the one hand, there was the Gould-inspired consensus that we were questioning. And the thing about Gould was that his views were not mainstream within evolutionary biology though people outside the field were not aware of that. And there was also the Chomsky viewpoint." He continued:

> It's by no means the case that everyone in child language acquisition or cognitive science in general is a Chomskyan. He's a deeply divisive figure. But there are large sectors that are in almost religious thrall to him. If he says it, it must be true, and if you disagree with him, then you must misunderstand. Non-biologists even get their evolutionary biology from Chomsky's footnotes. I remember Chomsky made a throwaway mention in a footnote of an argument by a mathematician and an engineer that natural selection could not work. It was a back-of-the-envelope calculation, whose flaws were immediately pointed out by biologists, and no one but Chomsky ever took it seriously again.

Pinker is now back at Harvard. His suite on the ninth floor of William James Hall is airy, spacious, and clean. The walls are lined with books, and a large table with room for six, as well as space in the middle for one-on-one discussions. Against the wall near a large window is Pinker's desk, and on it a brass statue, the Emperor Has No Clothes Award, from the Freedom from Religion Foundation. At the other end of the room, behind a sliding whiteboard, is a brain in a jar. Pinker himself, apart from the famous flop of curls seen in his many author photos, is contained, his comments brief and well measured.

As a first-year student Pinker had cross-registered for a course at MIT taught by Noam Chomsky and Jerry Fodor. When he became a professor at the school, he attended a few lectures Chomsky gave, but he never worked directly with him. "Although in the grand scheme of things I'm probably closer to Chomsky than many people in cognitive science," he said, "I'm not part of the cult of personality that has grown around him." Pinker is now the Johnstone Family Professor of Psychology at Harvard. In response to a question about why people were so willing to take one of the most fundamental questions about language—how it evolved—on faith, he replied, "There were a few reasons. Chomsky was a well-known left politician, and people perceived sociobiology, as it was then called, as right-wing. Truly, it doesn't need to be seen that way.

"Also, academics are lazy. They are unwilling to make their discipline rigorous in terms of the standards of another discipline, and that's how it was with evolution and cognitive science for a long time."

After a few months Pinker and Bloom wrote their paper up for the MIT Occasional Papers series. These technical reports are circulated throughout the university and sent to interested individuals outside it as an opportunity for researchers to get commentary from their peers.[3] In it they wrote: "Noam Chomsky, the world's best known linguist, and Stephen Jay Gould, the world's best known evolutionary theorist, have repeatedly suggested language may not be the product of natural selection but a side-effect of other evolutionary forces such as an increase in overall brain size and constraints of as yet unknown laws of structure and growth." As a result, they said, "in many discussions with cognitive scientists, we have found that adaptation and natural selection have become dirty words."[4]

Pinker and Bloom continued with an appeal to rationality. "In one sense our goal is terribly boring," they wrote. "All we argue is that language is no different from other complex abilities, such as echolocation or stereopsis [the visual process that gives rise to depth perception], and that the only way to explain the origin of such abilities is through the theory of natural selection."[5]

An e-mail exchange between the two authors and Chomsky ensued. In his e-mail, Chomsky made a series of unambiguously clear statements about the evolution of language. He said that he was not at all opposed to the idea that language evolved—of course it did—and that many parts of it were adaptive for communication. But he had great reservations about whether what he and serious linguists called language—the unique mental syntactic component—originated in the act of communication. He reiterated that there were factors in evolution other than natural selection, which were as likely to be significant. And in this regard, Chomsky, Pinker, and Bloom were essentially in agreement, their debate arising more from differing emphases than actual discord. Pinker and Bloom were still generativists at heart, and their goal was to discover where evolutionary theory and generative grammar were compatible. They also said that natural selection couldn't explain everything about the evolution of language. Yet they questioned how much "as yet undiscovered theorems of physics" would explain language's intricate design. In their e-mail to Chomsky, they wrote, "No matter what the constraints are on how you can grow a fin in a biological system, you need an explanation as to why fish have them and moles don't."

Certainly, the researchers also disagreed on fundamental issues, if not about what the key aspects of language were, then

about how much they mattered in evolution. Though they concurred that language was indeed used for communication, they differed on how much this mattered for natural selection.

Ultimately, they disagreed most in what they felt the value of the debate was. On the one hand, Chomsky believed many of the relevant issues were either too trivial or too hard, and on the other, Pinker and Bloom claimed the study of language evolution was neither too mysterious nor too challenging to grapple with. It was, instead, a productive and scientifically valid endeavor.

Before they launched their argument about adaptation and natural selection, the authors reiterated some important and, at the time, well-accepted facts about language. For example, as far as we know, humanity has always had language. There were no creatures that we would think of as effectively human, no highly organized societies of people that hunted, gathered, and nurtured their offspring through a long period of vulnerable infancy, without language.

Additionally, pretty much everyone agrees that all languages are equally complex.[6] English, the dominant language of the United States with its advanced technology, is no more or less complicated than the language of the Andaman islanders off the coast of India. Moreover, said Pinker and Bloom, Modern English is no more complex than the English of six hundred years ago. Anyone who's tried to read Chaucer knows that Middle English is painfully different from today's English, but even though it has undergone enormous change, our language is in no sense an improvement on Chaucer's.

Children, said Pinker and Bloom, master complicated grammars by the age of three without any formal instruction. They can make grammatical distinctions that no one has ever demonstrated for them. Once they have acquired language as adults, brain damage can severely affect their language but leave other mental abilities intact. Or it can happen the other way around, with rich and complex language skills continuing to exist in a brain that has trouble with other, simple tasks.

They particularly emphasized that language is incredibly complex, as Chomsky had been saying for decades. Indeed, it was the enormous complexity of language that made it hard to imagine not merely how it had evolved but that it had evolved at all.

But, continued Pinker and Bloom, complexity is not a problem for evolution. Consider the eye. The little organ is composed of many specialized parts, each delicately calibrated to perform its role in conjunction with the others. It includes the cornea, the transparent, dome-shaped tissue that covers the front of the eye and refracts light, and the colored iris, which, like the aperture of a camera, controls the amount of light that enters the eye. Exceedingly tiny muscles pull apart the opening of the iris —the pupil—or shut it down, depending on the amount of light hitting the eye. The lens, suspended by fine fibers behind the iris, adjusts its own shape, so that the eye can focus on objects that are very near or very far. And the retina, layers and layers of differently specialized tissue at the back of the eye, takes the light entering the eye and translates it into a biological signal that's transmitted along the optic nerve to the brain.

All of these tiny, perfect biological devices operate in brilliant conjunction with one another to produce vision. The paradox of the eye is that evolution occurs in extremely small steps, yet it makes no sense for an eye to have evolved piece by piece. A cornea wouldn't begin to grow without the rest of the eye around it, and the same goes for all the other components. What about the vitreous humor, the goo that plumps the small globe up? Did it arrive with a sudden squirt, or did it inflate the eye slowly over time? It's infinitely unlikely that some lucky creature was one day born from unseeing parents with a complete eye in its head. Even Darwin said that it was hard to imagine how the eye could have evolved.[7]

And yet, he explained, it did evolve, and the only possible way is through natural selection—the inestimable back-and-forth of random genetic mutation with small effects and then the selection creatures with those effects by nature. It evolved to meet a specific need—vision. In the case of eyes, each time a small random change increased a creature's ability to register signals from its environment, that ability meant that it was likelier to survive and have offspring, and then its progeny got to pass on those changed genes. Over the eons, those small changes accreted and eventually resulted in the eye as we know it.

In the same way that the eye evolved to meet the need of seeing, said Pinker and Bloom, language evolved to meet the need of communication. The survival advantages of our kind of communication are as obvious and profound as the survival advantages of our kind of vision. Language enables us to learn from others. Humans don't have to experience something directly to know that it's either a good or a bad thing to do. If we have been warned about them beforehand, we can stay away from dangerous situations and move toward safer ones. The more we all get to share with one another, the more collectively we know.

Because this talking network is so important, knowing what our interlocutors are feeling, thinking, and meaning is also pretty important to survival, and language is superb for interpreting the thoughts and feelings of others as well. Moreover, there are distinct advantages to evolving a language that uses sound as a medium. If you're talking rather than, for example, signing, you don't have to look at someone, you don't even have to see him or be seen by him; it could be the dark of night, you could be hiding behind a tree, and your hands and body would remain free to do other things.

The kind of communication we specialize in, said Pinker and Bloom, is the production of propositions: "I am hungry"; "There's a bear"; "You are cute." And the communication of propositions is fundamentally connected to the channel in which it occurs—sound, from mouth to ear. This means that propositions occur one after the other, not all at once. Language is essentially serial.

The building blocks of serial communication, they explained, are nouns and verbs and the rules of structure and sound with which we put them together. They allow us to talk about events, objects, places and times, agents and patients, our intentions and others'. Words and rules allow us to build complicated sentences from smaller ones, and they help us pick the right meaning in an ambiguous statement.

Pinker and Bloom stressed again and again that even though what they were suggesting would be novel for cognitive scientists, it was not new for evolutionary biologists. All we are doing, they insisted, is applying the same kind of reasoning biologists apply when they discover complicated systems in other animals.

Pinker and Bloom originally planned to send their paper to *Cognition* as a reply to the Piatelli-Palmarini article. "But very

quickly it grew," said Bloom, "and we decided to send it out as a freestanding article to *Behavioral and Brain Sciences*."

For Bloom, working with Steven Pinker was a thrill. "He was always understood to be a genius," said Bloom.

> He has a reputation as a genius. But while there are a lot of smart people who are full of themselves and difficult to work with, Steve is a mensch—very intellectually generous and kind.
>
> We submitted the paper, then another thing happened. Steve and I were asked to give a talk at the MIT Center for Cognitive Science seminar series. And so we were set to give this talk and expound the position of this paper, and then I found out that the commentators would be Stephen Jay Gould and Noam Chomsky.
>
> I was absolutely terrified. Besides his obvious status in the field—he's like the Descartes of our time, people will look back a thousand years from now and will know his name—Chomsky is utterly merciless in debate, and I didn't really want the experience of getting my ass kicked by him.
>
> And there were other people who were very unhappy about the article. One colleague of Steve's at MIT was extremely upset. He was very much of a Chomskyan and was really mad. He thought we were being hugely naive about evolution and wrote a long letter that was quite angry, accusing us of all sorts of things.
>
> And I think a lot of people were really upset in part just because we disagreed with Chomsky. A lot of that anger was directed at Steve. I might have been thought of as a poor graduate student who was seduced into it, an Oliver Twist to Steve's Fagin. But Steve was at MIT, Chomsky was at MIT, and I think some people felt it was betrayal. You'd expect it from Phil Lieberman at Brown or Elizabeth Bates at the University of California, San Diego, they were always disagreeing with Chomsky, but Steve was at the center of things.
>
> That evening, something happened. I think Chomsky's back went out and he couldn't do it. I felt *transcendent* relief. Chomsky was later replaced by Massimo Piatelli-Palmarini.

Still, going up against Stephen Jay Gould in debate was no small feat for any academic, let alone a student:

> We met before for an informal dinner, but I was too nervous to eat. When we got there, the auditorium was packed, and they sure as hell weren't there to see me.
>
> The room was crowded for Gould, but a lot of people wanted to hear what Steve had to say. Leda Cosmides was there. And there were a lot of major figures like Ray Jackendoff and Daniel Dennett. On a previous Tuesday night thing, Steve and Alan Prince had had a major battle with Jay McClelland over computational models of language. It was an astonishing intellectual event, and the graduate students were talking about Steve's presentation many months later.
>
> So Steve and I split our talk. Then Gould began his talk with, of all things, a mildly offensive joke. He said something like, "I just got back from a flight from Japan, and I'm exhausted—I got jet rag!" People hissed.

Pinker likewise remembered the auditorium for the Tuesday night colloquium overflowing with people. "The crowd was far bigger than any previous audience at the series, and a partition had been taken down to double the room size. They were all there to hear Gould.[8]

"But what Gould said," observed Pinker, "was surprisingly feeble. It was clear that he hadn't prepared at all. He said something like, 'Well, language can't be an adaptation for communication because it isn't always used for communication. For example, when I came here tonight from the airport, people asked me how I was, but they didn't really mean it.'"

The main thrust of Pinker and Bloom's argument was that it was obvious from the design of language that it had evolved: "If someone told you that John uses X as a paperweight, you would certainly be hard-pressed to guess what X is because all sorts of things make good paperweights. But if someone told you that John uses X to display television broadcasts, it would be a very good bet that X is a television set or is similar in structure to one, and that it was designed for that purpose. The reason is that it would be vanishingly unlikely for something that was not designed as a television set to display television programs; the engineering demands are simply too complex."

No matter how you look at it, they said, whether you consider organs that evolved to serve a specific purpose or something that started off as one thing, like a heat exchange, and then evolved to fulfill another purpose, a wing; there was no a priori reason that language could not have evolved stepwise like many other products of evolution.

It made as much sense to say that language evolved as a spandrel as it did to say that the eye could be some kind of architectural side effect of another kind of evolutionary change, said Pinker and Bloom. The reason you have all these very specific parts of the eye that perform particular jobs is because they evolved to do those jobs. Their jobs were their very reason for existence. The same is true for language. The rules of syntax and intonation and words matured over time into the system we have today because they were progressively refined by use and the forge of survival and reproduction—not because the brain got big and complicated for some other reason, and all of a sudden we discovered we could now manipulate symbols as well.

In addition to arguing for evolution from the design of language, Pinker and Bloom said there were many reasons why language could not be a Gouldian spandrel. Language was just too complicated. Spandrels are usually quite simple features. Even if a spandrel ends up being modified by evolutionary change and used in complicated ways, spandrels are typically "one-part or repetitive shapes or processes that correspond to simple physical or geometric laws, such as chins, hexagonal honeycombs, large heads on large bodies, and spiral markings."[9]

They reiterated that one of Gould's main problems with language evolution was that its supporters tended to rely on "just-so" stories, like the Rudyard Kipling tales that told how the leopard got its spots, to explain some critical developments. (Chomsky calls them "fairy tales.") In academia this is considered a term of abuse, and it essentially means you are making things up. The fear of being accused of fabrication was one reason that people stayed away from the issue of language evolution, said Pinker. But he and Bloom laid out many reasons why the evolution of language was a legitimate area of study. There are other compelling clues to the ways that language evolved; for example, our vocal tracts are shaped to produce speech, just as our hearing is specialized to register it.

Finally, they said, the argument against the evolution of language seemed to be based on nothing at all but the force of

incredulity.

"Dan Dennett was there that night," said Pinker, "and more than once since then he has told me that he thought the debate was won by us. And yet as everyone was leaving, he was shocked to hear many people saying that Gould had clearly won." (Dennett was so incensed by this that he was inspired to write *Darwin's Dangerous Idea,* a bestselling book about the theory of natural selection.)

"After the talk," said Pinker, "we sent the paper to *Behavioral and Brain Sciences.* It had one round of reviews. We made the changes, and then it was accepted. We wrote it in 1989 and it got published in 1990, which for academia is fast."

Behavioral and Brain Sciences has an unusual format. When it publishes a paper, it includes comments from many other academics, to which the authors then get a chance to respond. Compared with just reading a single paper from a team of researchers (and then possibly reading a response to it two years later in another journal), it's a rich way to gauge the complexities of a subject and to understand what is at stake. The effect is of a dialogue.

The back-and-forth on the subject of the natural selection of language ran seventy pages: Pinker and Bloom's original paper was twenty pages, thirty-seven pages of comments from thirty-one different sources followed, and Pinker and Bloom responded in thirteen additional pages.

Many commentators were delighted by the paper. Jim Hurford, a linguist at the University of Edinburgh, who had been interested in the area of language evolution for some years, was thrilled. "I felt freed," he recalled, and aptly titled his reply "Liberation!" "Pinker and Bloom's target article is deeply satisfying," he wrote. "They correctly diagnose the consensus in linguistics and cognitive science, nurtured by the writings of Chomsky and Gould, that 'language may not be the product of natural selection.' Pinker and Bloom confront this stifling consensus head on."

The overwhelming impact of Pinker and Bloom's contribution stemmed not so much from the specific ideas about adaptation they proposed as from the stand they took against the idea that language evolution was an uninteresting or intractable subject. Working out the details of how language might have evolved remained a monumental task, but with their paper it was as if a door had been flung open. From that point on, more and more researchers felt that studying the origin and evolution of language was a legitimate academic inquiry. After a hundred years or so of uncomfortable silence, it had become intelligent, respectable, and interesting to wonder aloud how on earth we had come to be a species with words.

Influence isn't easy to define in academia. It may be obvious that a person or his ideas are powerful, but it can be hard to prove beyond simply pointing out that everyone seems to accept them. A more specific, if incomplete, measure of influence is counting how many times a scholar's papers are mentioned by other scholars in their own work. Yet another measure is the prestige of the journal in which the scholar publishes. (The influence of a journal is determined by how many times anyone cites papers it has published.) For instance, *Language,* the biggest journal in linguistics, has an Impact Factor (a measure of how often it is cited) of only 3. *Behavioral and Brain Sciences* has a score of 15.6, making it a powerhouse. In the case of Pinker and Bloom, although it's not possible to determine the relative contribution of all these factors, it's clear that together they had an impact. Before their paper, relatively few books and papers were published on the topic. Since then, many books and more than one thousand papers have been published on language evolution.

Why did the paper have such an impact? There's no guarantee that a clever, fascinating, and quite possibly correct academic article is going to be read. The products of science, like works of art, require intense focus and a lot of time to create, and then, typically, all but a few are ignored.

In part, the paper had the effect it did because of Pinker's stature. "Finally," Jim Hurford explained, "someone prominent, someone sort of in the Chomsky camp, someone generativist, was interested in language evolution."

Pinker agreed, "I think people liked it possibly because I was coming from so close to the politburo headquarters—being at MIT, where Chomsky was, and also just down the street from Gould at Harvard. Many people saw the paper as coming from someone who had no ideological ax to grind against Chomsky. I'm often seen as Chomskyan, even though I disagree with him on many things. But I'm close enough that that statement was all the more attention-getting."

Ironically, others were angered by the piece for the same reason—that Pinker was seen as an influential Chomskyan and yet he was disagreeing with Chomsky.

"Overall," said Pinker, "some people were grumpy. I think they were disgruntled because we contradicted the official line. And there was one exceptionally long and sarcastic letter written in response to our paper that was withdrawn from publication."

The language evolution paper also turned out to be a turning point in Pinker's development as an academic, for it got him started in evolutionary psychology. About a year after it was published, he started to think about writing a book for nonspecialists. In 1994 he published *The Language Instinct,* a prizewinning account of language as a biological instinct that hit the bestseller lists.

Bloom also did well. The *Behavioral and Brain Sciences* piece, only the second paper he had published, drew a lot of attention, and at the time he was on the job market—a fortunate coincidence for any graduate student. Today Bloom is a professor at Yale and a successful author, as well as a coeditor of *Behavioral and Brain Sciences*.

After Pinker and Bloom, more and more people stopped asking, "Did language evolve?" and instead wondered, "How did language evolve?" Instead of being treated as an indivisible mystery, the problem of language evolution began to fracture into many good and answerable questions, like "What does gesture have to do with human language?" "How did categorical perception evolve?" "What's the relationship between music and language?"

In addition to its political impact, Pinker and Bloom's paper had the effect it did because they were writing about an idea whose time had come. Indeed, it was remarkable how many of the commentaries on their paper began with a remark like "Oh, how nice to see that Pinker and Bloom are now saying what I've been saying for twenty years. How nice that they agree with me."

It's true—while no one had previously enjoyed the attention that Pinker and Bloom got, a number of researchers had been toiling for years on the mystery of language and adaptation. By encouraging scholars to move beyond the Chomsky-Gould consensus, Pinker and Bloom not only inspired them to ask questions anew but created an opportunity for scholars to seek out earlier research on the topic and find out what had already been discovered beyond the borders of mainstream linguistic

respectability.

4. Philip Lieberman

Because the light of evolution is not instantaneous or blinding, it is difficult to visualize the immensely slow and gradual change that is brought about by mutation and natural selection. When you consider a protozoan cell or an amphibian, on the one hand, and dolphins or, say, commuters, on the other, there is no intuitive way to make sense of the line that runs from one form of life to the next.

The popular cartoon of evolution, where an ape slowly unbends, straightens up, starts walking, and mutates into some form of modern-day human, is probably the easiest way to think about it. But as Stephen Jay Gould insisted, this caricature is misleading. Evolution does not follow the course of a single line. The tree of life bristles with stems, boughs, and branches. Most lines from one form to another are densely surrounded by branches leading to different species or to dead ends.

When it comes to the idea of language as an adaptation, the challenge of grasping evolution is further compounded by our inability to imagine ourselves without language. Language not only fills our lives, but we do our imagining, to a large extent, with language. Every now and then, we get a glimmer of what it might be like to exist without words. Sometimes there is a moment on waking when we are conscious but not self-conscious and our thoughts aren't shaped by language. We are looking up at the ceiling or across the room, and the ceiling or the objects in the room are just there, as we are there. We're awake but not much more. Is this what it's like to be pre-linguistic?

In addition to the natural obstacles to imagining how language, or anything, evolved, the way language was defined by generative linguistics made its evolution seem even more incomprehensible. Although Chomsky forswore explicit discussion of the language evolution question, many scholars thought the answer was implicit in his model of language. Indeed, Chomsky spoke often of innateness, and when you invoke innateness, it's hard not to make a few assumptions about genetics and evolution.

As a result, it seemed to many linguists and other cognitive scientists that the only way an innate universal grammar could exist, the only way humans could be born with a language organ, was if it was genetically endowed. The implication was that the language organ was specified in the genome, and generally it was assumed that there was a gene or genes specifically for language.

At the same time, Chomsky saw language as a perfect, formal system. So it appeared that a gene for this mathematical entity must have appeared out of nowhere with no precursors in other animals. This contributed to the widespread view that language evolution was impossible and language's very existence was miraculous.

Although Pinker and Bloom helped considerably to challenge that belief, some researchers had been resistant to this idea even earlier—Philip Lieberman, for example. Although Lieberman was once a student of Chomsky's, there is no interaction between them now. Both men are famously combative, and they have taken opposite positions on the subject of the evolution of language. In the 1980s and 1990s, while Chomsky expressed no interest in its study, Lieberman was examining skulls, listening to apes, and testing brains, all in search of clues to language's origins. Lieberman argues that not only should you study language evolution, but you can't even begin to understand language if you don't start with evolution. His research is grounded in the basic tenets of messy biology. When you look at the problem through his eyes, it becomes harder to see language evolution as either mystical or impossible. Instead, it looks merely insanely complicated.

Lieberman was born to a family of idealists and fix-it types. Both his parents had gone to the Soviet Union in the 1930s to save the world, but after a few of their Russian friends disappeared in purges, they left. Still, Lieberman grew up with books like *The Commissar of the Gold Express* lying about the house in Brooklyn. (He suspects his mother remained a sympathizer.) Lieberman's father, who learned his plumbing skills in the Soviet Union, ended up building highly classified plants for the atomic bomb project.

Lieberman himself completed a B.S. and an M.S. in electrical engineering at MIT in 1958, but after working on a few real-world projects for General Electric, he was bored with transistors and breadboards and decided to take a linguistics class. It was a low-key arrangement. There were only three other students, and the teacher handed out purple-ink ditto-machine copies of his notes on syntactic structures and transformations. The idea of transforming one syntactic structure into another by preordained steps had been around in linguistics, but in this class it was taken a step further. Transformations weren't just notational devices, said the teacher, but actual operations of the mind. It was the first linguistics class that Noam Chomsky taught.

Lieberman, who was twenty-two years old, found the class exciting, for he liked language and was intrigued by the idea of using it to understand the mind. Despite his enjoyment, however, his path soon diverged from Chomsky's. One day soon after his shift to linguistics, he wandered through the department—it was housed in a wooden building on campus where the first laser had been built—and was drawn by funny noises coming from a room off the hallway. He had heard the DAVO, one of the first speech synthesizers, and the engineer-turned-linguist became interested in how speech actually works.

He ended up writing his Ph.D. thesis (which eventually became the second book ever published by MIT Press) about how the physiology of breathing structures how we speak. Speakers make all sorts of muscular maneuvers in articulating words, and these are carefully controlled to make sure that the air pressure generated by their lungs stays at a steady level as they talk. Lieberman found that these maneuvers are keyed to the length of the sentence we *intend* to speak, showing that humans anticipate a long sentence before they utter a sound. The more he became engaged with these fundamental physical constraints on human language, the more he moved away from the abstract properties of language and toward all the things that Chomsky had dismissed as epiphenomena.

The problems of speech synthesis and voice recognition are far from solved today. When Lieberman began to wonder about speech, scientists were just beginning to get a glimmer of how complicated it was, and how enormously difficult it was to get a machine to either produce or understand speech. (One of the big differences between now and then is not that the problems have been solved but that researchers have come to appreciate the magnitude of the task.)

Once he started investigating the biophysics of speech, Lieberman only became more intrigued. The revelation that really

shaped his future career came to him one night in the bath. After finishing his Ph.D., he got a job at the University of Connecticut, and one evening after work he lay in the tub, listening to WGBH. The presenter remarked that apes couldn't talk, and this struck him as worthy of investigation. Why not?

Lieberman often traveled to New York to teach at Haskins Laboratories and started spending time at Brooklyn's Prospect Park Zoo. When he took his tapes of hours and hours of ape vocalizations back to the lab to analyze, he found that apes do not make the full range of human sounds. This, he discovered, was because of the physiology of their tongues.

The human tongue extends from the larynx, deep in the throat, to just behind the teeth. At points along its length it can change its shape. It can be moved up, down, forward, and back; it can be bunched up or extended, widened or curled. Whenever the tongue changes shape, the whole vocal tract is altered, and each different configuration results in a different sound. In contrast, the tongues of other apes lie mostly in their mouths. As a consequence, they don't have the facility for generating as many specific sounds.

Lieberman also realized that even though there weren't as many sounds in the ape repertoire as in human speech, there were enough for the creatures to make a decent stab at talking. Chimpanzees can make *m, b, p, n, d, t,* and a number of vowel sounds. For a nonhuman, this is not bad. Few other animals can get close—if you could transplant a human brain into, say, a horse's head, it would not be able to speak human language, because its mouth and tongue could never make the sounds we do.

Where we differ from the chimpanzees is that they don't selectively articulate these sounds and manipulate their sequence, as we do when, for example, we say "pie," "my," "buy," "die," "tie," or "nigh." It is as if they have the same vocal instrument—or at least one that is reasonably similar—but they just don't use it in the same way.

If it was not the actual range of sounds produced by our respective vocal tracts that enabled us to speak but prevented apes from doing so, then, thought Lieberman, we must differ in our ability to control those sounds. This realization launched him on a quest to determine the connections between motor control and the higher levels of language. He quickly came to the conclusion that in order to truly understand language, you have to begin with biology, and—he is very fond of quoting Theodosius Dobzhansky, a famous evolutionary biologist who died in 1975—"nothing in biology makes sense except in light of evolution."

Lieberman's first book, *The Biology and Evolution of Language,* was published in 1984. In it he argued against the popular notion that there was a "linguistic saltation"—that is, no single dramatic event gave birth to human language. The Chomskyan idea of an ideal speaker and hearer confused the origins of language rather than illuminated them he said. Instead, he proposed: "Human syntactic ability, in [my] view, is a product of the Darwinian mechanism of preadaptation, the channeling of a facility that evolved for one function toward a different one."[1] He cited Darwin's discussion of the evolution of lungs from swim bladders: "The illustration of the swim bladder in fish is a good one, because it shows us clearly the highly important fact that an organ originally constructed for one purpose, namely flotation, may be converted into one for a wholly different purpose—namely respiration."[2]

Lieberman was not arguing, as he was careful to explain, that there was no uniquely human specialization for syntax. Rather, his point was that in the brain there was an overlap between the parts that control bodily movements and the parts that allow us to order thoughts and words in cognition and speech. This physical overlap had come about because of the way we had evolved, he said, first developing the ability to physically move our bodies in space and then, overlaid upon that, developing the ability to move words in abstract patterns.

All was peace and tranquility before the book, said Lieberman, but after its publication he and Chomsky fell out. For months, they argued back and forth, and then for the next eighteen years there was silence.

In 1990 Lieberman was invited by *Behavioral and Brain Sciences* to contribute one of the comments on Pinker and Bloom's paper. He wrote, "It is refreshing to see Pinker and Bloom adopting some of the major premises of my 1984 book: (a) that human linguistic ability evolved by means of Darwinian processes, (b) that the biological substrate for human linguistic ability is subject to the constraints of biology, in particular variation, and(c) that data from psycholinguistics, anthropology, neurophysiology, and so forth, are germane. However, Pinker and Bloom still carry much of the baggage of the MIT School of Linguistics, in particular that guiding principle 'Not invented here.'"

What he meant was that if research hadn't been done at MIT, then, as far as MIT was concerned, it didn't really exist. Clearly he was more annoyed than gratified.

Even though Lieberman, Pinker, and Bloom were all writing about language evolution, and even though they all agreed that any analysis of language needed to take biology seriously, there was at least one fundamental difference in their goals. Pinker and Bloom believed that Darwinian evolution and Chomsky's universal grammar were compatible, and sought to prove both Darwin and Chomsky right. Lieberman, on the other hand, believed the incongruity between slow evolutionary change and an innate language-specific organ was irresolvable. Pinker and Bloom's argument that universal grammar should and could take account of genetic variation was not acceptable, he said. In order to explore language evolution, you have to completely abandon the idea that humans are born with some kind of grammar device. It just wasn't possible for both Darwin and Chomsky to be right.

What Chomsky had wrong about language, according to Lieberman, fell into a larger category of misunderstanding biology. Throughout history, he argued, the most complicated piece of current technology was often used as an analogy for the human body or brain. For example, in the eighteenth and nineteenth centuries the brain was often thought of as a clock or a timepiece. It was imagined to be a telephone exchange in the early twentieth century. And from the 1950s onward, the brain was seen as a digital computer.[3]

These metaphors, Lieberman explained, often take on a life of their own. In the early nineteenth century, for example, physicians likened the body to a steam engine. When early steam engines became hot, they would explode, unless safety

valves were used to release the intensely heated pressure inside. By analogy, doctors of the time bled patients who had a fever in the belief that releasing blood would lower the body's temperature.[4]

The human mind-brain implied by Chomsky's theory of language, Lieberman argued, was fundamentally based on the architecture and processes of a computer. In a computer, the central processing unit is a discrete device that generates output by algorithms. Random-access memory and hard drives are also modular mechanisms. The Chomskyan brain, similarly, has a localized language organ that generates syntax. Sound, structure, and meaning are constructed separately. And the language organ is separate from other parts of the brain, these parts also being separate from one another.

According to Lieberman, the analogy between the computer and the brain prevents a true understanding of language. Even though formulas can describe a set of sentences, they don't have much to do with how language is produced by the brain or how the brain and language evolved. "Syntax is not the touchstone of human language, and evolution is not logical," declared Lieberman. "Evolution doesn't give a damn about formal elegance."[5]

When Lieberman began working at Brown University in 1976, he turned his attention to the connection between higher levels of language and the motor system. He started with the basal ganglia. These neural structures, the striatum and the globus pallidus, lie beneath the cortex, the brain's outermost rind. The basal ganglia are responsible for learning patterns of motor activity—playing tennis, dancing, picking up a cup of tea. They also control the way different physical movements or mental operations are ordered, one dance step after another, and they are crucial in responding to a change in the direction of movement or thought.

Lieberman compared the basal ganglia of neurologically normal people with patients who had Parkinson's disease. In Parkinson's the brain progressively degenerates, and among the first and hardest-hit structures are the basal ganglia. The cortex is generally one of the last parts of the brain to be damaged, but when it is, the patient falls victim to dementia. People suffering from Parkinson's have tremors and rigidity and repeated patterns of movement. What intrigued Lieberman about these people was that they also had trouble comprehending and producing syntax. In addition to showing their physical symptoms, they tended to produce sentences that were particularly short, with only simple syntax.

Lieberman carried out a study of Parkinson's patients in which they were asked to say "one," "two," or "three" in order to identify which of three pictures best corresponded to a sentence they had heard. People who are neurologically normal generally make no errors when taking this test, but a number of the Parkinson's patients with damage to the basal ganglia struggled with sentences with slightly complicated syntax and with long, conjoined sentences of simple syntax.

In another study many Parkinson's patients were shown to have trouble if they first heard an active sentence ("The hawk ate the sparrow") and then were asked a related question in the passive voice ("Who was the sparrow eaten by?"). They also had difficulty when the original sentence was passive and the subsequent question was active. The patients experienced no problems in working out the meaning of sentences; it was just the syntax that tripped them up.

The fact that damage to a brain area that controlled motor skills also affected syntax was a smoking gun for a biological relationship between language and motor control. The basic idea, Lieberman argued, is that there is a dependent relationship "between the syntax of motor control and the syntax of language."

Interestingly, these findings overlapped with some of Steven Pinker's experimental results. Even though the two researchers began with opposite ideas about language and the mind-brain, they agreed on the subject of the basal ganglia and syntax. "Lieberman long ago predicted that the basal ganglia should have an important role in syntax," said Pinker. "And I found corroborative data that shows it." He continued:

> A lot of my work on language uses a comparison between regular and irregular verbs as a way of tapping into the combinatorial, recursive part of language and the memory component of language. In particular, when we use "walked" as the past tense of "walk," you don't have to memorize that because you can just crank it out using the rule "add 'ed' to a verb." Whereas if you use "broke" as the past tense of "break," there you can't use a rule, because there is no rule. You have "break/ broke," but you have "take/took" and you have "fake/faked." So that relies on memory.
>
> So comparing regular and irregular forms is a way of studying this recursive-combinatorial component in the simplest possible way—sticking an "ed" onto a verb is the smallest operation that anyone would be willing to call combinatorial or recursive grammar. The reason that the irregular is a nice comparison is that it doesn't involve a recursive-combinatorial component, but it means the same thing. It's just another way of expressing the past tense at the same length and same complexity.
>
> We found that patients with Parkinson's disease have more trouble with regular than with irregular verbs, and they have more trouble with novel verbs. Like, when a new word enters the language, like, "to spam," everyone knows that the past tense is "spammed." I don't think you'd look that up in a dictionary or memorize it, but you can just deduce it from your world of recursive grammar. That's something that patients with Parkinson's disease have more trouble with than irregular forms, and that fits into Lieberman's theory that the basal ganglia are implicated in recursive syntax.

Lieberman has gone on to explore the basal ganglia in a completely different group of subjects. Starting in 1993, he began to compare the linguistic and motor performance of Parkinson's patients with that of individuals who were climbing Mount Everest. Both sets of people incur brain damage, specifically to the basal ganglia, though the basic cause is very different. Parkinson's is a progressive and fatal disease, whereas the basal ganglia damage suffered by climbers on Everest results from the lack of oxygen. In most cases it is temporary. Nevertheless, the climbers exhibit a lot of the same deficits experienced by Parkinson's patients.

Lieberman set up a monitoring unit at Everest's Base Camp, fifty-three hundred meters above sea level. His research team administered baseline cognitive tests to the climbers and took samples of their speech. As the climbers ascended the mountain and stopped at the next four camps, further tests and speech samples were obtained by radio link.

One of the abilities that Lieberman examined was how the climbers assembled the bits that make up distinctive sounds of speech. For example, when you pronounce *b,* you must coordinate at least two movements. At some point, you open your lips and release air while simultaneously vibrating the vocal cords deep in your throat. Timing the onset of voicing in speech sounds is yet another complicated motor skill at which every normal speaker is expert, though few are consciously aware of it. It is also another kind of movement sequence that gets affected in Parkinson's disease.

For example, the only difference between a *b* and a *p* is that you vibrate your vocal cords much sooner for the former than for the latter. With a *b,* voicing occurs within twenty-five milliseconds of opening your lips; with a *p,* your vocal cords start vibrating more than twenty-five milliseconds after you open your lips. Because Parkinson's patients experience a breakdown in the onset timing of voicing in speech sounds, some of their *b*'s sound like *p*'s, and vice versa. (The same applies to *d* and *t* and to *g* and *k*.) This deficit occurs alongside an increase in syntactic errors and a delay in the comprehension of simple sentences.

Lieberman showed that the higher the climbers went up the mountain, the more trouble they had with the timing of their voicing and the more their comprehension of syntax degraded. The farther up they went, the less oxygen they breathed, and just like Parkinson's patients, they became less adept at distinctly pronouncing sounds like *b* and *p,* and they took longer to understand test sentences.

It's clear from this evidence, according to Lieberman, that the basal ganglia are crucial in regulating speech and language, making the motor system one of the starting points for our ability not only to coordinate the larynx and lips in talking but to use abstract syntax to create meaningful and complicated expressions.

One of the important functions of the basal ganglia is their ability to interrupt certain motor or thought sequences and switch to a different motor or thought sequence. Climbers on Everest become increasingly inflexible in their thinking as they ascend the mountain—stories about bad decision making in adverse circumstances abound. Accordingly, Lieberman's climbers showed basic trouble with their thinking.

One mountaineer monitored by Lieberman scored well at base camp but demonstrated extreme anomalies in his speech and a dramatic decline in thinking as he ascended. The researchers told him that he wasn't functioning normally and advised him to descend, but he refused, insisting he was fine. When the weather took a turn for the worse and his companions descended, he persevered in going forward. A few days later he fell to his death.

It was later discovered that at the time of his death, a harness the climber needed to secure himself to fixed ropes was not properly attached. There was nothing wrong with the harness itself; the problem was in how it had been used. In order to secure the harness, a correct sequence of steps had to be carried out. It appears that the lack of oxygen supply to the basal ganglia affected the climber's ability to follow the basic sequence of clipping and unclipping.

Basal ganglia motor control is something we have in common with many, many animals. Millions of years ago, an animal that had basal ganglia and a motor system existed, and this creature is the ancestor of many different species alive today, including us. When we deploy syntax, Lieberman argued, we are using the neural bases for a system that evolved a long time ago for reasons other than stringing words together.

Chimpanzees, obviously, have basal ganglia. Birds have basal ganglia. So do rats. When rats carry out genetically preprogrammed sequences of grooming steps, they are using the basal ganglia. If their basal ganglia are damaged, then their separate grooming moves are left intact, but their ability to execute a sequence of them is disrupted. (Lieberman calls their grooming pattern UGG, universal grooming grammar.)

The fact that a number of different animals use the basal ganglia for sequencing, whether it involves grooming or words, said Lieberman, suggests that there is no innately human specialization for simple syntax. Instead of being a contained and recent innovation in the human lineage, the foundation of syntactic ability is an adaptation of our motor system, a primitive part of our anatomy.

Lieberman's contrarian (at least prior to 1990) take on language and its history offers an entirely different way of thinking about language evolution. When he started engaging with the subject of language, he wrote of it as not so much a new thing that humans *have* as a new thing we *do,* and we do it with a collection of neural parts that has long been available to us. Moreover, when you think about language this way, it is not really a "thing" at all but a suite of abilities and predispositions, some recently evolved and some primitive. The many parts of the brain and body that make up the language suite allow us to program into our own heads how our parents speak. When Lieberman calls language part-primitive and part-derived, he echoes Charles Darwin, who wrote in *The Descent of Man* that language was half art and half instinct.

The nineteenth-century German philosopher Arthur Schopenhauer said: "All truth passes through three stages. First, it is ridiculed. Second, it is violently opposed. Third, it is accepted as being self-evident."

The study of language evolution from the nineteenth century onward has rather neatly followed the same course as Schopenhauer's aphorism. Linguists once considered pursuing the topic an absurd endeavor. Then it was banned. After that, the official ban developed fairly seamlessly into a virtual ban. Now, where most researchers once glibly proclaimed that you can't study it, many say you can, including the scholar best known for saying you can't (or at least, you shouldn't bother).

We are at a strange now-you-see-it-now-you-don't moment in the history of language and mind where it seems that everyone is taking possession of the same new attitude. It's remarkable, now that the rhetoric about language evolution has shifted, how quickly what was once heretical has become received wisdom. Within a few years, students in Linguistics 101 will probably assume that asking about language evolution was always this easy and obvious.

In a relatively short time, academics like Savage-Rumbaugh, Lieberman, and Pinker, in their different ways, have had enough influence to make the subject no longer controversial or taboo but a legitimate line of inquiry—an endeavor about which reasonable people could disagree.[6] When questioned about the investigation of language evolution at the 2005 Morris Symposium on the Evolution of Language, Chomsky himself shrugged his shoulders and said, "I wouldn't have guessed it could go so far."

Of course, there are still profound disagreements among the researchers. Even though Chomsky published a paper that

discussed language evolution in 2002, he remains immensely discouraging about the subject. In addition, he argues that it is possible to engage with language evolution for purely logical reasons that are internal to linguistic analysis. Pinker and Lieberman, on the other hand, build their respective cases with findings from genetics, psycholinguistic studies, and experiments that compare the cognition and communication of various animals and humans. However, they disagree completely about the nature of syntax. In 2003 Sue Savage-Rumbaugh announced that Kanzi had uttered his first spoken word, but of Chomsky, Pinker, and Lieberman, only Lieberman considers her work to have crucial insights for language evolution.

Nevertheless, the findings of all these scientists are important touchstones, and thanks to their disagreements, engagement, and even disengagement, the field has widened considerably. A great multidisciplinary conversation is now taking place. American biologists, Italian physicists, Australian neuroscientists, British anthropologists, and a variety of linguists and computer scientists are but a few of the academics investigating the origins of language. Researchers like Marc Hauser and Tecumseh Fitch, who co-wrote Chomsky's 2002 paper on language and evolution, are proposing an entirely new field of study —evolutionary linguistics. The consensus among these researchers resonates with one of Savage-Rumbaugh's and Lieberman's main points: that what evolved was not a single thing. Language is not a monolith.

Part 4 of this book will delve more deeply into the disagreements provoked by the new questions, but first we will survey the diverse array of experiments that purport to explain what the components of language are and what processes were responsible for drawing them together. Lieberman showed that the basal ganglia are implicated in the evolutionary trajectory that led to language, but what other parts of the brain are involved? What do they contribute? What about thought? What about gesture and speech and words? How ancient are they? And what relationship do genes have with language?

Michael Arbib, a neuroscientist who investigates mirror neurons, thought now to be important for language, prophetically claimed that as the field develops, "we are going to be dazzled and puzzled and infuriated by the number of ways that language is defined."