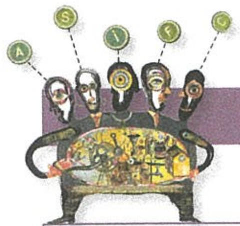


LANGUAGE AT LARGE 2.1

Engineering the perfect language

In all likelihood, the earliest users of languages never sat down to deliberately invent a system of communication in the way that humans invented Morse code or even the system of writing that we use to visually express our spoken languages. More likely, people intuitively fumbled around for the most natural-seeming way to express themselves, and language as we now know it was the eventual result. And the result *is* impressive. The combinatorial properties of human languages make them enormously powerful as communicative systems. By combining sounds into words and then words into sentences, we can create tens of thousands of meaningful symbols that can be combined in potentially infinite ways, all within the bounds of human ability to learn, use, and understand. An elegant solution indeed. But can it be improved upon?

It's interesting that when modern humans have turned their deliberate attention to language, they've often concluded that naturally occurring language is messy and poorly constructed. Many have pointed out its maddening irregularities and lapses of logic. For example, why in the world do we have the nicely behaved singular/plural forms *dog/dogs, book/books, lamp/lamps*, and *toe/toes* on the one hand—but then have *foot/feet, child/children, bacterium/bacteria, fungus/fungi*, and *sheep/sheep*? Why is language shot through with ambiguity and unpredictability, allowing us to talk about noses running and feet smelling? And why do we use the same word (*head*) for such different concepts in phrases like *head of hair, head of the class, head of the nail, head table, head him off at the pass*?

In a fascinating survey of invented languages throughout history, Arika Okrent (2010) described the various ways in which humans have sought to improve on the unruly languages they were made to learn. Many of these languages, such as Esperanto, were designed with the intention of creating tidier, more predictable, and less ambiguous systems. But unlike Esperanto, which was based heavily on European languages, some invented languages reject even the most basic properties of natural languages in their quest for linguistic perfection.

For example, in the 1600s, John Wilkins, an English philosopher and ambitious scholar, famously proposed a universal language because he was displeased with the fact that words arbitrarily stand in for concepts. In a more enlightened language, he felt, the words themselves should *illuminate* the meanings of the concepts. He set about creating an elaborate categorization of thousands of concepts, taking large categories such as "beasts" and subdividing them down into smaller categories so that each concept fit into an enormous hierarchically organized system. He assigned specific sounds to the various categories and subcategories, which were then systematically combined to form words. The end result is that the sounds of the words themselves don't just arbitrarily pick out a concept; instead, they provide very specific information about exactly where in the hierarchical structure the concept happens to fall. For example, the sounds for the concept of dog were transcribed by Wilkins as *Zita*, where *Zi* corresponds to the category of "beasts," *t* corresponds to the "oblong-headed" subcategory, and *a* corresponds to a sub-subcategory meaning "bigger kind."

Wilkins's project was a sincere effort to create a new universal language that would communicate meaning with admirable transparency, and he held high hopes that it might be used for the international dissemination of scientific results. And many very educated people praised his system as a gorgeous piece of linguistic engineering. But notice that the Wilkins creation dispenses with Hockett's feature of *duality of patterning*, which requires that meaningful units (words) are formed by combining together a number of inherently meaningless units (sounds). Wilkins used intrinsically meaning*ful* sounds as the building blocks for his words, seeing this as an enormously desirable improvement.

But the fact that languages around the world *don't* look like this raises some interesting questions: Why not? And do languages that are based on duality of patterning somehow fit together better with human brains than languages that don't, no matter how logically the latter might be constructed? As far as I know, nobody ever tried to teach Wilkins's language to children as their native tongue, so we have no way of knowing whether it was learnable by young human minds. But surely, to anyone tempted to build the ideal linguistic system, learnability would have to be a serious design consideration.

that all languages are trying to solve certain communicative problems. We can come back to our much simpler analogy of the seeming universality of arrows. Arrows, presumably invented independently by a great many human groups, tend to have certain striking similarities—they have a sharp point at the front end and something to stabilize the back end; they tend to be similar lengths, etc. But these properties simply reflect the optimal solutions for the problem at hand. Language is far more complex than arrows, and it's hard to see *intuitively* how the specific shape of languages might have arisen as a result of the nature of the communicative problems that they solve—namely, how to express a great many ideas in ways that don't overly tax the human cognitive system. But an increasing amount of thinking and hypothesis testing is being done to develop ideas on this front.

2.4 The Evolution of Speech

The ability to speak: Humans versus the other primates

In the previous sections, we explored two separate skills that contribute to human language: (1) the ability to use and understand intentional symbols to communicate meanings, perhaps made possible by complex social coordination skills; and (2) the ability to combine linguistic units to express a great variety of complex meanings. In this section, we consider a third attribute: a finely tuned delivery system through which the linguistic signal is transmitted.

To many, it seems intuitively obvious that speech is central to human language. Hockett believed human language to be inherently dependent on the vocal-auditory tract, and listed this as the very first of his universal design features. And, just as humans seem to differ markedly from the great apes when it comes to symbols and structure, we also seem to be unique among primates in controlling the capacity for speech—or, more generally, for making and controlling a large variety of subtly distinct vocal noises. In an early and revealing experiment, Keith and Cathy Hayes (1951) raised a young female chimpanzee named Viki in their home, socializing her as they would a young child. Despite heroic efforts to get her to speak, Viki was eventually able to utter only four indistinct words: *mama, papa, up*, and *cup*. To understand why humans can easily make a range of speechlike sounds while great apes can't, it makes sense to start with an overview of how these sounds are made.

Most human speech sounds are produced by pushing air out of our lungs and through the vocal folds in our larynx. The vocal folds are commonly called the "vocal *cords*," but this is a misnomer. Vocal sounds are definitely not made by "plucking" cord-like tissue to make it vibrate, but by passing air through the vocal folds, which act like flaps and vibrate as the air is pushed up. (The concept is a bit like that of making vibrating noises through the mouth of a balloon where air is let out of it.) The vibrations of the vocal folds create vocal sound—you can do this even without opening your mouth, when you making a humming sound. But to make different speech sounds, you need to control the shape of your mouth, lips, and tongue as the air passes through the vocal tract. To see this, try resting a lollipop on your tongue while uttering the vowels in the words *bad, bed*, and *bead*—the lollipop stick moves progressively higher with each vowel, reflecting how high in your mouth the tongue is. In addition to tongue height, you can also change the shape of a vowel by varying how much you round your lips (for instance, try saying *bead*, but round your lips like you do when you make the sound "w"), or by varying whether the tongue is extended forward in the mouth or pulled back. To make the full range of consonants and

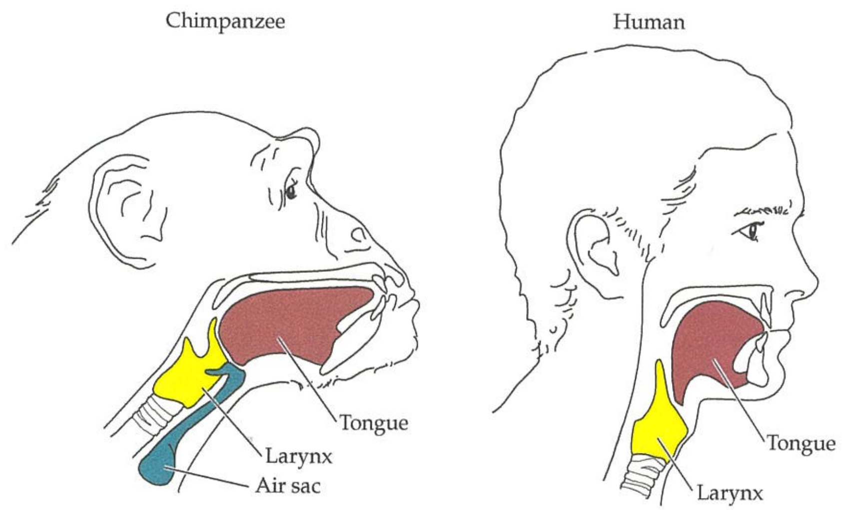


Figure 2.3 Comparison of the vocal anatomy of chimpanzees (which is similar to that of the other non-human great apes) and humans. Their lowered larynx and down-curving tongue allow humans to make a much wider variety of sounds than other primates. Humans also differ from other primates in the lack of air sacs (blue) in the throat; the precise consequences of this anatomical difference are not known. (After Fitch, 2000.)

vowels, you have to coordinate the shape and movement of your tongue, lips, and vocal folds with millisecond-level timing.

A comparative glance at the vocal apparatus of humans versus the great apes reveals some striking differences. Looking at **Figure 2.3**, you can see that the human larynx rests much lower in the vocal tract than that of chimpanzees. This creates a roomier mouth in which the tongue can move around and make acoustically distinct sounds. We also have a very broad tongue that curves downward toward the throat. Chimpanzees, whose tongues rest flat in their long and narrow oral cavity, have more trouble producing sounds like the vowels in *bead* or *boo*.

The distinct shape of our vocal tract comes at a tremendous cost: for the great apes, the height of the larynx means that they can breathe and swallow at the same time. We can't, and so quite a few human beings die as a result of choking on their food or drink. It's implausible that this potentially lethal trait would have evolved if it didn't confer a benefit great enough to outweigh the risk. Some researchers have argued that speech is precisely such a benefit, and that (genetically speaking) our species accepted some risk of choking as a fair trade for talking (Lieberman et al., 1969). Still, the link between speech and a lowered larynx is not clear. Many animals can and do actively lower their larynx during vocalization, possibly as a way to exaggerate how large they sound to other animals (see, e.g., Fitch, 2010).

In any case, having the right anatomy for speech is only part of the story. Somewhere in the evolutionary line between chimpanzees and us, our ancestors also had to learn to gain control over whatever articulatory equipment they had. As an analogy, if someone gives you a guitar, that doesn't make you a guitar player (even if it's a really terrific guitar). You still have to develop the ability to play it. And there's reason to believe that, aside from any physical constraints they might have, non-human primates are surprisingly lacking in talent when it comes to manipulating sound. More specifically, they appear to have almost no ability to *learn* to make new vocal sounds—clearly a key component of being able to acquire a spoken language.

As we saw in Section 2.1, most primates come into the world with a relatively fixed and largely innate set of vocalizations. The sounds they produce are only very slightly affected by their environment. Michael Owren and his colleagues (1993) looked at what happened when two infant rhesus macaques were "switched at birth" with two Japanese macaques and each pair was raised

by the other species. One revelation of this cross-fostering experiment was that the adopted animals sounded much more like their biological parents than their adoptive ones—obviously a very different situation than what happens with adoptive human infants (see **Box 2.4**).

The failure of primates to learn to produce a variety of vocal sounds is all the more mysterious when you consider that there are many species of birds—genetically *very* distant from us—who have superb vocal imitation skills. Songbirds learn to reproduce extremely complex sequences of sounds, and if not exposed to the songs of adults of their species, they never get it right as adults, showing that much of their vocal prowess is learned and not directly programmed into their genes (Catchpole & Slater, 1995). Many birds such as ravens or mockingbirds easily mimic sounds not naturally found among their species—for instance, the sounds of crickets or car alarms. And parrots are

BOX 2.4
Practice makes perfect: The "babbling" stage of human infancy

Non-human primates are essentially born with their entire vocal repertoire, skimpy though it is. Human children, however, are certainly not born talking, or even born making anything close to intelligible speech sounds. They take years to learn to make them properly, so even after children have learned hundreds or thousands of words, they still cutely mispronounce them. Some sounds seem to be harder to learn than others—so words like *red* or *yellow* might sound like *wed* or *wewo* coming from the mouth of a toddler. All of this lends further support to the idea that there's a sharp distinction between human speech sounds and the primates' unlearned vocalizations, which need no practice.

Human babies go through an important stage in their vocal learning beginning at about five to seven months of age, when they start to experiment with their vocal instrument, sometimes spending long sessions just repeating certain sounds over and over. Language scientists use the highly technical term *babbling* to describe this behavior. Babies aren't necessarily trying to communicate anything by making these sounds; they babble even in the privacy of their own cribs or while playing by themselves. Very early babbling often involves simple repeated syllables like *baba* or *dodo*, and there tends to be a progression from a smaller set of early sounds to others that make a later appearance. The sounds of the *a* in *cat* and those of the consonants *b, m, d,* and *p* tend to be among the earliest sounds. (Want to guess why so many languages make heavy use of these sounds in the words for the concepts of mother and father—*mama, papa, daddy, abba,* etc.? I personally suspect parental vanity is at play.) Later on, babies string together more-varied sequences of sounds (for example, *badogubu*), and eventually they may produce what sound like convincing "sentences," if only they contained recognizable words.

The purpose of babbling seems to be to practice the complicated motions needed to make speech sounds, and to match up these motions with the sounds that babies hear in the language around them. Infants appear to babble no matter what language environment they're in, but the sounds they make are clearly related to their linguistic input, so the babbling of Korean babies sounds more Korean than that of babies in English-speaking families. In fact, babbling is so flexible that both deaf and hearing babies who are exposed mainly to a signed language rather than a spoken one "babble" manually, practicing with their hands instead of their mouths. This suggests that an important aspect of babbling is its *imitative* function.

The babbling stage underscores just how much skill is involved in learning to use the vocal apparatus to make speech sounds with the consistency that language requires. When we talk about how "effortlessly" language emerges in children, it's worth keeping in mind the number of hours they log, just learning how to get the sounds right. It's also noteworthy that no one needs to cajole kids to put in these hours of practice, the way parents do with other skills like piano playing or arithmetic. If you've ever watched a babbling baby in action, it's usually obvious that she's having fun doing it, regardless of the cognitive effort it takes. This too speaks to an inherent drive to acquire essential communication skills.

affective pathway Sound production (vocalizations) arising from states of arousal, emotion, and motivation. Affective sound production is innate, doesn't require learning, and is generally inflexible.

cognitive pathway Controlled, highly malleable sound production that requires extensive auditory learning and practice. Includes human language sounds and some birdsong.

even able to faithfully reproduce human speech sounds—a feat that is far beyond the capabilities of the great apes—despite the fact that the vocal apparatus of parrots is quite unlike our own. This suggests that the particular vocal instrument an animal is born with is less important than the animal's skills at willfully coaxing a large variety of sounds from it.

Sophisticated vocal learning is increasingly being found in other non-primate species. For example, seals, dolphins, and whales are all excellent vocal learners, able to imitate a variety of novel sounds, and there are even reports that they can mimic human speech (e.g., Ralls et al., 1985; Ridgway et al., 2012). Recently, researchers have found that an Asian elephant is able to imitate aspects of human speech (Stooger et al., 2012). As evolution researcher Tecumseh Fitch (2000) puts it, "when it comes to accomplished vocal imitation, humans are members of a strangely disjoint group that includes birds and aquatic animals, but excludes our nearest relatives, the apes and other primates."

Why are other primates so unequipped to produce speech sounds? Several researchers (e.g., Jürgens et al., 1982; Owren et al., 2011) have argued that not all vocalizations made by humans or other animals are routed through the same neural pathways. They've pointed out that both humans and other primates make vocalizations that come from an **affective pathway**—that is, these sounds have to do with states of arousal, emotion, and motivation. The sounds that are made via this pathway are largely inborn, don't require learning, and aren't especially flexible. Among humans, the noises that crying babies make would fall into this category, as would the exclamations of surprise, fear, or amusement that we all emit. Notice that, while languages have different words for the concept of a dog, laughter means the same thing the world over, and no one ever needs to learn how to cry out in pain when they accidentally pound their thumb with a hammer. Non-human primates seem to be, for the most part, limited to vocalizations that are made by the affective pathway, and the alarm calls of animals such as the vervets are most likely of this innate and inflexible affective kind.

But humans (and some other animals, including songbirds and aquatic mammals) can also make vocal sounds via a **cognitive pathway**. These sounds usually involve a great deal of auditory learning before they can be reliably produced, take practice, and are highly malleable. Language sounds (unlike giggles or cries of terror) are the result of the cognitive pathway and are, under this view, different from ape vocalizations not just in variety and complexity, but in their fundamental nature.

Language without speech

It would appear, then, that perhaps the sharpest discontinuity between human and non-human primates lies in the ability to produce the speech signal by which linguistic meaning is usually conveyed. But here, the evolutionary story has a very interesting twist: as it turns out, Hockett was wrong, and human languages *aren't* universally spoken. It's true that speech is the default mode along which to transmit language—in every known society whose members have normal hearing, people communicate by shaping the noises that come out of their mouths. But when humans are deprived of their usual auditory powers, they can readily adapt language and produce it by means of gesture instead of speech. *Language*, as it turns out, is not at all the same thing as *speech*, and can exist independently of it. Far from being a form of pantomime, signed languages produced by deaf and hearing people alike have all the characteristics of fully fledged languages. This includes a level of "sound-like" structure where basic gestural elements are combined in various ways to form new words, and a level of complex syntactic structure that includes recursion (see Box 2.3). In fact, as far as language researchers can tell, there are no fundamental differences at all between spoken and signed languages and the ways in which they're learned, used, and understood by human beings. For the purpose of this book, just about all of the ideas that we explore about the psychology of language will apply equally well to signed and spoken languages, and I'll normally use the term *language* to refer to language in either modality. And since English doesn't have a separate word that means "to produce language by means of a signed linguistic system," I'll often use words such as *speak* or *speaker* without intending to exclude signed languages in any way.

So, we've arrived at an evolutionary paradox. It seems apparent that humans have evolved an anatomy and nervous system that outfit them perfectly for speech—and it seems quite plausible that these reflect adaptations *for* linguistic communication. But at the same time, humans aren't dependent on speech in order to communicate linguistically. This state of affairs has led some researchers (e.g., Corballis, 1999) to hypothesize that the earliest forms of human language were gestural, and that at some later point in time, humans developed the capacity to speak. This idea fits well with several facts.

First of all, the great apes are spectacularly bad at learning to communicate with humans through any semblance of speech. But they do far better in learning to communicate through signed languages. In fact, if researchers had thought to look only at whether apes can learn *spoken* modes of language, we'd still be completely ignorant of the fact that they can easily learn to use hundreds of different meaningful symbols and even combine them in novel, if rudimentary, ways. So, while apes have close to zero capacity for speaking through their mouths, they can obviously control their hands and limbs well enough to make a great many distinct gestures and movements.

Second, primatologists have found that when apes communicate with each other in the wild, they *do* spontaneously use gestures. What's especially intriguing is that their gestures tend to be more communicatively flexible than their vocalizations, as noted by several researchers, including Frans de Waal and Amy Pollick (2012). Vocal sounds are often limited to very specific contexts, but apes seem to be able to repurpose the same gesture in a variety of settings, much as we can flexibly use words. For example, a bonobo involved in a fight with another might stretch out its hand toward a third bonobo as a way of requesting help. But the same gesture might then be used in a very different situation, such as requesting food from a bonobo in possession of a treat. Unlike vocalizations (and again, like words in human language), gestures also seem to be more culturally specific, since chimpanzees have been found to use some gestures that are specific to their particular group.

Finally, when you trace the various communicative behaviors through the primate line, gesture makes a plausible precursor to human language compared to vocal communication. We've already talked about how the vocal alarm calls of vervets are quite unlike human speech vocalizations, suggesting that there's a qualitative difference between the two. But it's also interesting that apes, who are genetically most closely related to us, don't make alarm calls, and don't seem to have vocalizations that have a clearly referential function. This makes apes unlike many species of monkeys and other mammals such as prairie dogs, and makes it less likely that alarm calls served as the bedrock on which language was built. At the same time, monkeys don't appear to use manual gestures to communicate in the way that apes and humans do, hinting that gesturing is a trait that arose after apes diverged from their common ancestor with monkeys, but before humans diverged from our common ancestor with apes (see Figure 2.2).

BOX 2.5
What can songbirds tell us about speaking?

One of the most delightful things about science is that insights often come from unexpected places, which should encourage you to look there more often. At first glance, it might seem that studying birds would be an unlikely place to learn how we might have acquired that most human of traits, language. Birds don't look anything like us, their singing appears to be essentially an elaborate courtship display rather than a way to exchange information, and our evolutionary paths diverged some *300 million* years ago rather than the mere 6 million years or so when our ancestral line split off from the chimpanzees'. But none of this stopped Charles Darwin from remarking, back in 1871, that birdsong was the closest analogue to language found in nature.

Through his careful observations, Darwin understood that different species could have similar traits to each other for one of two reasons: they could have a *homologous* trait, meaning that they all inherited it from a common ancestor, or they could have developed *analogous* traits, which means that the species independently arrived at similar solutions because they faced similar evolutionary pressures. For instance, fish and whales have a similar body shape because they need to swim efficiently in the water, not because they are close genetic relatives. For this reason, we shouldn't limit our search for language-like skills to just those species that are most closely related to us.

But even someone as astute as Darwin couldn't have known just how similar to human language birdsong would turn out to be. Hundreds of studies of birds since Darwin's time have revealed the following:

- Unlike the vocalizations of most mammals, birdsong is not rigidly fixed from birth. Instead, it seems to require the opportunity for learning. In many species baby birds need to hear adult birds singing before developing normal song. They also seem to need to practice their skills, much like humans do, but unlike other mammals. For instance, there's evidence that baby birds go through a "babbling" stage, just like human babies, and even-more intriguing evidence that their mastery of vocal sounds progresses through similar stages (Lipkind et al., 2013) and is affected similarly by the responses of parents (Goldstein et al., 2003).
- Beyond showing highly developed skills in vocal learning and imitation, songbirds also seem to avail themselves of complex ways of structuring their songs. Individual notes can be combined into "syllables," these "syllables" can be combined into larger "motifs," and "motifs" can be combined into entire songs. In many ways, this looks similar to humans' ability to reuse and combine smaller units in order to make larger, more complex units like sentences. It certainly goes well beyond what apes can do in terms of showing an ability to keep track of complex sequences that have a definite underlying structure.

But there's no evidence that any of the elements birds consistently combine into complex, rule-governed sequences have any *meaning* whatsoever. All of these sophisticated capabilities seem to exist mainly to allow male birds to advertise their sexiness to female birds, and to discourage other males from entering their territory. As far as we know, the song's individual components don't mean anything specific. Perhaps the overall complexity of the song simply serves to broadcast information about the bird's reproductive merits. Think of it as the equivalent of a male rock star getting onstage and demonstrating his skill on the guitar, with subsequent effects on the females in the vicinity.

So research on birdsong leads to the intriguing conclusion that, when it comes to both vocal sophistication and combinatorial talents, we may have more in common with our distant feathered relatives than with our primate cousins. It also suggests that even a complex, combinatorial system can evolve for reasons other than the one that seems most obvious in human language—namely, to give enormous communicative power to a language. The similarities and dissimilarities between birdsong and language create an interesting tension, and encourage scientists to look at language evolution from less familiar angles. For example, are there other distant species that show evidence of having some highly developed language-like skills? Do combinatorial skills necessarily go hand in hand with general communicative skills and motivation? And what is the relationship between language and music in humans? Human music and human language show some structural similarities, but only one is used to carry meanings.

But whether gestures served as the vehicle for the first complex, truly language-like systems is hard to know. Clearly, gesture can be used by modern humans when spoken language is not an option, which shows that language can be overlaid on more than one modality. But we simply don't know when complex vocal skills might have emerged relative to some of the other abilities needed to support a fully fledged language. Maybe even more importantly, we don't really have a sense of how these independent skills might have interacted and influenced each other once present in a species.

It may be that to answer these questions, we'll have to broaden our scope and take a close look at animals that are more distant from us genetically than our favorite non-human research subjects, the primates. There's not much evidence that the ancestors we share with other primates had speech capabilities, but there *is* evidence that vocal skills evolved independently in a number of quite different animals. This means we can look for clues as to why such skills might have developed, and how closely tied they might be to some of the other abilities that are needed for human language (see **Box 2.5**).

2.5 How Humans Invent Languages

Communicating from scratch

In the previous sections, we've spent a fair bit of time exploring the linguistic capabilities of animals, and contrasting them with those of humans. One of the interesting findings from this body of research is that when animals interact with humans, they generally prove themselves capable of more sophisticated language skills than we've been able to observe in the wild (presuming, of course, that we're looking for the right kind of "language" when we observe them in the wild). This would seem to be at least modest evidence in favor of the "language-as-tool" camp, which claims that rather than being innately programmed for language, humans invented it to fill a need, and being the supremely social beings that we are, then transmitted this knowledge to subsequent generations. When animals are on the receiving end of this kind of cultural transmission, it seems that they edge somewhat closer to human-like language capability.

But there's another side to the cultural transmission story, and that is that when developing a linguistic system, humans are surprisingly less dependent on cultural transmission than one might think. True enough, no child deprived of hearing German has ever grown up to speak German, fluently or otherwise. A central theme throughout this chapter is how our particular linguistic knowledge relies heavily on *learning*. But, as it turns out, a child deprived of any real language at all *does* have the resources to invent from scratch at least the basic framework of a language that has just about all of the properties that researchers agree are common to all human languages.

How do we know this? You might be relieved to know that language researchers don't deliberately assign children to experimental conditions in which no one speaks to them for 10 years, in order to see what happens. But researchers *can* see what happens in situations where nature has deprived children of their ability to hear the language spoken around them. Over 90% of deaf children are born to hearing parents, and since only a very small minority of hearing adults know any signed languages, these children are born into a situation where they can't receive the linguistic input that the adults around them are able to provide.

homesign A personal communication system initiated by a deaf person to communicate through gestures with others who, like the deaf person, do not know sign language.

Nevertheless, these youngsters are highly innovative when it comes to creating a gestural system for communication. This phenomenon is referred to as **homesign**. The fascinating thing about homesign is that it comes about at the initiative of the child, who has not yet had the opportunity to learn what a human language might look like, rather than being invented by the adult, who has already mastered at least one language. According to Susan Goldin-Meadow, one of the researchers who has studied gesture and homesign most extensively, the parents of these children do gesture, but usually as an accompaniment to speaking, and they generally don't use their gestures in a way that systematically carries meaning. In contrast, children who homesign typically do make systematically meaningful gestures, as described below (a more detailed description can be found in Goldin-Meadow, 2005).

When gestures replace language

In homesign, children produce separate signs as separate symbols. This is different from how people normally gesture while speaking. When people speak, they often gesture to show emphasis, or to bring out some perceptual aspect of what they're talking about—for example, while talking about a particular person, a gesture might be used to indicate that he's large, or that someone is curvaceous. But these gestures don't have a *referential* value the way that the spoken names do—that is, they don't stand in as symbols for that particular person. Children's homesign gestures, however, *do* have such a referential function, and children tend to reuse the same gestures to convey the same meaning across a wide variety of situations—for example, to make requests, to ask questions, and to comment on a person or situation, whether present or not at the time.

> WEB ACTIVITY 2.3
>
> **Children using homesign** In this activity, you'll view video clips of children using homesign to communicate.

Children also use combinations of signs to convey complex ideas—for example, rather than having a separate sign for holding an umbrella and holding a balloon, a child would invent a sign for the general notion of holding, and combine that with signs for the concepts of balloon and umbrella. Combinations of this sort are used systematically in such a way that the relations between the units can be surmised from their order.

All fully fledged languages have bits of sound (or signs) that reflect inherently relational concepts—that is, words or parts of words like *and, if, since; -s* at the end of a word to mark plural or *-ed* to mark past, and so on. Homesigning children have been seen to invent signs to mark past and future, or the concept that's captured by the word *but*. Goldin-Meadow has even argued that children show evidence of recursion, being able to create more complex sentential units out of simpler sentences.

In terms of the structural complexity of the homesign system, children deprived of any reliable linguistic input already exceed apes who have the benefit of a rich linguistic environment. They also exceed apes in the variety of uses that they put their communication system to. In addition to making requests or commenting on people and situations, children can use homesign to spin a narrative; to talk about hypothetical events; to make statements not just about particular things, but also about things in general (for example, to convey that dogs bark); to talk to themselves; and to comment on their homesign system. And there's evidence that if they have to rely on their homesign system into adulthood (for example, if they never properly learn a commonly used signed language or a spoken language), they continue to innovate and add complexity over time.

The existence of homesign ought to make advocates of the language-as-tool scenario sit up and take notice. It's clear that in addition to being born with the capacity to *learn* language, children are born with, at least to some degree, the capacity to *invent* language, and that these invented languages share some significant similarities with each other as well as with more developed languages. And, more tellingly, this inventive capacity seems to be exercised by all children who are not provided with a culturally transmitted language, but who are otherwise raised in a highly social environment. Maybe it's useful to return to the analogy of arrow-making, which Daniel Everett (2012) argues is a good way to think about language: Given the usefulness of arrows, it's not surprising that just about every human society developed some form of them, and it's also likely that every human being of normal intelligence has the *capacity* to invent an arrow. But this doesn't mean that every single person in any given society *would* invent an arrow if presented anew with the problem of protein-catching. More likely, some would, some wouldn't (maybe they'd explore other possible solutions), and those who didn't would look over at the arrows made by their ingenious peers, say "What a great idea!" and promptly copy it. Yet, language of some kind does seem to be truly universal even at the level of individuals, and not just at the level of groups.

> WEB ACTIVITY 2.4
>
> **Gestures supporting or replacing speech** In this activity, you'll observe people as they describe events. Note how they use gesture, either as an accompaniment to speech, or as a replacement for speech when they are instructed to communicate non-verbally. Note also the similarities and differences in the gestures across the two situations.

Language: It takes a village

Homesign systems don't develop into full languages if the engine behind them is a single person, suggesting that something more is needed than just one person's inventiveness. But that something more doesn't need to involve a more sophisticated form of language providing a model that can be copied. It turns out that when *a number of people* engage in the same system of homesign, it quickly ratchets up in its complexity and systematicity.

In most of North America, deaf people are either surrounded by hearing people who try to use their own spoken languages to communicate with them, or they have access to a community of speakers of American Sign Language (ASL), a fully formed language in its own right. Typically a deaf person's experience involves both situations. But recent events in Nicaragua have provided researchers with a fascinating natural experiment in which a group of deaf people who did not know either signed or spoken language were brought together and began to communicate in a shared homesign system.

Before the 1970s, deaf people in Nicaragua had very little contact with each other, usually growing up in hearing families with little access to a broader educational system or services for the deaf. But in 1977, a school for the deaf was founded in the capital city of Managua and quickly expanded to serve hundreds of students in the region. The aim of the school was to teach the children Spanish via lip-reading, and it was not overly successful in this respect. But the really interesting linguistic action took place when children were allowed to use gesture to communicate with each other in the schoolyard or on the bus. The staff at the school initially took no part in this gestural system, but when it became apparent that this parallel system of communication was becoming the dominant means of communication for their students, they called in some experts in signed languages to provide some insight. Since then, the students' emerging sign language has been documented by researchers, among them Judy Kegl, Annie Senghas, Marie Coppola, and Laura Polich.

What seems to have happened is this: The children arrived, each having developed, to a greater or lesser degree of complexity, some system of homesign that they'd used to communicate with their hearing families and friends. Once together, they quickly negotiated a shared, standard homesign system to use with each other. By the time the researchers showed up (Kegl et al., 1999), they noticed that, as with many homesign systems, the Nicaraguan kids showed some basic language-like patterns in their gestures. But they also noticed that as younger students arrived and were exposed to the shared homesign system, they began to alter it in ways that gave it greater communicative power. For example, in comparison to the older, original group of students, the younger signers used gestures more efficiently—they made more compact gestures that required less movement, and they combined them more fluently with each other. Whereas the older signers were found to be able to express 24 different events per minute, the younger singers almost doubled this expressive capacity, to 46 events per minute. Individual signs also came to carry more information, and the younger signers were more consistent in the ways they used signs.

Streamlining signing

Along with the efficiency gain, the researchers also documented some significant ways in which the signed system was being restructured and reorganized. As noted by Susan Goldin-Meadow and her colleagues (1996), when gestures accompany speech, they often have a pantomimed quality to them—for example, if you were pantomiming an event in which someone ate a cookie, you might imitate the action of taking a cookie out of the cookie jar and eating it. But when gestures are used *instead* of speech, they're more likely to be produced as separate signs corresponding to separate concepts that are then combined together in sequence. So the same cookie-eating event might be communicated by pointing to a cookie, or by representing it as a round shape and then using a separate gestural symbol to communicate the notion of eating. In a deep way, this reflects a shift from a purely gestural system (playing a supporting role to language) toward a more *linguistic* one in its own right, where symbols are used for general concepts in such a way that they can be recombined with other elements. (You may have noticed this in the examples from Web Activity 2.4)

Annie Senghas and her colleagues (2004) noticed that the younger learners of Nicaraguan Sign Language were pushing their new language further along this trend, abandoning holistic signs in favor of more sequential ones (see Figure 2.4). To test this trend in a systematic way, the researchers showed older and younger signers some animated cartoons that depicted objects in motion (such as rolling down a hill) and had them use sign to communicate what had happened in the videos. (For comparison, they also recorded the gestures that were made by hearing Spanish speakers while orally describing the events.) In these events, it might be especially tempting to use a single holistic sign to simulate the motion. And in fact, when the videos were described by the Spanish speakers with accompanying gestures, the gestures were *always* holistic rather than sequential. The oldest signers were more likely than the Spanish speakers to break down the event into two component parts, produced one after the other, but they still produced holistic gestures more often than not. However, things were dramatically different with the younger signers; the two groups of students who arrived later than the original group were both found to use sequential signs most of the time.

WEB ACTIVITY 2.5

Inventing a sign language In this activity, you'll get together with classmates to brainstorm and negotiate ways to mark certain kinds of linguistic information using the modality of gesture. Take a stab at coming up with creative ways to communicate some of the abstract information that languages are so good at capturing!

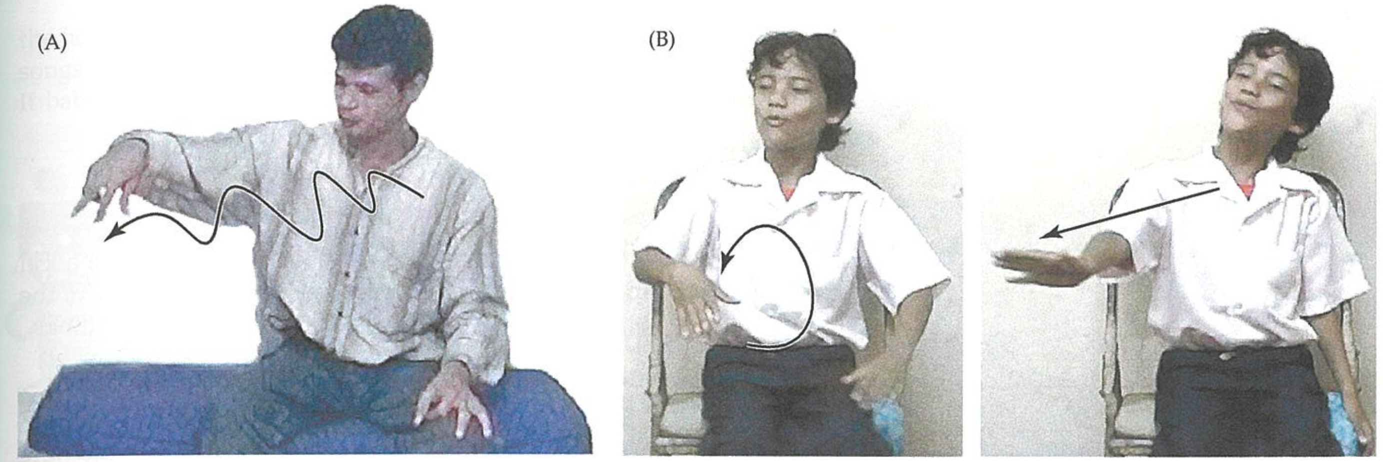


Figure 2.4 Holistic gestures (A) and sequential signs (B) exemplified by two individuals expressing the motion of rolling downhill. (A) A Spanish speaker gestures while talking. Notice how he has incorporated both the manner of motion (rolling) and the path (down) into a single gesture. (B) The person in these two photos is a third-cohort signer of Nicaraguan Sign Language; she has separated the manner and path of the motion into two separate signs, performed in sequence. (From Senghas et al., 2004.)

Another interesting change was in the way in which the signers came to use spatial location for grammatical purposes. Signs within Nicaraguan Sign Language (NSL) are usually made in a neutral position, right in front of the body, so shifting away from that neutral position can be used to imbue the sign with some additional information. Mature sign languages make use of shifts in the spatial locations of signs for a variety of different reasons—for marking past and future, for example, or even to distinguish between the grammatical subject and object of a verb. When Annie Senghas and Marie Coppola (2001) looked at how NSL signers used space, they found that older signers produced signs in non-neutral locations for a number of different reasons—for example, to introduce new characters or topics, or to indicate different points in time. But the younger signers had settled on a very specific function of spatial signing: they used it when making the signs for verbs, in order to show that the individual involved in two different actions was the same. For example, if they made the signs for *see* and *pay* in the same non-neutral location, this meant that the same person who was seen was also paid. But to the older signers, who hadn't yet attached a specific function to spatial locations for signs, the same two verbs signed in this way could mean either that the same person was seen and paid, or that one person was seen, while another, different person was paid.

Many other changes have been observed for Nicaraguan Sign Language over time. Overall, these changes have had the general effect of putting more information into the conventionalized system of signs—the **linguistic code**—so that there is less of a burden on the viewer to rely on context or shared knowledge to fill in the gaps. Older languages that have developed over many generations rely on a great many abstract grammatical markers to mark subtle nuances of meaning. To get a feel for why all this grammatical marking might have emerged, let's imagine a version of English that has a much sparser linguistic code than our current version, in terms of its structure and markers—think of a simplified form of English spoken by a small child, or by someone just beginning to learn English. For each of the simplified versions below (the *a* sentences), think about the additional contextual knowledge you'd need to have in order to understand it as equivalent to the *b* version of the sentence, but distinct from the *c* version:

(*a*) Christopher Columbus sail America.
(*b*) Christopher Columbus sailed to America.
(*c*) Christopher Columbus will sail from America.

linguistic code The system of symbols and combinatory rules that are conventionally agreed upon by a community of language users as conveying specific meanings. Often, the linguistic code is not enough to fully convey the speaker's *intended* meaning, so that hearers must augment the linguistic code with inferences based on the context.

(a) Francis build house last year.
(b) Francis was building a house all of last year.
(c) Francis built a house last year.

(a) Timmy marry girl. Girl have baby.
(b) Timmy is going to marry a girl who's had a baby.
(c) The girl that Timmy married is going to have a baby.

It's not hard to see how elaborating the linguistic code with the grammatical embellishments found in the more complex sentences might help improve the efficiency of communication and reduce the possibility of misunderstandings.

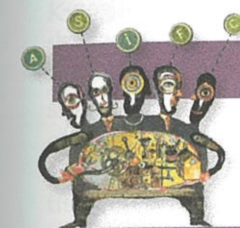
The sensitive period and innate language ability

Senghas and other NSL researchers have suggested that two ingredients were needed in order for this shared homesign to progress beyond its humble beginnings: (1) a community of speakers using the same linguistic system; and (2) a generational progression in which very young speakers were exposed to the structured input of their linguistic predecessors. The greatest competency in the language, and the most sophisticated innovations, were observed in new learners who had the benefit of the structured system that had been put in place by a previous cohort of students. In particular, students who were very young when exposed to this structured input benefited the most. This fits with the notion that there's a **sensitive period**, a window of time during which children seem to have a special aptitude for learning language. In general, young children who are exposed to a foreign language learn it quickly and in a native-like manner, whereas most adults who start learning a foreign language never achieve native fluency, even after decades of exposure. It's easy to see this in immigrant families in which the kids rapidly shoot past their parents' or grandparents' abilities to speak in their newly adopted tongue—much to the annoyance and envy of their elders.

Many nativists have argued that evidence of a sensitive period for language learning supports the view that language is innately specified. If, as the non-nativists claim, language is simply a by-product of our vigorous intellectual capacity, then it's hard to explain why it should be that small children—who overall are *not* as smart as adolescents or adults—seem to have a leg up on their intellectual superiors when it comes to language learning. On the other hand, it's not hard to explain under a nativist view, as there are other cases in nature where a genetically hardwired ability never develops properly if it hasn't been activated within a certain window of time. For instance, if songbirds are kept from hearing the songs made by adults of their species during a certain period of their development, they never manage to sing normally afterwards (e.g., Brainard & Doupe, 2002).

The parallel to songbirds is especially intriguing, given that there's a surprising amount of overlap between human language and complex birdsong, as discussed in Box 2.5 (see p. 36). Birdsong, like human language, seems to involve a mixture of genetic programming and learning from experience, though it looks like the precise balance between genes and experience varies somewhat among bird species. But the songbird story gets especially interesting when we consider that researchers have found among our avian friends some parallels to the emergence of NSL. In a study by Olga Feher and her colleagues (2009), young male zebra finches were kept from contact with other birds (researchers use the term *isolate* to refer to a young bird in this situation). Isolates that aren't exposed to adult song never grow to sing normally, but parallel to human homesigners, they do produce simpler, distorted songs with some of the elements present in the normal adult songs. It turns out that new baby birds will readily imitate the songs of isolates even though they sound abnormal. The researchers wondered: If baby birds only hear songs of isolates and are kept from hearing normal

sensitive period A window of time during which a specific type of learning (such as learning language) takes place more easily than at any other time.



LANGUAGE AT LARGE 2.2

From disability to diversity: Language studies and deaf culture

If you're a primate, there are some obvious advantages to being able to hear: you can get advance warning of approaching predators, locate your youngster when she's out of sight, and generally gain a fair bit of valuable information about the physical world. But if you're a *human* primate, your social world is at least as important as your physical world, and the advantages of hearing come mostly from giving you access to language. Without language, how do you benefit from knowledge accumulated by previous generations, how do you learn about the institutional cultures of your society, and how do you teach your own children all these things?

As late as 1960, the time at which Hockett published his ideas about language universals (see Box 2.1), it was widely thought that all languages were spoken. The predominant belief was that humans learned language by imitating their parents, and by being rewarded by them for producing the right sounds. The notion that languages could leap spontaneously from human brains whenever there was a need to communicate and people to communicate with was a foreign one to most people. So perhaps it was not too surprising that existing sign languages—which, after all, simply *happened* without anyone teaching them—were not seen as true languages, but rather as systems of pantomime. Efforts to teach linguistic skills to those who could not hear focused mainly on the torturous instruction of lip-reading and vocal training, since this was seen as the only entry point into language.

All of this began to change when William Stokoe, an English instructor teaching at Gallaudet University, began a more systematic study of the sign language used by his deaf students. He concluded that, far from being a pantomime, their sign language had grammatical elements and structures, and moreover, that these grammatical elements were completely different from those found in English (though no less systematic). He declared the system to be a language in its own right, giving it the name American Sign Language (ASL), and published the enormously influential book *Sign Language Structure* in 1960—the same year that Hockett's paper on language universals listed the vocal/auditory modality of language as the very first universal feature. Since then, many language researchers have confirmed and extended Stokoe's findings that ASL and other sign languages use many grammatical devices that are analogous to spoken languages, and that they're just as capable of expressing abstract thoughts and ideas.

This knowledge has changed everything about the public perception of sign language and its role in the education and development of deaf people. It used to be thought that signing interfered with a deaf child's learning of a "real" language. Today it is broadly recognized that giving young children access to a sign language very early in their lives is the best way to make sure they'll be able to acquire a native language that they can effortlessly manipulate. Far from being seen as a poor substitute for spoken language, sign languages now have the status of common spoken languages, like German or Arabic. There is deaf theater performed in sign language, there are ASL interpreters at conferences and on TV, and there are courses on ASL in the language departments at colleges and universities; you can even buy an instructional DVD. And most dramatically, there's a general recognition that deafness need not be a disability at all, especially if one lives and works in a community of people who use sign language to carry out the business and pleasures of their daily lives. It's not the deafness itself that is disabling, so much as the mismatch in language modalities that deaf people have experienced with the people around them.

Many advocates for the deaf feel that there are lingering misconceptions and biases about sign language and deaf culture. And, as with any minority culture, tensions exist within both deaf and hearing communities about the appropriate degree of integration between the two cultures. Nevertheless, the core insight that sign languages are *languages*—achieved through rigorous and scientific study—has transformed the lives of many deaf individuals around the world.

adult song, what do they grow up to sound like? Do they sound just like the first-generation isolates, or do they, like later cohorts of NSL signers, add on to the song system and change it? Their experiments found that the second-generation isolates, exposed only to the songs of the first generation, produced sounds that came closer to the normal songs of zebra finches than the first generation did. The researchers then had progressive generations of zebra finches learn from their predecessors and found that over the course of three or four generations, the songs of the zebra finches raised in this way came to sound very much like what the birds produce in a normal environment. It seems that birdsong, like human language, can reconstitute itself from nothingness into something approaching its full glory in a small number of generations.

So where does language come from?

It's tempting to see the emergence of homesign and NSL as evidence that children are innately hardwired for language. Certainly, *something* is driving the creation of a linguistic system that has many of the features of fully developed languages. But we still don't know exactly what that something is. We also don't know exactly why it is that in order to create a "full" language with all the complexities of more developed languages, kids need exposure to language from other people, even if it's not exposure to a fully formed variety of language. Nor do we know which of the features commonly found across languages are universal because they are written by nature into our genetic code, and which of these features might arise simply because they represent the optimal solution for how to package and transmit the kinds of information that human beings are inclined to share with each other.

What is clear is that language is the result of an intricate collaboration between biology and culture. It's extremely unlikely that *all* of the features of language are genetically determined, or conversely, that *all* of them are cultural inventions made possible by our big brains. In the upcoming chapters of this book, you'll learn a great deal more about how language works within the context of our other cognitive systems. All of the knowledge in this book will ultimately bear on the question of where language comes from and why it is that we have it.

2.6 Survival of the Fittest Language?

Changes in languages

So far, we've talked about language evolution and adaptation entirely from a biological perspective. That is, a trait is adaptive to the extent that it helps an organism survive and procreate. Organisms that survive and procreate pass on their genes, while those that die young or can't attract a mate fail to leave a genetic legacy. As a result of this cold, hard reality, the genes for an adaptive trait spread throughout a population or species. In this scenario, what changes over time is the genetic makeup of the individuals that make up the species. In language nativist terms, the capacity for language is adaptive and those humans who readily learned and used language had a reproductive advantage over those who didn't, so over many generations, the general human population came to possess a highly efficient set of cognitive skills tuned for the learning and use of language. By this account, the human brain as shaped by our genes has changed over time and has become specifically good at language.

But it's also possible to talk about the evolution of language from a completely different angle. Languages *themselves* are in a constant state of change, and not just when they're being newly formed, as with Nicaraguan Sign Language. The English in which Chaucer wrote the *Canterbury Tales* is incomprehensible to most people who speak English today. Americans have come to speak a variety of English that is different from the one people in the United Kingdom speak—and neither of those varieties is the same as the English that came out of Shakespeare's mouth 500 years ago (see **Box 2.6**). In fact, your version of English isn't even exactly the same as your grandparents' version (even assuming your grandparents were native English speakers). It's common for older generations to complain about the "poor grammar" of younger generations, and perhaps you've had someone older than you chastise you for saying "I'm good" instead of "I'm well," or inform you that it's wrong to say "less than three cookies"—that it should be "fewer than three cookies," or that "Who did you call?" should be "Whom did you call?" If so, maybe *you* should inform *them* that these aren't grammatical errors—they're grammatical *mutations*.

Languages—like genes within populations—are in constant flux. English has seen some significant changes over the years, including how words are pronounced, what words mean, and which grammatical markers or structures have been adopted. As one minor example, back in the 1600s, over the great

BOX 2.6
Evolution of a prayer

These five versions of the "Lord's Prayer," a common Christian prayer (Matthew 6: 9–13), reflect changes from Old English to present-day English. This text was chosen as an example because of its ready availability across historical periods that span 1,000 years, and because it illustrates how the same message has been expressed during these different periods (see Hock 1986, from which this presentation is modified). It is interesting to note that even today the King James version of 1611 remains the most widely recognized English rendition of this prayer.

Old English (ca. 950)
Fader urer ðu arð in heofnum, sie gehalgad noma ðin, to-cymeð ric ðin, sie willo ðin suæ is in heofne on in eorðo, half userne oferwistlic sel is todæg ond forgef us scylda usra suæ uœ forgefon scyldum usum, ond ne inlæd usih in costunge, ah gefrig usich from yfle.

Middle English (Late fourteenth century)
Oure fadir þat art in heuenes, halwid be þi name, þi kyngdom come to be. Be þi wille don in herþe as it is doun in heuene. Geue to vs to-day oure eche dayes bred. And forgeue to vs our dettis, þat is oure synnys, as we forgeuen to oure dettoris, þat is to men þat han synned in vs. And lede vs not into temptacion, but delyvere vs from euyl. Amen, so be it.

Early New English (William Tyndale's translation, 1534)
O oure father which arte in heven, hallowed be thy name. Let thy kingdome come. Thy wyll be fulfilled, as well in erth, as it ys in heven. Geve vs this daye oure dayly breede. And forgeve vs oure treaspases, even as we forgeve our trespacers. And leade vs not into temptacion, but delyver vs from evell. For thyne is the kyngedome and the power and the glorye for ever. Amen.

Elizabethan English (King James Bible, 1611)
Our Father which art in heaven, Hallowed be thy name. Thy kingdom come. Thy will be done in earth, as it is in heaven. Give us this day our daily bread. And forgive us our debts, as we forgive our debtors. And lead us not into temptation, but deliver us from evil: For thine is the kingdom, and the power, and the glory, for ever. Amen.

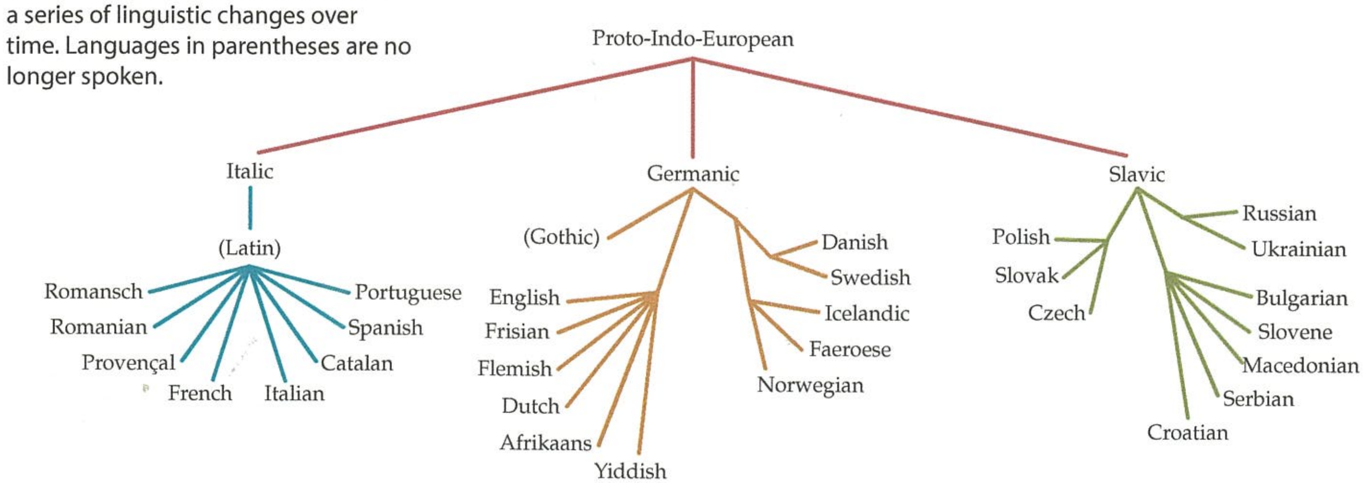
Modern English
Our father in heaven, may your name be sacred. Let your kingdom come. May your will be fulfilled as much on earth as it is in heaven. Give us today our daily bread. And forgive us our transgressions, as we forgive those who transgress against us. And do not lead us into temptation, but free us from sin. For the kingdom and the power and the glory are yours forever. Amen.

protests of stodgier generations, speakers of the English language stopped differentiating between singular and plural pronouns for the second person—*you* (plural) and *thou* (singular) became collapsed into the pronoun *you*, used for either the plural or singular. The phenomenon of language change has long been studied with great interest by linguists. In fact, at the time Charles Darwin was still mulling over his ideas about biological evolution, linguists were already well aware of language's tendency to mutate and gradually shape-shift—often diverging over time into separate languages, just as genetic drift can eventually result in distinct species (see **Figure 2.5**).

In biological evolution, mutations occur randomly and natural selection determines whether a mutation spreads throughout a population. Some contemporary language researchers have been advocating a modified notion of natural selection as a force that shapes linguistic mutations. This perspective raises an interesting question: What characteristics does a language need to have in order to ensure its survival? It seems logical that at least two criteria would need to be met:

1. *The language needs to be communicatively useful.* This means that the language should be able to convey the information that people want to get across in an efficient way. Efficiency probably needs to be seen from the perspectives of both the speaker and the hearer. Ideally, the delivery of information should take as little time as possible to utter (and to make sense of), and it also shouldn't put too much strain on the processing resources of either the speaker or the hearer. Forms that take too long to utter, or that mentally tax the speaker, or that are subject to misunderstandings by the hearer, will simply be used less often than more optimal forms, so over time, people will converge on the best communicative solutions.
2. *New learners need to be able to learn the language.* The features of a language that are difficult to learn will simply *not* be learned and, as a result, won't be passed down to a new generation of learners. This means that new learners may play an important *filtering* role in shaping language. In fact, several researchers (e.g., Mufwene, 2008) have proposed that this filter is the driving force behind linguistic changes that take place when a language is passed from one generation to another—maybe it's not so much that children *innovate* changes more than previous users of the language, but that they play a key role in selecting which of a number of inconsistently produced innovations will survive and become more systematically used by speakers of the language.

Figure 2.5 A dendrogram (tree) presenting the relationships among some of the modern European languages, showing how they diverged from a common ancestral language through a series of linguistic changes over time. Languages in parentheses are no longer spoken.



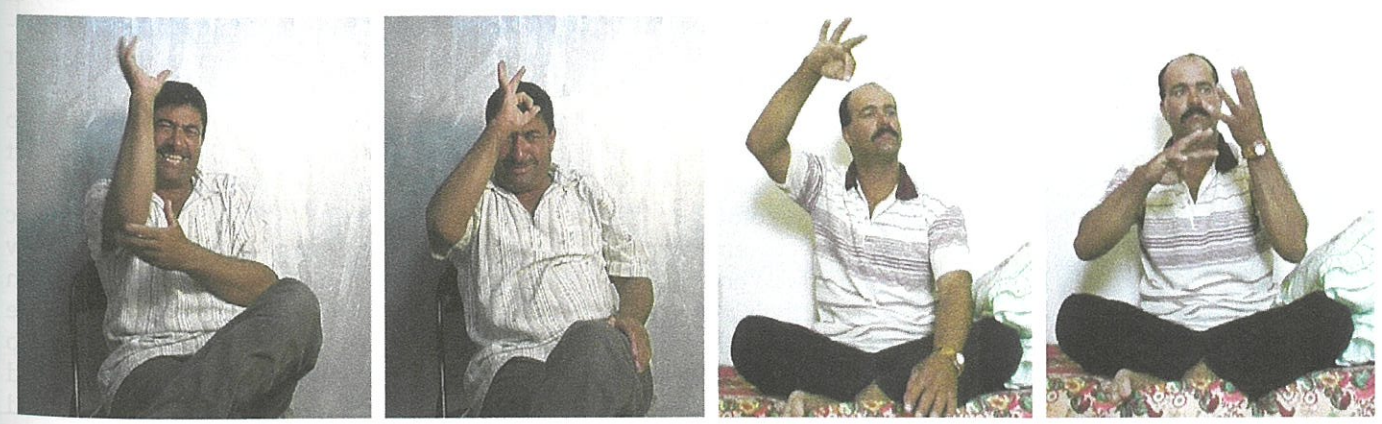
What's adapting to what?

The perspective of linguistic evolution offers a dramatic reversal of the traditional nativist stance on language, as noted by Nick Chater and Morten Christiansen (2008). Nativists who argue that children are innately outfitted with a universal grammar take the view that the human mind has changed over time so as to adapt to the forms and structures that occur in human languages. But the alternative perspective I've just sketched out—let's call it the **cultural transmission view of language change**—says that it's *languages* that have changed over time so as to adapt to the human mind, with all the constraints, limitations, and abilities that human minds bring to the task of learning or using language. Each of these two accounts offers an explanation for why it is that human languages share a number of similarities with each other, but the explanations look strikingly different. Under the nativist view, commonalities across languages reflect hardwired biases to learn certain forms of language. These biases allow children to quickly zoom in on the correct structures of their languages rather than floundering around considering all the logical possibilities. Under the cultural transmission view, languages are similar to each other because they've all had to adapt to the human brain, and presumably, the capabilities and limitations of the human brain are similar across many cultures.

cultural transmission view of language change The notion that languages change over time to adapt to the human mind, with all the constraints, limitations, and abilities that human minds bring to the task of learning or using language. This view stands in contrast to the nativist view, which holds that the human mind has changed over time because it has become adapted for the requirements of language.

The cultural transmission view has some fascinating implications to explore. For example, if the cultural forces of "natural selection" include both a language's usefulness *and* its learnability, then perhaps a language might be coaxed into different shapes depending on the makeup of the population that uses and learns it. For instance, it might be very interesting to compare the development of Nicaraguan Sign Language with another emerging sign language that has recently caught the attention of language scientists, Al-Sayyid Bedouin Sign Language, or ABSL (see **Figure 2.6**). First described by Wendy Sandler and colleagues in 2005, ABSL has emerged in a small Bedouin community in Israel. This community is unusual in that a great many of its members have an inherited form of deafness because of the high rates of intermarriage within the small population. Far from posing a problem for the community, this has led to a new signed language, created by the people and used by deaf and hearing individuals alike. A deaf child grows up fully integrated within the society, and usually marries a hearing person—which means that families continue to be a mixture of hearing and non-hearing individuals, which in turn motivates hearing members of the family to learn ABSL. This emerging language is now three generations old; its earliest

Figure 2.6 Two speakers of Al-Sayyid Bedouin Sign Language, spoken by about 150 deaf and hearing speakers of the Al-Sayyid Bedouin community in the Negev desert in southern Israel. (From Senghas, 2005; photographs by Shai Davidi, University of Haifa.)



adopters are now dead, so it's not possible to know exactly how this language first came to be, and whether it was at the initiative of deaf or hearing people or the result of a joint effort. But what is known is that even the basic word order is different from any of the spoken languages in the region, so from the beginning, it seems to have sprung up with its own structures rather than simply importing them from the nearest spoken language at hand.

There are a few striking differences between the groups of people who collectively created NSL and ABSL, and as pointed out by Annie Senghas (2005), these differences might turn out to be relevant for how the languages take shape. First of all, the speakers of ABSL all come from a single very tight-knit community, whereas the speakers of NSL were bused in from across a large region, coming from many different families and villages that have little connection to each other. Why might this matter? Remember that many of the innovations that were brought into NSL involved making the linguistic code more precise and unambiguous. This reduced people's need to rely on shared contextual knowledge in order to recover the subtleties of the intended meaning. The earliest speakers of NSL, gathered together as they were from diverse backgrounds, would likely have had much less shared knowledge with each other than the earliest speakers of ABSL. Because of this, the communicative pressures within the two communities might have been quite different, with possibly more pressure on the NSL community to pack a lot of information into its linguistic code very early on.

A second important difference between the two communities speaks to the issue of learnability. New learners of ABSL are exposed to the language from birth within their own families. But deaf children in Nicaragua typically don't start to learn NSL until they're old enough to be sent to school. This means that the cognitive makeup of the new learners is quite different across the two groups—if children serve as "filters" for the form of a language, this might result in different kinds of information being filtered out of the language system by the two different groups.

Linguistic directional selection

Newly emerging signed languages provide a special opportunity to look at how languages are shaped in their early stages of development. But perhaps we need not hunt far and wide for these rare cases of newborn languages in order to see the effects that different populations of learners might have on the languages that they pass on to later generations. It's true that the most common language-learning scenario is one in which children learn from birth the language of their parents, which their parents in turn learned as infants from *their* parents. But historical events intervene often enough to create a variety of different learning situations. We can look pretty close to home, at the historical development of English. In the ninth and tenth centuries, a large number of Vikings from Scandinavia invaded England and settled there. Their language was Old Norse, but they interacted with English speakers, picking up the English language and mixing bits of Old Norse with Old English—a fact to which we owe words like *window, cake, smile,* and *skin,* among many others. But according to linguist John McWhorter (2002), the Vikings' linguistic legacy went much deeper than simply sprinkling our language with some new words. McWhorter argues that many of the first Viking learners of English learned their new language as adults, not as children, and as a result were past the age of smooth and effortless language learning. They'd be unlikely to have achieved native-like proficiency, which means that if their children relied mainly on their parents for English language input, they would have received

a distorted, inconsistent version of it. McWhorter goes on to suggest that this unusual learning situation was responsible for a long-standing puzzle in the history of the English language—namely, the fact that English has shorn off many of the grammatical markers that are found in related languages such as German and Dutch, and which were presumably present in the ancestral language from which they all evolved. There are many ways in which English is different from its Germanic sibling languages, but overall, the effect has been to strip away certain grammatical markers from the linguistic code in places where the meaning can be inferred from the context (see **Box 2.7** for an example). McWhorter's theory is that a generation of adult learners of English caused a disruption in the normal transmission process, thereby simplifying the grammar.

Notice that this trend of simplifying the grammar goes in exactly the opposite direction from the NSL innovations you saw earlier. In looking at NSL, we saw how a younger generation of signers elaborated the language by creating new grammatical markers to *consistently communicate certain concepts in the linguistic code* rather than leaving them dependent on context. McWhorter argues that over extended periods of time, languages have a tendency to accumulate such markers and force their use even in situations where they're not really needed. Markers become entrenched in the language, he claims, because they're easy for children to learn, given their superior language-learning abilities. But if a language ever has to contend with large numbers of adult learners,

BOX 2.7
Reflexive markers in Germanic languages

In his 2002 paper, John McWhorter discusses a number of ways in which English has dropped grammatical markers that are present in other Germanic languages. The reflexive marker is one such example.

In English, we use pronouns like *himself* or *herself* to communicate reflexive actions—that is, actions in which the person who initiated an action is also on the receiving end of it, as in *he shot himself* or *she scratched herself.* But when it's the case that the action is *usually* performed on oneself, we don't have to include the pronoun (though we can): *he shaved (himself), she bathed (herself).* When the reflexive is absent, it's understood that the action was performed on oneself.

But in other Germanic languages (see Figure 2.5), a reflexive grammatical marker is obligatory, even if this information seems obvious from the context. In these languages, it's even obligatory to attach these markers with many verbs that English speakers think of as so inherently reflexive that it would be very odd to ornament them with a pronoun like *himself*—for example, verbs like *move, hurry, bow, sneak,* and so on. In the following examples of expressions in which reflexive markers are obligatorily attached, the reflexive markers are in bold italics.

German: ***sich*** *rasieren* "to shave"; ***sich*** *beeilen* "to hurry"; ***sich*** *erinnern* "to remember"

Dutch: ***zich*** *scheren* "to shave"; ***zich*** *bewegen* "to move"; ***zich*** *herinneren* "to remember"

Frisian: *hy skeart* ***him*** "he shaves"; *ik skamje* ***my*** "I am embarrassed"; *ik stel* ***my*** *foar* "I imagine"

Afrikaans: *hy bevind* ***hom*** "he is situated (at)"; *hy roer* ***hom*** "he gets going"; *hy herinner* ***hom*** "he remembers"

Swedish: *raka* ***sig*** "to shave"; *röra* ***sig*** "to move"; *känna* ***sig*** "to feel"

Faeroese: *raka* ***sær*** "to shave"; *snúgva* ***sær*** "to turn"; ætla ***sær*** "to intend"

Yiddish: *bukn* ***zikh*** "to bow"; *shlaykhn* ***zikh*** "to sneak"; *shemen* ***zikh*** "to be ashamed" a highly elaborate set of grammatical markers can impose an especially stringent learnability filter.

Proposals like McWhorter's arouse a fair bit of controversy within the language research community. But by portraying language as a system that evolves and adapts to its particular population of users, these ideas provoke new ways of thinking about why languages are the way they are and what they have in common. And in doing so, these ideas force us to think about the role that cultural transmission plays in the emergence of language.

Theories of cultural transmission provide an alternative to the notion of universal grammar when it comes to thinking about how language and the human mind fit together. But the two general approaches need not be incompatible. It could well turn out that we have a core set of innate predispositions that come from our being genetically adapted for language. But it may also be true that not all of the universal properties of languages have come out of these predispositions—some of them may have arisen as adaptations of languages to us.

What we still don't know

While language science isn't yet in a state where we can confidently choose among any of the competing views of language evolution that we've described in this chapter, it *is* in a state where it makes sense to spend a lot of time discussing them. The various theories can now serve as an engine to drive the more detailed questions that researchers need to resolve before being able to answer the big questions of where language came from and why we have it. Much of the detailed groundwork will have to do with questions like these:

- What do our language-related abilities look like, and how specialized are they—that is, how similar or different are language abilities from the cognitive abilities we use for purposes other than language?
- What are the structural properties of language, and what are the optional versus obligatory aspects of language?
- How are the various components of language learned, and why do children seem to learn them better than adults?
- How do we produce and understand language, and under what conditions do we do these things smoothly or bumpily?
- How do speakers and hearers negotiate how much information needs to be put into the linguistic code, and how much can be left to be figured out from the context?

The upcoming chapters will deal with these questions. Here's an interesting exercise: After you've worked your way through this book, come back and reread this chapter. You'll likely find that with the knowledge you've gained, the big themes that have been sketched out in this chapter will feel more "alive" for you. You may find yourself developing strong opinions about competing ideas about language evolution, spinning off new questions, generating new hypotheses, and even thinking of ingenious ways to test some of those new ideas.

GO TO
sites.sinauer.com/languageinmind
for web activities, further readings, research updates, new essays, and other features

DIGGING DEEPER

Language evolution in the lab

Spontaneously invented languages such as homesign or NSL and ABSL, don't spring up very often in the real world; they rely on a special set of circumstances where individuals are cut off from a community language. But it's possible to create an artificial analogue by throwing together a group of individuals and making them communicate with each other in a way that doesn't rely on the conventional language they share. This is the strategy that's been adopted by a number of researchers who are interested in the origins of language. In setting up artificial "language games," the goal is to generate insights about what kinds of features tend to recur in human communicative systems, and why. And by studying multiple iterations of the language game, where each learner of a "language" serves as the source of input to the next new learner, researchers can study how communicative forms are altered, smoothed out, or restructured. These changes can reveal which aspects of the system are most readily learned by subsequent "generations" of learners, or which features prove most useful for communication.

In this chapter, we've seen that human language is highly adaptable, and that if sound isn't an option, people can readily create a language out of gestural cloth. Lab-based language games use a variety of starting ingredients and can reveal common processes applying across very different types of symbols. For instance, in one study led by Carrie Ann Theisen (Theisen et al., 2010), pairs of adults played a game in which one of the participants (the Drawer) was presented with a word such as *teacher* or *university* and had to convey this concept to his partner (the Matcher) by drawing it on a computer with a mouse. The players interacted via computer in separate soundproof booths, and the only linguistic exchange that was allowed between them was when the Matcher typed his guess at which word was being conveyed and the Drawer responded by typing the actual word. There were 26 words as part of the game, and they were chosen so as to share some overlapping semantic features—for instance, a number of the words conveyed types of buildings, or people in certain professions, and there were thematic connections among the various words (e.g., *teacher, school, classroom, school bus; soldier, barracks, war, tank*). The players played the game for a total of 2 hours, with words being drawn randomly from the set of 26; over the course of the game, they would come across multiple examples of the same word.

One of the interesting findings from the study was that, over time, the drawings became more and more arbitrary—that is, they came to be less transparent in communicating the concepts, with the players making do with very schematic, simple visual signs. For example, take a look at **Figure 2.7**, which shows some of the drawings of one pair toward the end of the game. The drawings are hard to interpret for anyone not privy to the evolving system of signs. Over time, the drawings became

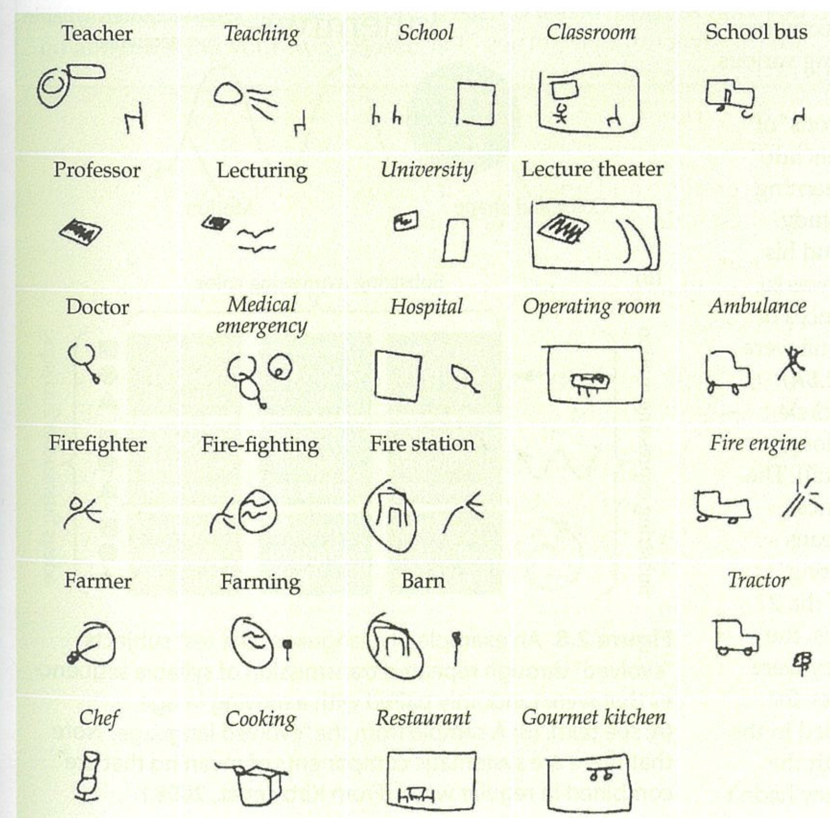


Figure 2.7 Signs used by one pair of participants in the drawing task studied by Theisen et al. (2010).

much more efficient—they required very little time to draw—but they relied on shared interactions with previous, more elaborate signs.

This development echoes some of the transformations over time within Nicaraguan Sign Language. Many of the earliest signs produced by children in the NSL community were highly iconic—that is, they were transparently related to the concepts they were intended to convey. Over time, the signs became much more compact, included less detail, were quicker to produce, and as a result, became more arbitrary. The drawing study suggests that this apparently universal feature of human languages reflects a highly general process in which the repeated use of a sign allows it to become pared down and less transparent.

Another interesting aspect of the drawing study was the extent to which the players re-used elements to communicate concepts that shared certain semantic features. For instance, in Figure 2.7, all of the words that are thematically related to the concept of "school" include a little symbol representing a chair. Buildings of various kinds are often represented by a square. The partners devised a system in which meaningful elements like these could be combined with each other. By re-using and combining meaningful elements, the drawers enabled their partners to better predict new drawings that they'd never seen before. Again, this reflects some of the processes that are visible in NSL and homesign. Rather than faithfully reproducing the details of an event through pantomime, signers tend to break signs apart into smaller linguistic units and combine them in ways that highlight the relationships among various sequences of signs.

Language games that involve multiple "generations" of players over a number of iterations can offer insights into how a system might evolve over time to adapt to learning challenges and expressive needs. One interesting study along these lines was carried out by Simon Kirby and his colleagues (2008). Players were told that their task was to learn an "alien" language that paired written sequences of syllables with certain visual stimuli. The visual stimuli were set up to vary along three dimensions (see Figure 2.8A). They consisted of three geometric shapes (square, circle, triangle) in three colors (black, blue, red) moving along three motion paths (left to right, bouncing, in a spiral). The starting language was set up so that syllable sequences were randomly paired up with the stimuli—this means that there could be no patterns inherent in the starting language. The first generation of subjects saw 14 of the 27 possible stimulus pairs in a training phase. After this, the subjects went through a testing phase, in which they were shown all 27 of the visual stimuli and asked to guess, for each visual stimulus, what that object would be called in the alien language. This meant that they were faced with the impossible task of guessing the names of objects they hadn't seen before. The guesses they came up with then served as the input language to the next learner, and so on, until the language had gone through 10 iterations.

Despite the fact that the word/object pairs were random, the players soon imposed a pattern on the language—for instance, if by coincidence the same syllables appeared in the words for objects that shared features, this might be seized upon, and the relationship would be amplified by a player in his guesses. Since these guesses served as the input language to the next player, the connection between the sounds and features would be even more frequent than in the original, and therefore even more likely to be noticed and amplified by the next learner. Over a series of generations, the link between features and syllables would come to reflect highly systematic relationships between features and sound sequences, as seen in Figure 2.8B.

Lab experiments like these give us a window into the biases that shape communicative systems at their outset, and into the ways in which such systems tend to be transformed as a result of repeated interactions between people, and over a series of generations. But what can they tell us about the origin of the forces that shape the language-like systems? For example, can they yield some insight into the question of whether these general biases are innate, or instead, whether they're the result of languages adapting to the learning constraints and communicative goals of their users?

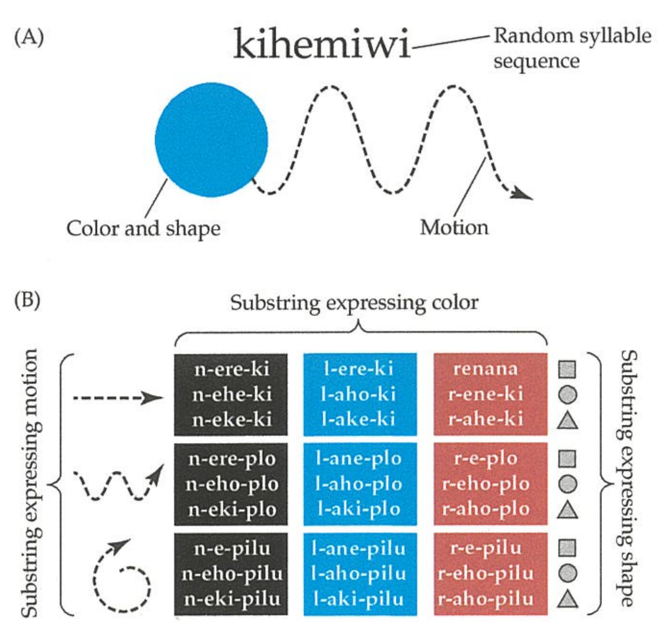


Figure 2.8 An example of a language that test subjects "evolved" through repeated transmission of syllable sequences that were randomly paired with a moving image (A; see text). (B) A sample from the "evolved language." Note that there are systematic components of meaning that are combined in regular ways. (From Kirby et al., 2008.)

The real power of studying language evolution in the lab lies in the possibility of tweaking important variables and observing their effects. We can tell whether certain biases are fixed or highly responsive to the communicative demands of a situation simply by changing some aspect of the language game. If the biases are highly malleable, this suggests that their origin lies in the communicative pressures imposed by the game. For example, Kirby and colleagues found that not all versions of their language game resulted in the system shown here, in which people encoded specific semantic features with particular syllables and combined these in a predictable way. This only happened if players were led to expect that the language had to differentiate between any two different visual stimuli. When this expectation wasn't built into the game, the players settled on a language system where a single syllable string (e.g., *tuge*) could be used to describe all objects moving in a left-to-right manner, regardless of their shape or color. This made the language much easier to learn than the combinatorial version—but it also made it less expressive.

Other variables can also be manipulated within an experiment. We might want to see how an emerging language is shaped by young learners versus older learners; we might want to observe the effects of learning within a large community of speakers versus a small one; or observe a learning situation in which most of the learning comes through contact with a small number of speakers of the language, or a large and diffuse community of speakers. Variations like these could provide a great deal of insight into the nature of universal or highly common aspects of language.

PROJECT

Do some research and identify several aspects of English grammar that have changed over the years. Do the changes codify a distinction that had been previously left to context, or do they drop off or collapse together earlier grammatical distinctions that now need to be recovered from context? Speculate about the possible forces driving these changes. Do they make the language easier to produce? Easier to understand? Easier to learn? Discuss how you might go about testing your hypotheses.