7 Language

One important aspect of being human is our ability and desire to communicate with one another. In this chapter, I will emphasize an evolutionary understanding of language. Like emotion, everyone knows what language is, but no one can define it. In 1866, the Linguistic Society of Paris banned papers or debates regarding language because no one could agree on the nature of language. Even today it has been suggested that linguists will not be able to understand evolutionary questions related to language until they are able to define what language is (see Locke, 2010 for an overview). Without a definition of language, it is difficult to answer such questions as "Do animals have language?" We know that bees perform a "dance" that tells other bees where to find nectar. Is this language? Or, should American Sign Language (ASL) used by deaf humans be considered a language?

As you will see in this chapter, there has been considerable debate about the nature of language and its relation to evolutionary processes. Some researchers emphasize the social nature of language and its importance in group dynamics and look to the history of social interactions as an important evolutionary driving force (Dunbar, 1996). Others have emphasized the manner in which language may have been important in sexual selection and see its evolution from this standpoint (Miller, 2000). Still others suggest there is nothing special about language. That is to say, language is like many cultural processes that we learn from our society, but there is nothing biologically special concerning its acquisition and production (Skinner, 1957, 1986). This is countered by those who see language as different from other learning (Chomsky, 1959) and part of our evolutionary history, even to the extent that language can be considered a trait or instinct (Pinker, 1994). In fact, some researchers have suggested that language is the key to what makes us human (Bickerton, 2009).

From an evolutionary perspective, one can ask, "Does language have the earmarks of an adaption?" Hauser and Fitch (2003) suggest it does. In particular, they suggest that language has its own particular design features:

1. It is present in all humans.
2. It is mediated by dedicated neural circuits.
3. It exhibits a characteristic pattern of development.
4. It is grounded in a suite of constraints that can be characterized by formal parameters.

They further suggest that if we consider language to be an adaptation, it becomes fruitful to study it neuroscientifically and as an evolutionary process that can be examined across a variety of species. I begin with the nature of language. Later chapters will include additional information on social and sexual aspects of communication.

The Nature of Language

It is challenging to understand human language in the context of evolution. Since 1990, a large number of scientific articles and at least one book a year have been devoted to the theme of language evolution (see Bickerton, 1995, 2009; Christiansen & Kirby, 2003; Deacon, 1997; Locke & Bogin, 2006; Pinker, 1994, 2007). As humans, we understand language and speak without effort. In an amazing manner, a human infant can acquire any of the more than 6,000 existing languages on earth. Environmental factors, of course, determine which languages any of us learn. We appear to be the only species that speaks. However, a variety of species, including certain marine mammals, parrots, hummingbirds, and songbirds, have the ability to imitate sounds, which is necessary for the evolution of language, whereas primates do not (see Berwick, Okanoya, Beckers, & Bolhuis, 2011; Bolhuis, Okanoya, & Scharff, 2010; Hillix & Rumbaugh, 2004 for overviews).

Darwin noted the parallels between language learning in infants and song learning in birds. Current research suggests that there are a number of similarities in vocal learning between humans and songbirds (Berwick et al., 2011; Bolhuis et al., 2010). One parallel is the way human infants learn to speak and songbirds learn to sing. In both cases, learning results from an interaction of internal programs and specific experiences. Songbirds can imitate a variety of sounds, although they generally imitate songs heard from their own species. Human infants are quick to imitate other humans, even though other sounds are available to them from pets and other sources. If songbirds are reared in isolation, their singing does not develop normally. Abnormal language development is also seen in the few cases of humans who developed without access to human language. Thus, in both songbirds and humans, there is a critical period after which vocal learning becomes more difficult. This can be seen in humans who try to learn another language after puberty. In both the human infant and young songbird, a listening phase precedes a production phase. The initial stage of the production phase is not like the adult vocal productions (e.g., the babbling stage in human infants). Further, for both humans and songbirds, vocal learning is enhanced by social interaction. The parallels of human and bird vocal learning suggest the possibility of parallel brain and genetic mechanisms underlying this learning.

At least since the writing of Condillac in the 1700s until the present day, scientists have noted the large gap between the types of communication patterns seen in humans and those of other organisms. In terms of complexity, including vocabulary, grammar, and the range of ideas that can be expressed, there is nothing like human language in other species. Humans communicate with language in a way that is different from every other species. In other species, communication systems tend to be mapped in a one-to-one manner. A chickadee, for example, can produce a sound directly related to the size and location of a predator. Vervet monkeys will emit different alarm calls depending upon whether they see an eagle, a leopard, or a snake. However, these species have only one way of saying what was said. Even songbirds do not have the ability to combine sounds to create new meanings. With human language, on the other hand, there are a variety of ways of conveying the same information. If there is a dangerous fire, you can say "leave," "run," "get out of here," "there is a fire," "there is danger," and so forth. Pinker (2003) suggests that the most powerful aspect of language is its ability to convey an unlimited number of ideas from one person to another using only a stream of sounds.

Honey bees are one species that does appear to have a more complex system of communication. Bees can use their sensory systems to determine color, scent of flowers, locations, and other factors as they gather food. What is interesting is that once they locate a food source, they return to the hive and use various types of movements to communicate to the other bees the direction, distance, and quality of food. These movements or dances were carefully studied by the Austrian ethologist Karl von Frisch (1967). Von Frisch was able to determine the meaning of these bee movements, and in 1967 he won the Nobel Prize along with Nikolaas Tinbergen and Konrad Lorenz. Although the communication system involving movement is complex, it is also limited in vocabulary or concepts. For example, one of von Frisch's assistants placed a food supply in a tower that the bees were able to discover. These bees then returned and described the location of the food to the other bees, who then went to the location. They discovered the tower but not the food, which was higher up. Thus, it appears that the communication system of the bees is two-dimensional and has no means to communicate height. Although von Frisch called his book *The Dance Language and Orientation of Bees*, there are those who question whether this is really a language. Let us now turn to the nature of human language.

There are at least four questions that can be asked from an evolutionary perspective (Kirby, 2007):

1. Structure: Why is language the way it is and not some other way? How can an evolutionary approach explain the particular language universals we observe?
2. Uniqueness: Why are we unique in possessing language? What is so special about humans?
3. Function: How could language evolve? What were the selective pressures involved?
4. History: What is the evolutionary story for language? When did it evolve? Were there intermediate stages?

These questions reflect the different approaches a variety of researchers have taken over the years. However, at this point we do not have clear answers to these questions. In this chapter, I will help you understand what we have discovered thus far.

THE EVOLUTION OF LANGUAGE

What is the function of language and how did it evolve? Darwin viewed language as the result of an evolution that began with inarticulate cries, gestures, and expressions, as seen across a variety of species, followed by a series of steps in which humans moved to an articulated language. Indeed, one hypothesis suggests that a common origin for vocalization evolved more than 400 million years ago in fish. We usually do not think of fish vocalizing, but some are able to do so with the aid of an air sac that is used for buoyancy. Using muscles associated with the air sac, these fish are able to vibrate the air sac in such a way that it functions as a resonance chamber and amplifies sound. These vocalizations are related to mating and defense of territory. Researchers have been able to examine the brain circuits related to these sounds (Bass, Gilland, & Baker, 2008). What is intriguing is that the organization of these circuits is consistent with vocal systems in frogs, birds, and mammals, suggesting a common body plan for vocalization. The relation of this type of social vocalization to speech in humans is still being determined.

It has been suggested by a variety of authors that the expanded childhood of humans set the stage for language learning. That is to say, the longer contact of the child with its family and the need for complex communication would support the development of language. This, in turn, is followed by a period of adolescence, with the pressures of social interactions (Locke & Bogin, 2006). Surprisingly, a variety of research studies from numerous cultures suggest that one main topic of language is social relationships—generally referred to as gossip. What do you talk to your friends about? The answer is usually other people. In this sense, one function of language is to keep the connection in social relationships. What do other primates do to bond social groups? The answer is grooming. By analogy, Dunbar (1996, 2003, 2004) suggested that language is to humans what grooming is to other primates. Actually, he suggests that language evolved in a series of stages, with grooming at the earliest stage, followed by vocal chorusing as a way of bonding a group, followed by a socially focused language, and finally the metaphoric and technical language we use today (Dunbar, 2003). Although we don't pick small insects from each other's heads, we do gossip. It is clearly a way we bond with each other. Walk across a college campus and notice what most people are saying to each other on their cell phones. They are usually talking about other people and, of course, themselves.

The idea of language as grooming might also support the idea that language evolved from basic motor processes (Lieberman, 2000, 2006). For example, think about the importance of using our hands as we talk to others. It might also suggest that language is an extension of the basic mating dances seen in a variety of species. Rather than perform a mating dance, we "chat someone up," as the British say. Further, language is used to convey a variety of underlying processes. Sometimes we use sounds as a place filler, such as "uhhh" or other sounds. Also, there are numerous types of logic that underlie our words. Teenagers tend to reason by analogy: They will, like, say that, like, everything is like something else. Scientists use more formal logic to rule out alternative hypotheses. We also use language to describe empathetic reasoning, to show we understand another person's experience. The point is that language can describe a variety of internal and external processes. It is this cumulative process that enables languages and their derivatives (spoken and written forms) to set the stage for culture to play a role in human history that is very different from that of other species.

THE STRUCTURE OF LANGUAGE

When we think about language, there are at least five factors that should be considered. First, a language is regular and has rules, which we call a *grammar.* Second, it is productive. That is to say, there are an almost infinite number of combinations of words that can be used to express thoughts. Third, words in a language are arbitrary, in that across languages any word can refer to any thing. For example, the words "dog," "chien," "perro," and "hund" all refer to the same animal but in different languages

(English, French, Spanish, and German). As far as anyone can tell, there is an arbitrary relationship between words and their meanings. An exception to this is onomatopoeia, which refers to a word that imitates the sound it represents, such as "tick tock" or "cuckoo." Fourth, languages are discrete, in that sentences can be divided into words and then into smaller bites of meaning called *morphemes* and then into sounds. And fifth, languages are linear, in that words are presented one after the other. Further, language can help us to describe both the internal world that we experience personally and the external world that we experience around us.

Researchers interested in language separate it into levels of analysis. All languages begin with sounds. The basic sound of a language is referred to as a **phoneme**. The study of the ways phonemes can be combined in a language is called **phonology**. There are approximately 100 different phonemes used in all languages around the world. English uses approximately 40 phonemes. For example, the phoneme "ba" associated with the letter "b" is an element unto itself. By itself, it has no meaning other than the sound we process. As we will see, every infant can recognize and reproduce all of the 100-plus phonemes. As we grow older, we lose this ability and are limited to the phonemes in the languages we learned early in our lives. For example, Japanese does not have the "qu" phoneme associated with the initial sound in the English word "quack," and Japanese speakers find it almost impossible to pronounce that word. Of course, English speakers have similar problems when repeating phonemes in other languages, such as the "ch" sound in German. What is interesting in terms of language learning is that we rarely hear these basic sounds in isolation.

The next level of analysis is a **morpheme**—the smallest meaningful unit of a language. Morphemes can be words (e.g., "cat," "house," or "paint"). Morphemes that can stand alone are called *free* morphemes. Morphemes can also be *bound*; that is, they cannot stand alone. Examples of such morphemes are tense markers on verbs (e.g., paint-ed, drive-s), number markers on nouns (e.g., boy-s, child-ren, church-es), prefixes on adjectives (e.g., un-believable, in-tolerant, co-worker), suffixes on nouns and adjectives (e.g., boy-hood, formal-ity, good-ness), and so forth. Words can become quite complex morphologically, even in a language like English, which is not known for its morphological makeup. For example, a word (morpheme) like *form* can be suffixed to form an adjective (*form-al*), prefixed to become the opposite (*in-form-al*), turned into another noun (*in-form-al-ity*), then pluralized with yet another suffix (*in-form-al-iti-es*), with the final outcome containing five morphemes.

The next level of analysis is **syntax**—the structure of a sentence and the rules that govern it. For example, one rule is that sentences must have both a noun and a verb. Finally, **semantics** is the study of meaning. That is, how do we understand what is being said? A critical question in the study of language is how humans are able to move between the levels of meaning and syntax.

What Is Language?

In the 1960s, Noam Chomsky (1966, 1968) helped to establish many of the ideas and debates that today influence how we think about language. He suggested that all humans have a set of innate principles and parameters, which he called *universal grammar*. The **universal grammar** describes the total range of morphological and syntactic rules that can occur in any language. Chomsky's original goal was to describe the manner in which spoken language is mapped onto meaning. The actual spoken word, with its grammatical structure, is called "surface structure," whereas the meaning of the speech is called "deep structure." As illustrated previously with the example of a dangerous fire, there are a variety of ways (surface structure) of saying this, which would convey the same meaning (deep structure). An extension of this idea is shown with bilingual individuals who often will remember an event or idea but cannot remember in which language they learned about the event.

Chomsky (1966, 1968) was interested in describing the rules by which deep structure is transformed to speech, and vice versa, by investigating the rules shared among all languages and those that are language-specific. Related to the notion of universal grammar is the critical idea that language is generative. This suggests that there exists a learnable finite system of rules that can generate an infinite number of sentences. The basic observation is that we can generate sentences we have never uttered before, as well as understand sentences we have never heard before. By the age of 3, children are fluent speakers of their language without any formal instruction in the nature of grammar. Even more impressive is their ability to invent languages that are more systematic than the ones they hear and to follow subtle grammatical principles for which there are no examples in their environment (Pinker & Bloom, 1990). Listen to what you say to your friends. Each time you speak, you generally use a sentence you have never used before. Sure, the meaning is similar to other times you have spoken, but the exact wording is different. Without thinking, you produce the sentences and you understand the sentences. What is more, you extract meaning even when there is ambiguity. A sentence like "Flying planes are dangerous" or "The sailor passed the port" is simple for humans to understand, given a context, but difficult for a computer to understand due to the ambiguous nature of the sentence. Further, we extract meaning from language in a way that is not always logical: "We park in a driveway and drive on a parkway." Although children learn to speak a language and use the rules of grammar so quickly, Chomsky was not convinced that language could be explained by Darwin's understanding of evolution. According to Chomsky, language may have appeared as our brains became larger and more complex. Thus, language learning was not a product of natural selection but an emergent property of brain complexity. It is unclear why Chomsky rejected language being influenced by natural selection, unless it was his view that language is somehow different from other human faculties. However, he still saw language facility as an inborn ability and referred to language learning in humans as the innate *Language Acquisition Device* or LAD.

One language researcher who does see language as shaped by natural selection is Steven Pinker. Pinker (1994) begins with the suggestion that the process of language learning must be innate. In this way, language can be considered the same as any sensory process or instinct whose development can be viewed from an evolutionary perspective. In fact, Pinker suggests that language possesses the same type of design features as physical structures such as the eye. What is especially intriguing to Pinker is that in teaching a language, parents give children examples of language through their speech but do not teach rules per se. However, children are able to infer the rules and apply them automatically. One example of this in English is when children say "he runned" or "she goed," rather than "he ran" or "she went." Clearly, the child is applying a past tense rule rather than just repeating what his or her parents said. The fact that children apply such language rules suggests innate mechanisms for language learning based on universal principles, rather than just copying what a parent says. In this sense, Pinker asks us to look to biological predispositions, rather than culture, in order to understand language learning.

One fundamental question of language relates to its role in the natural world (Pinker & Jackendoff, 2005). That is to say, how should we consider the evolution of language in relation to our biological processes as well as that of other species? Pinker and Jackendoff suggest that language is like other biological systems in that it has evolved by natural selection and shows signs of complex adaptive design. In particular, Pinker and Jackendoff suggest three specific questions to answer in this regard. First, which aspects of language are learned from environmental input, and which aspects arise from the design of our brains? Second, which parts of a person's language ability are specific to language per se, and which parts belong to more general abilities? And third, which aspects of language are uniquely human?

Over the years, it has been argued by such researchers as Alvin Liberman (1985) that speech is special. That is to say, humans are able to recognize certain sounds used in human speech in ways that other species cannot. However, other research has suggested that certain other species are also able to make these discriminations and that human language may not be special (see Pinker & Jackendoff, 2005 for an overview). This would suggest that the ability to perceive speech-like sounds predates the evolution of language in humans. The picture is complicated by the fact that humans use different areas of their brains for perceiving speech versus other auditory sounds. In fact, there is a certain type of brain damage called "pure word deafness," in which a person can hear environmental sounds but not analyze speech. There is also the opposite condition, in which a person can analyze speech but not recognize environmental sounds.

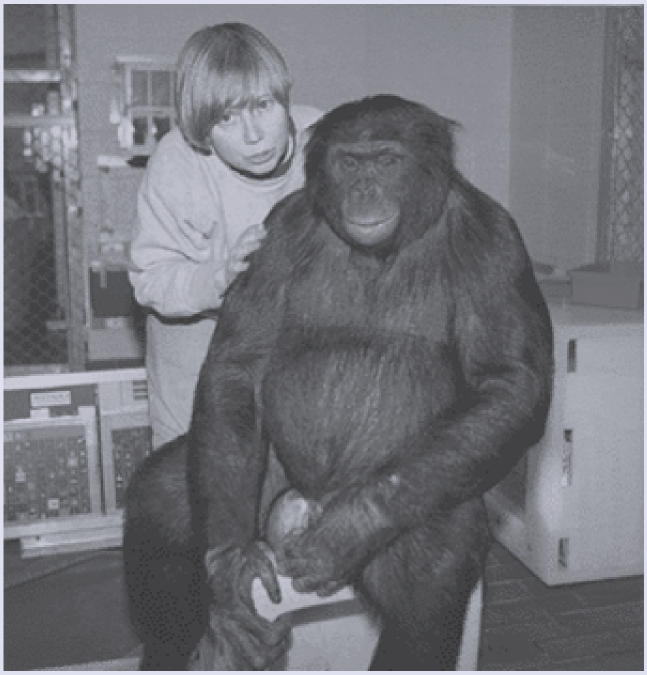
PRIMATES AND LANGUAGE

If language is special for humans, what aspects of language represent this specialness? We know that human infants, raised in an environment in which they are introduced to language, will perceive and produce language generally before age 3. We also know from some tragic situations that human children raised without exposure to language will never develop normal language abilities. It is also clear that other species do not develop the major aspects of human language in the wild. What would happen if a chimp, who is our closest genetic relative, were reared in an environment in which language was present (see Hillix & Rumbaugh, 2004 for an overview)?

In the 1960s, Allen and Beatrix Gardner raised a chimp named Washoe in their home. She was born in Africa and brought to the United States. Beginning when she was 10 months old, she was taught ASL, as if she were a deaf child. She had her own space in a house trailer in the Gardner's backyard. She actually wore clothes and shoes and learned to use a spoon and a cup. She was with adults who used sign language both with each other and with her. By the end of her first year with the Gardners, she knew about 50 words in sign language. What was intriguing was that Washoe was able to combine signs, such as YOU ME DRINK. Her level of sign language equaled that of human infants who lived in a household in which sign language was used. At one point, she dropped a toy down a space in her trailer when another assistant was taking care of her. When Allen Gardner came to the trailer, she signed the word OPEN at the place where the toy had fallen behind the wall. She is also reported to have signed WATER BIRD when she saw ducks on a pond. These examples would suggest that Washoe was doing more than just presenting information that had been previously learned. However, at about age 2, human infants show an increased learning of language not seen in Washoe. After about five years, Washoe's vocabulary was about 140 words. In comparison, a human first grader would know about 10,000 words, which would increase to 50,000 by the fifth grade.

In the 1980s, Sue Savage-Rumbaugh took a somewhat different approach to teaching communication to a bonobo, also referred to as a pygmy chimpanzee. This bonobo was named Kanzi (see Figure 7.1). What was really interesting was that Kanzi learned his first words by watching the researchers try to teach language to his mother. He actually displayed knowledge of words without ever being asked. The idea with Kanzi was to teach him to communicate. Like Washoe, Kanzi played with toys and was involved in

Figure 7.1 Sue Savage-Rumbaugh and Kanzi



Source: http://www.primatesworld.com/TalkWithChimps.html

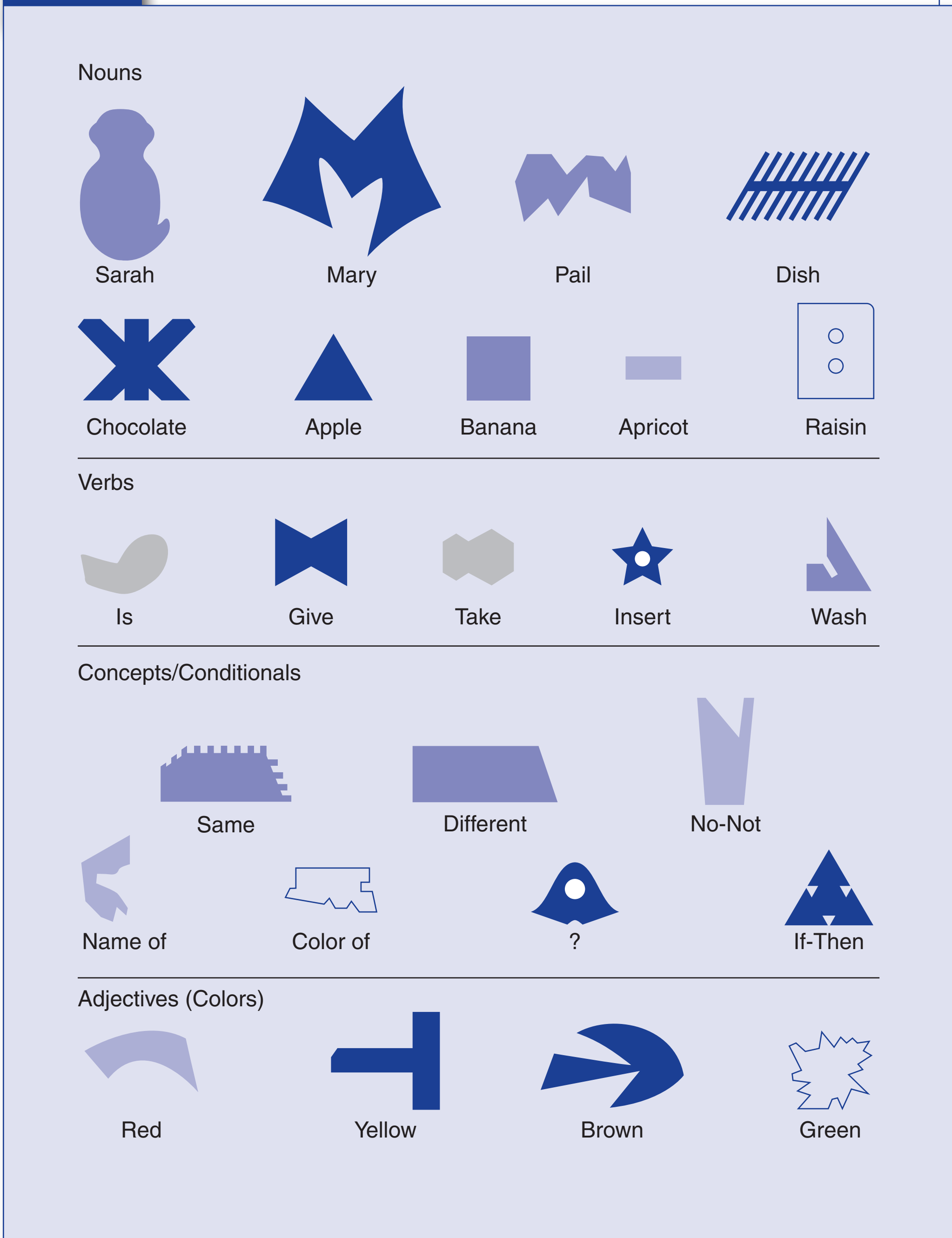
conversations taking place around him. He was also taken on walks around the research center, during which he was spoken to. However, this time the conversations were in spoken English and not sign language. There are a number of videos showing Kanzi responding to such English sentences as "Take off Sue's shoe" by performing the requested action. Also, Kanzi could respond by pointing to symbols. Each symbol represented an English word. Given Kanzi's ability to perform acts and respond to English questions, many researchers suggest he was able to understand sentence structure. For example, he was correct 75% of the time when given sentences like "place the book on the rock" as opposed to "place the rock on the book." However, he had more difficulty when asked to do two activities, such as "give Sue the bottle and the cup." He could do one, but not both.

Like Washoe, Kanzi's comprehension of language appeared to be comparable to that of a 2 ½-year-old child. If you would like to read an interview with Dr. Savage-Rumbaugh about primate language, you can go to http://pubpages.unh.edu/~jel/512/chimps/SSR.html and http://www.ted.com/talks/lang/eng/susan_savage_rumbaugh_on_apes_that_write.html. The research involving primate language suggests that basic linguistic abilities of some form existed before the evolution of human speech. What allowed humans to develop speech and move beyond the level of a 2-year-old child is still a hotly debated question (see Deacon, 1997; Lieberman, 2000 for overviews).

A different approach to teaching primates language was adopted by Ann and David Premack (Premack, 1976). The Premacks were more interested in cognitive processes and intelligence than language per se. However, their work helps inform animal language studies. They worked with a young female chimpanzee named Sarah. Ann Premack was born in China and drew from Chinese pictograms to create a similar set of pictograms for English (see Figure 7.2). These symbols could be placed on a magnetic board. The basic procedure was to study how Sarah learned a specific linguistic function. They were particularly interested in (1) how word meaning was related to existing knowledge; (2) how the primate learned such concepts as name of, color of, same and different, and other such concepts; and (3) rules for relating words to one another, including word order. Although size of vocabulary was not the focus of their training, they reported similar vocabulary size (approximately 130 words) as found with Washoe. Further, the Premacks suggested that language training actually changed cognitive abilities. For example, when shown an apple, a space for another object, and a cut apple, the language-trained primates could correctly pick out that a knife, as opposed to other objects, should be put in the space. Non-language-trained primates could not perform this task. They were also able to show that primates could learn same, different, and similar concepts. For example, big and small red squares would be seen as similar. In terms of language, the Premacks suggested that although primates could show some forms of reasoning and reading of symbols, they do not possess the ability to construct sentences or understand grammar as do humans. One critical part of this work was to show the connection between language and cognitive processes.

Duane Rumbaugh spent more than 30 years teaching animals to learn aspects of language (Hillix & Rumbaugh, 2004). One important primate in this work was a chimpanzee named Lana. Lana was taught through a key press board to name objects and ask for things (see Figure 7.3 on page 229). Each key was a lexigram that stood for a word. The keys were color coded: red lexigrams represented edibles and violet ones stood for the name of a person. It was also possible to reposition the lexigrams on the board, so that Lana was actually learning the lexigram rather than just its position. There was also a period key that would end and erase the sentence. Lana not only learned to ask for different types of food but also to push the period button if she made a mistake in her request or the sequence of key presses and wanted to start over. Interestingly, it was reported that Lana was 95% correct in completing valid sentence stems and rejecting those with fatal grammatical flaws. For example, she loved

Figure 7.2 The plastic symbols that the Premacks used with Sarah and other chimpanzees. These could be placed in various orders on a metallic board.



Source: Hillix and Rumbaugh (2004, p. 114).

the drink Coke and over the years would ask for it in different ways, such as YOU GIVE COKE IN CUP TO LANA as well as YOU GIVE CUP OF COKE TO LANA. Equally interesting is that over the years, Lana was able to give names to things that had never been named. For example, she called a cucumber a BANANA WHICH IS GREEN and the citrus fruit orange the BALL THAT IS ORANGE. Although initially it took Lana 1600 trials to learn to distinguish the names for M&Ms and banana slices, later differentiations took much less time. Rumbaugh suggests that Lana learned the concept that everything has a name, and this made later naming tasks easier. What is most intriguing is that if the researchers did not give her what she wanted, she would engage in a conversation with them through the lexigram board until she received something she would accept.

Some current language research using primates can be found at http://www2.gsu.edu/~wwwlrc/

Figure 7.3 Lana in front of her board on which she could press the keys to point to objects and to ask for things. Once pressed, the key would remain lit. In this way, she did not need to remember which keys had been pressed.

Source: Hillix and Rambaugh (2004, p. 129).

STRUCTURE OF VOCAL CORDS

Most nonhuman primates have the larynx higher in the throat than do humans. This enables them to breathe and drink at the same time, but not to make speech sounds. The human infant actually begins life with the larynx high in the throat. This also enables breathing and drinking at the same time. In about the third month of life, their vocal tract begins to descend and they can begin to produce a unique set of vowels, as would be found in words such as see, saw, and sue. These three vowel sounds are arranged at maximum distance from each other in the oral cavity, thus allowing for maximum discrimination. Also, humans have a larger area of the spinal cord necessary for breath control in producing speech than other primates, as well as an auditory system tuned to the predominant frequencies found in speech. It has also been noted that, during the first year of life, the human face changes from one with the features found in Homo erectus and Neandertals to that of modern humans (Lieberman, 2006). In Figures 7.4 and 7.5, you can see the location of the larynx in a chimpanzee and in an adult human.

How do humans make sounds that we hear as speech? We do it with our larynx, which also contains a cartilage we call our Adam's apple. By having

Figure 7.4 The head and neck of an adult male chimpanzee. Note the high position of the larynx, the long oral cavity, and the position of the tongue in the mouth.

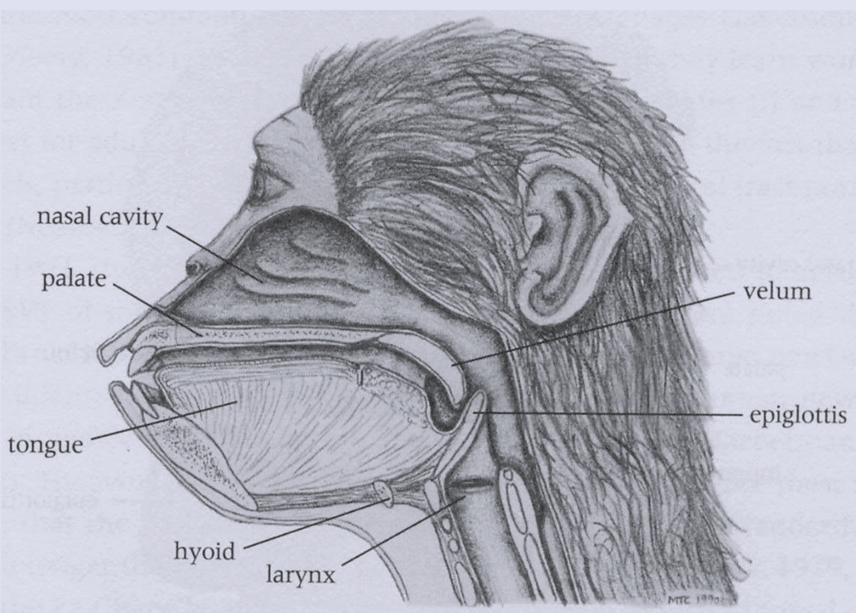
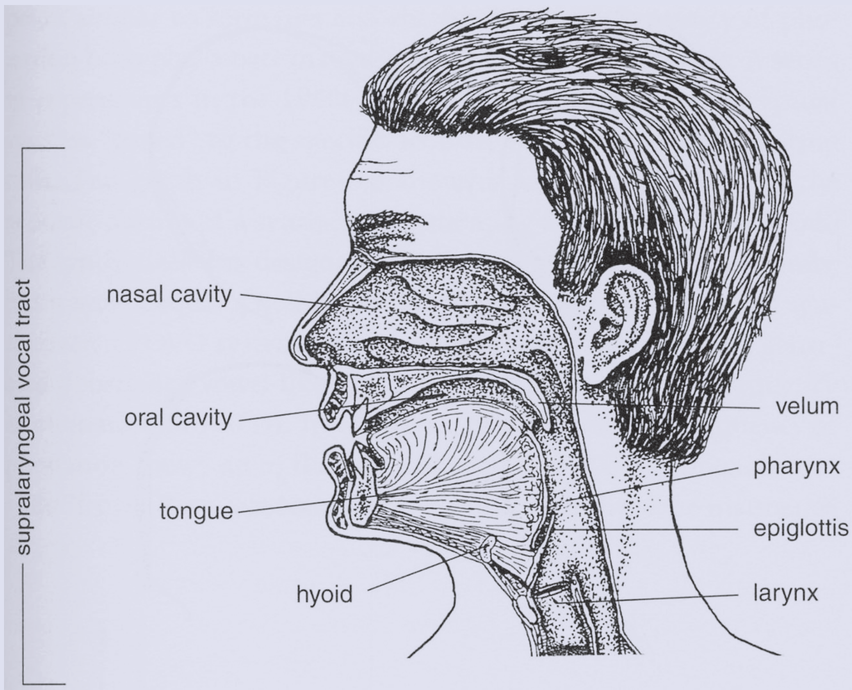


Figure 7.5 Diagram of the human vocal tract. Notice the lower position of the larynx.



your larynx low in your throat, you are able to make a wider range of sounds than other species can produce. To make a sound, the vocal cords in our larynx move in and out, modifying the continuous flow of air from our lungs into puffs of air. We also use our tongue and lips to modify speech sounds. Notice how your tongue is in different places and also has a different shape and manner of contact when you say "to" than when you say "shoe."

INFANT VOCALIZATION

One approach to understanding human vocalization has resulted from the study of the development of speech in human infants and young children (Oller & Griebel, 2005). During the first month of life, the human infant produces a wide variety of sounds that are assumed to be precursors to speech. These sounds may be uttered in any context—when the infant is alone, when he or she is with caregivers, and so forth. By the second month, the infant produces "cooing" sounds, especially in the context of interactions with others. Of course, throughout these periods, caregivers spend considerable time talking to the infant. During the next three months, children expand their range of sounds to include squeals, growls, and more vowel-like sounds, as their vocal cords begin to change. These "babbling" sounds contain both consonant and vowel sounds. What is interesting is that deaf and hearing infants coo and babble at the same ages. By about 10 months of age, however, the babbling of hearing infants becomes more like their native language. Deaf infants begin to babble with their hands if they have been exposed to sign language. Finally, at about a year of age, words begin to appear in the speech of hearing infants. They also begin to lose the ability to recognize speech sounds from any language other than their own. By two years of age, most infants have combined simple words and continue during the next year to reflect the grammatical rules of their language.

CREOLE LANGUAGES

What happens when a group moves or is moved to a new location in which people speak a different language? This was particularly the case during colonization by the major powers between the 16th and 19th centuries. Without formal language training in the new language, colonized individuals utilized a simple version of the new language, which is referred to as *pidgin.* Pidgin English, for example, was a much simpler version of English and often lacked correct grammatical structures as well as future and past tenses. Linguists have studied the manner in which pidgin has been created as well as the manner in which the children of these immigrants learn language. What is surprising is that the children do not just copy the pidgin of their parents, but instead create a new type of language with specific grammatical rules. This more structured form of the original pidgin is referred to as *Creole.*

It has been suggested that Creole languages throughout the world use a very similar grammatical structure. The structure is not related specifically to the new language; it appears to be universal. The argument that has been made by a variety of researchers is that the similarity of structures from a variety of Creole languages throughout the world is reflective of a biological program for language. This suggests that language is created in the brain by a set of biologically determined rules, rather than just copied by children from their parents. If Creole was just copied by the children from the parents, then you would expect that the children would speak the same pidgin that their parents spoke. One important statement of this position is that of Derek Bickerton (1984). He studied Hawaiian Pidgin and Hawaiian Creole and suggested that in this case, the movement from pidgin to Creole was accomplished in a single generation. He further suggests that this supports the idea suggested by Chomsky that there exists a modular organization of language, rather than a general process of the brain not related to language per se.

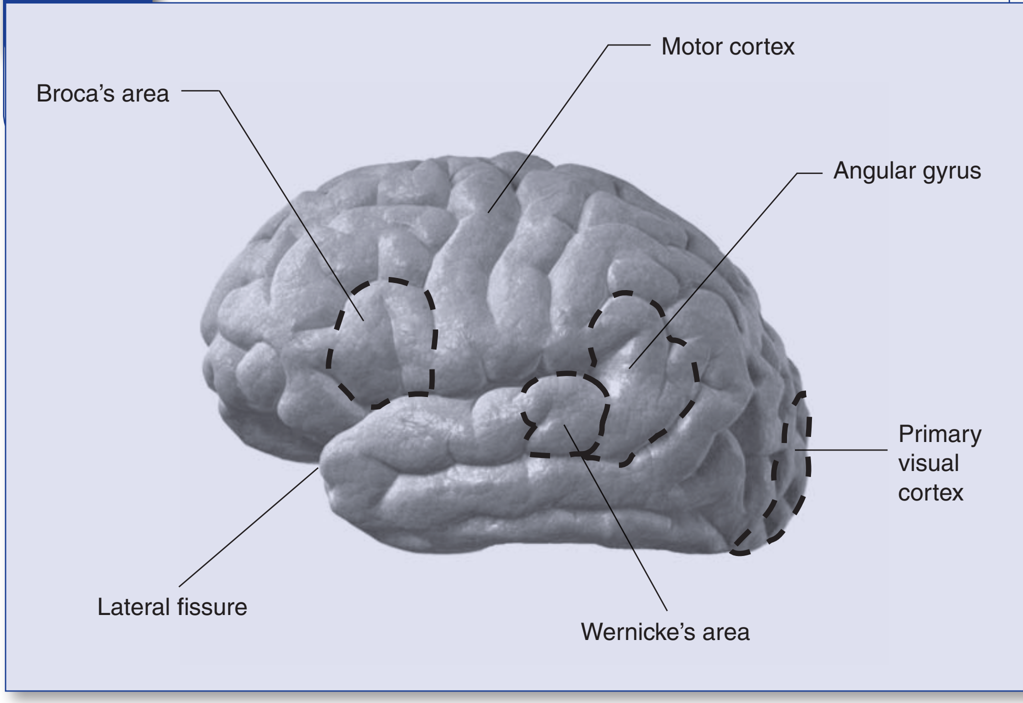
GENETICS AND LANGUAGE

There is a rare language disorder called *developmental verbal dyspraxia* (DVD) that is inherited and has been linked to an allele of the FoxP2 gene on chromosome 7. Humans with this allele show problems in articulation, production, comprehension, and judgments related to grammar. The normal version of the gene is found universally in humans but not other primates. However, the gene is found in songbirds and has been related to song production. In humans, the gene is related to vocal learning and the integration of auditory and motor processes. Some estimates suggest that this gene appeared within the last 200,000 years. At present, this research is in the early stages and there is controversy concerning the exact genetic basis of language.

BRAIN INVOLVEMENT

The traditional model of language processing in the brain dates back to the 1800s. The French neurologist Pierre-Paul Broca had a patient who had a stroke. The damage to the brain resulted in the patient having difficulty in producing speech, but not in understanding it. This type of language disorder has come to be called *Broca's aphasia,* and the left frontal area of the brain affected is called *Broca's area.* In 1887, about 25 years after Broca described his patient, the German neurologist Carl Wernicke described the opposite condition, in which a person could produce speech, but it lacked coherent meaning. This disorder came to be called *Wernicke's aphasia,* and the left posterior area generally affected in the brain is known as *Wernicke's area* (see Figure 7.6). The basic idea is that spoken language is first perceived in Wernicke's area, which is related to the processing of auditory information. This information is then transmitted by pathways to Broca's area. Broca's area is related to speech production. Studies of individuals with some form of brain damage suggest that Broca's area is involved in not only the production of speech but also syntax, which includes grammatical formations involving verbs. Individuals with damage in Wernicke's area do not have similar problems producing speech, but they have difficulty with those aspects related to the meaning of the words, especially nouns. More recent brain imaging studies have asked individuals either to read or to repeat spoken words. These studies show brain activation in the individual's left hemisphere in those areas associated with motor responses, such as the primary motor cortex, the premotor cortex, and the supplementary motor cortex, as well as areas in both hemispheres around Broca's area. However, Philip Lieberman (2000, 2006) cautions against seeing language as encapsulated in just Broca's and Wernicke's areas. He has described the evolution of language in terms of its connections with early motor processes, especially subcortical structures such as the basal

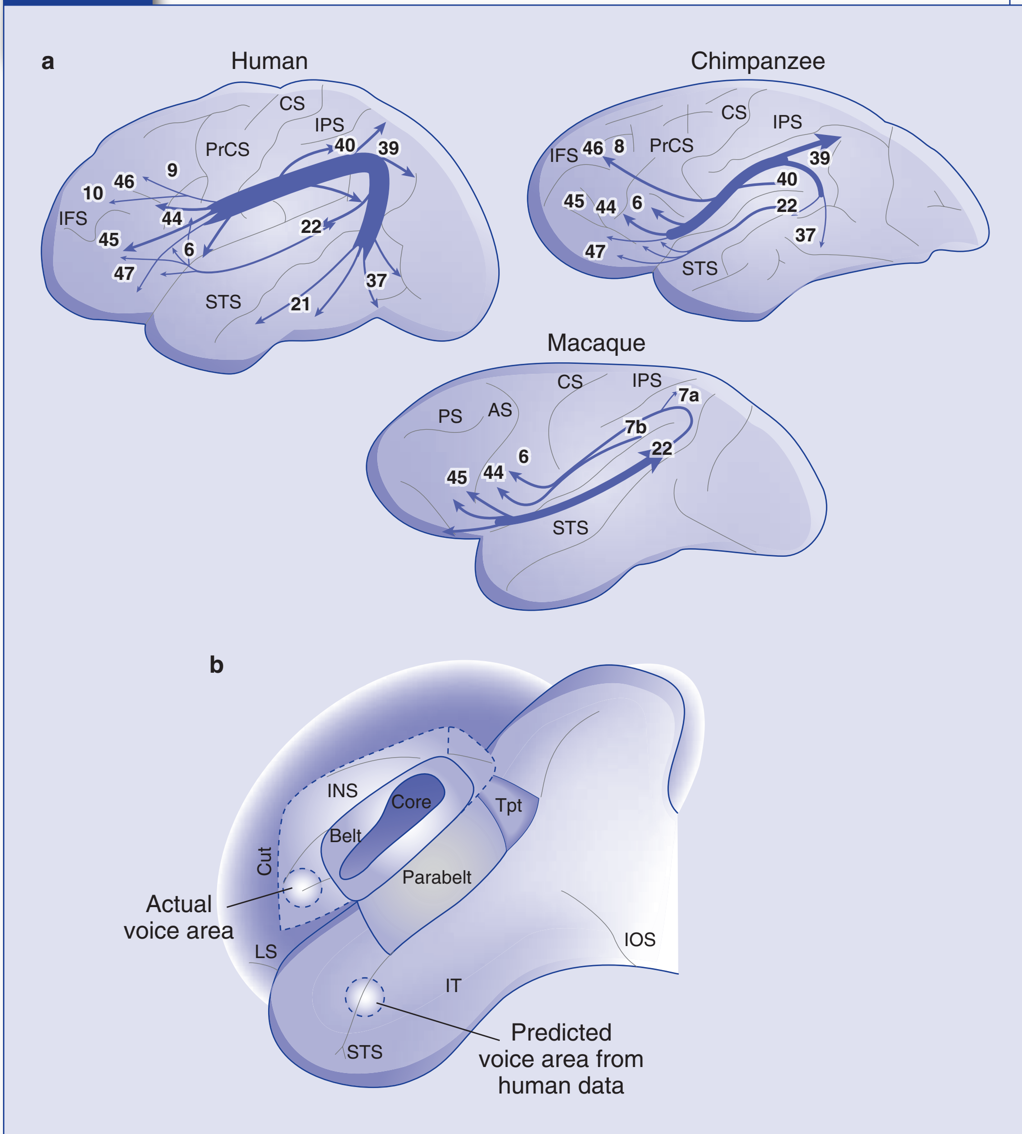
Figure 7.6 The Major Language Areas of the Brain



ganglia. Lieberman further notes that most language disorders include these subcortical structures along with Broca's and Wernicke's areas.

In terms of the evolution of language, there has been a debate as to whether it arose gradually over time or arose very quickly with the anatomical changes that give humans linguistic abilities (see Ghazanfar, 2008 for an overview). In a variety of human traits such as color vision, there is clear evidence for a gradual evolution. However, others have argued that language is totally human and happened quickly. Although the question is not settled, brain imaging studies are beginning to suggest a gradual development of language. For example, James Rilling and his colleagues (2008) examined the differences in the way fiber tracts connect the frontal and temporal lobe in humans and other primates. This is an important pathway in the brain for language. Damage to this pathway in humans leaves the person with the ability to understand speech but unable to repeat what was said. As can be seen in Figure 7.7, this pathway is different in humans compared to chimpanzees and macaque monkeys. However, it is more developed in the chimpanzee than the macaque. Because chimpanzees come between humans and macaques in terms of primate lineage, this suggests that language development may, indeed, have been a gradual process. This is further supported by the finding that all of these primates have areas in their cortex that are sensitive to the sounds of other members of the species (Petkov et al., 2008). However, this area in humans involves different circuits than that of other primates, as can be seen in illustration "b" in Figure 7.7. This suggests that, like human vision, human speech and language are the result of modifications to existing structures.

Figure 7.7 (a) Humans, chimpanzees, and macaques have circuits in the brain for recognizing sounds from their own species. (b) The voice area in macaques is located in a different place than would be predicted from the location of the human voice area.



SUMMARY

Language plays an important role in the life of humans. Evolution offers a lens by which to view language. Hauser and Fitch (2003) suggest that language can be considered an adaptation in evolutionary terms. Darwin noted parallels between language learning in infants and song learning in birds. The human developmental sequence allows for long periods of interactions with others, which supports the development of language.

From a structural sense, there are five factors of language. First, a language is regular and has rules, which we call a grammar. Second, it is productive. Third, words in a language are arbitrary in that across languages any word can refer to any thing. Fourth, languages are discrete in that sentences can be divided into words, and then into smaller bites of meaning called *morphemes,* and then into sounds. And fifth, languages are linear in that words are presented one after the other.

A variety of studies sought to determine whether language could be taught to primates. In general, none of these research programs could teach a primate to use language more sophisticated than that of a 3-year-old human child. Further, the structure of human vocal cords differs from that of other primates. In terms of human brain structure, human speech and language is the result of modifications to existing structures over evolutionary time.

STUDY RESOURCES

Review Questions

1. Researchers have suggested that human language evolved from an emotional vocalization system found in other species. What evidence do they point to in support of this position? Give some examples of the situations in which other species use their emotional vocalizations.
2. What is the function of language and how did it evolve?
3. List the five core factors that comprise our definition of language.
4. Define these building blocks of language structure: phoneme, morpheme, syntax.
5. What does Chomsky mean by humans having an innate universal grammar? What is the relationship between surface structure and deep structure?
6. What evidence does Pinker cite to show that language evolves like other biological systems?
7. If language is special for humans, what aspects of language represent this specialness?
8. How do humans make sounds that we hear as speech? How does this differ from other species?

9. Describe the stages of infant vocalization.
10. What does recent brain research tell us about the evolution of language?

For Further Reading

Bickerton, D. (1995). *Language and human behavior*. Seattle: University of Washington Press.
Bickerton, D. (2009). *Adam's tongue: How humans made language, how language made humans*. New York: Hill & Wang.
Deacon, T. (1997). *The symbolic species: The coevolution of language and the brain*. New York: Norton.
Hillix, W., & Rumbaugh, D. (2004). *Animal bodies, human minds: Ape, dolphin and parrot language skills*. New York: Kluwer.
Pinker, S. (1994). *The language instinct*. New York: William Morrow.
Pinker, S. (2007). *The stuff of thought: Language as a window into human nature*. New York: Viking.

Key Terms and Concepts

- The nature of language
    - The evolution of language
    - The structure of language
- What is language?
    - Primates and language
    - Structure of vocal cords
    - Infant vocalization
    - Creole languages
    - Genetics and language
    - Brain involvement

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Glossary Terms

- Morpheme
- Phoneme
- Phonology
- Semantics
- Syntax
- Universal grammar