Can Animals Acquire Human Language?  
Shakespeare’s Typewriter

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Overview

We start this chapter with a basic question: what is language? Being careful to distinguish between three separate concepts – language, talk and communication – we go on to consider some of the key differences between animal communication systems and language. No animal acquires language spontaneously, but can they be taught? We review evidence of attempts to teach a range of animals, including chimpanzees, monkeys, dogs and parrots. In some ways, animals have surprising linguistic gifts. Yet they fall far short of being able to string words together into grammatical sentences. We will see that attempts to teach the words and rules of a natural human language are overly ambitious. More recent research looks at basic psycholinguistic mechanisms, in particular, the processing of speech sounds. This research has shown that cotton-top tamarin monkeys can identify word-like units in a continuous stream of speech, in a way that is similar (though not identical) to the way human infants go about it. It emerges that humans and animals share many basic capacities that can be harnessed in the acquisition of language. At the same time, there remain clear differences between humans and non-humans. Language is a very human phenomenon.

What is language?

The infinite monkey theorem

The legend goes that if you sit a monkey down at a typewriter for an infinite length of time, then eventually, by hitting the keys at random, the monkey will type out the complete works of Shakespeare. This is one version of the infinite monkey theorem. You will not be surprised that the shelf life of this theorem is something less than infinity, once we hold it up to even the most casual scrutiny. First, monkeys are not random letter generators. Second, we are seduced by this problem into thinking about infinity as a vast but finite number. Third, it seduces me into showing you a picture of a chimpanzee (not a monkey) sitting at a typewriter (Figure 2.1). Fourth, the monkey would, in all likelihood, be dead long before the first sentence had been typed. And fifth, even Shakespeare would have trouble producing the complete works of Shakespeare, given that he couldn’t type.

Our sense of the ridiculous is provoked by this scenario. We find it laughable to think that a monkey could generate Shakespeare’s plays or even a simple ‘Hello, how are you?’ Monkeys do not have language. But this theorem suggests that they could acquire language, given sufficient time and an appropriate means of expression. The underlying assumption, therefore, is that humans and monkeys are not qualitatively different when it comes to language. The difference is merely quantitative. From this line of thinking it follows that animals (perhaps the more intelligent ones, at least) could acquire language, if they went about it in the right way. In fact, there have been several attempts to talk to the animals, and to get them to talk back to us. We will examine some of these efforts in this chapter and, in the process, we will discover how
this comparative approach can help clarify what, precisely, is unique, and possibly biologically determined, about the human capacity to acquire language.

Language, talk and communication

So,... can animals talk? At first glance, this question seems absurd. We do not find sheep debating the pros and cons of a vegetarian diet. Nor do we hear pigeons chatting about life in Trafalgar Square. But this question is deceptively simple. A number of bird species, including mynah birds and parrots, have astonishing abilities to mimic the human voice. Do these birds talk? We will consider some evidence on this question below, but first it is clear that the word talk is quite slippery. Talk can refer to the physical act of producing human speech sounds, but its meaning can be wider, including the communication of ideas via speech. Some parrots can talk in the former sense, but can they hold a conversation? In contrast, many deaf people cannot talk, in the sense of being able to produce speech sounds with great accuracy or fluency, but they can hold conversations every bit as sophisticated as those of hearing people, through the medium of sign language. When we consider the biological basis of language, it is this latter, conversational, meaning of talk that holds more interest. Perhaps we should abandon all talk of talk and go straight to the heart of the matter: do parrots (or any other animal) have language?

We’re almost in the clear, but not quite. We may have ditched talk, but up pops communication. Many people intuitively believe that some animals have language, because they use the terms language and communication interchangeably. But they are not the same thing. Many, possibly all, animals communicate, in the sense that they intentionally convey information to each other. To this end, dogs bark, sheep bleat and lions roar. But they do not have language. The upshot is that we
must be careful to distinguish the concepts of talk, communication and language. It is the biological basis of language that we are concerned with here.

The design of language

Language has a number of characteristics that sets it apart from animal communication. The American linguist, Charles Hockett, worked on this problem for many years, finally coming up with a list of 16 defining characteristics (Hockett, 1963). As we shall see, most of these so-called design features are shared to some extent with animal communication systems. On this approach, it is the combination of all 16 features that distinguishes human language. We will focus on just four of Hockett’s design features here (but see Box 2.1 for the complete list):

- creativity
- semanticity
- arbitrariness
- displacement

Hockett (1963) had two kinds of linguistic creativity in mind. The first refers to the creation of new words and idioms, a process that takes place all the time, and with especial enthusiasm among young people (Cheshire, 1982; see also Discussion Point 1 below). The second kind of creativity refers to our ability to produce and understand new messages. In recent times, Chomsky (1965), in particular, has emphasized the importance of this latter kind of creativity, helping to revive what is a very old observation in linguistics (von Humboldt, 1836/1988): the rules of grammar (a limited, or finite, set of rules) allow us to construct an infinite variety of new utterances. New sentences are created all the time.

Two aspects of child speech demonstrate that linguistic creativity is in evidence very early on: (1) novel utterances; and (2) grammatical errors. With regard to novelty, Chomsky (1959: 42) pointed out that 'a child will be able to construct and understand utterances which are quite new, and are, at the same time, acceptable sentences in his language'. The following sentences from Alex, aged 4 years, are in all likelihood, novel:

No, he bit this little tiger from this set.
You stood on my botty.
Yes, he slid down to the bottom with Panda.
Frog fell over and Bee fell over and Soldier fell over.
When I was building the zoo, I jumped down and hurt myself.

The examples above are grammatical sentences. The ones below (also from Alex) contain errors and, therefore, we can be even more confident that they are novel utterances, because young children are very rarely exposed to ungrammatical speech (Newport, Gleitman & Gleitman, 1977; see also Chapter 4). This means that errors have not been imitated.

She’s too wide asleep, I think.
I like Shinji because he’s the goodest.
Last day, when you had some toast, how many did you have?
Look, my scratches are going who I got at Colin's house.
I had a happy fry tuckey.

Incidentally, the 'happy fry tuckey' was a Kentucky Fried Chicken Happy Meal. Naturally, Alex was given this by his mother. I only ever gave him organic fish and vegetables. Cough. Both novel utterances and errors provide strong evidence that the child is an active producer of their own language, using a system of rules to assemble their own sentences. Throughout our lives, we create entirely new sentences at will, and the people listening to us can, for the most part, understand them. Creativity appears to be one of the few characteristics of language (perhaps the only one) that is unequivocally unique to human language. Animal communication systems simply do not yield creative potential.

**Box 2.1**

**Hockett's Design Features**

Charles Hockett set out 16 different characteristics which together help define human language and crystallize what sets it apart from animal communication systems (Hockett & Altmann, 1968).

1. **Vocal-auditory channel.** The conduit for language is sound (the human voice), transmitted to a hearing mechanism (the ears and auditory channel).
2. **Broadcast transmission and directional reception.** Sound is transmitted (broadcast) in every direction, but the listener perceives it as coming from a particular source.
3. **Rapid fading.** Speech sounds do not last very long; they are transitory.
4. **Interchangeability.** We can switch between transmitting and receiving linguistic signals.
5. **Complete feedback.** Speakers can hear what they are saying: they receive feedback on the signal they are sending out.
6. **Specialization.** The organs used for producing speech (including lips, tongue, larynx and throat) are specially adapted for language; they are not simply used for breathing and eating.
7. **Semanticity.** Linguistic signals (words) can be used to refer to actions, objects and ideas.
8. **Arbitrariness.** There is no intrinsic, necessary relationship between a word and the concept it denotes. There is nothing (in principle) to prevent us from dropping the word *cat* and switching to *zug* to denote the same object.
9. **Discreteness.** Language makes use of discrete units, for example, the two speech sounds (/p/ and /b/). The point at which the vocal cords begin to vibrate can vary, with more /p/-like sounds shading gradually into more /b/-like sounds. But we perceive a sharp cut-off between the two sounds (they are discrete), even though, physically, they figure on a single continuum. (see Chapter 6).

*(Continued)*
Discussion point 1.1: Creation of new words

Identify words and phrases that have only recently come into popular usage. They could well be expressions that you use with your friends, but would hesitate to use with your grandparents. You might think of this as slang or casual speech and would struggle to find such words in a dictionary. List five different words of this kind. For each one, consider the following:

• Think of how the word is pronounced (the sounds). Is it a new sequence of sounds? Or is it an old word form that has been given a new meaning (like cool to mean ‘admirable’ rather than ‘low temperature’). Or has it been pieced together from existing words and English sound sequences (like cowabunga, an expression of exhilaration for 1960s surfers and Teenage Mutant Ninja Turtles)?
• Does the word denote a new concept (have a new meaning)? If so, consider how you would express this new concept if you did not have this new word.
• If the word is, essentially, a synonym for a word that already exists, why do you think it has come into being?

The second of Hockett’s design features, semanticity, describes our use of symbols to refer to (or ‘mean’) something. These symbols are words, ostensibly sequences of speech sounds that can be used to refer to objects, actions or ideas. The word cat refers to a furry domestic animal with sharp teeth and an ability to sit on just that part of the paper you’re trying to read. What is more, the word cat can be used to pick out (or ‘mean’) all exemplars of this kind of animal. Do animals have anything that equates to words? One example might be the danger cry of the white-handed gibbon, issued to warn other gibbons about approaching predators, such as the clouded leopard (Clarke, Reichard & Zuberbühler, 2006).
We might argue that the cry ‘means’ danger in the way that *cat* ‘means’ my pet, especially since these gibbons use different calls in different situations. But the gibbon cry might just as easily be a violent emotional response that only incidentally communicates information to other gibbons. Even if the gibbon cry has meaning, it is highly general in its scope, which, if your life is in peril, might not be all that helpful. The type and number of predators, their proximity, the direction they are moving in: none of these are specified by the danger cry. Instead, the gibbon call seems to apply to a total situation. And although other gibbons, listening in, can obtain information from these calls, it is not clear that there has been any intention, in the human sense, to communicate that information to them (Seyfarth & Cheney, 2003). The (potential) semanticity of animal calls remains a matter for debate. But whichever way one looks at it, human beings far outstrip animals in their deployment of semanticity. There are many (many) thousands of words in English, compared to the extremely limited repertoires of animal vocal signals. So human beings exploit the benefits of semanticity to a far greater degree than any animal. We shall consider below whether animals (in particular, chimpanzees) can be encouraged to extend their repertoires and behave more like humans with regard to semanticity.

In the meantime, let’s consider arbitrariness, another key design feature of language. The central idea here is that word forms – the packages of sound mentioned above – bear no intrinsic relation to their referents (de Saussure, 1916). There is nothing in the nature of a domestic feline animal that forces me to call it *cat*. If I were in Paris, I would use the word *chat*. Leaping across to Tokyo, we would call it *neko*. The relation between the referent (the object in the world) and the word form is arbitrary, and the same holds true for the vast majority of words in any language. A tiny handful of exceptions can be found in the form of onomatopoeic words, like *pop*, *crack*, and *squash*. Animal cries, on the other hand, are often tied closely in form to the ‘meaning’ they express. The gibbon danger cry is invested with the heightened emotion of arousal. But if we scour the animal world thoroughly, examples of arbitrary signals can be found. Western gulls, for example, have a wide repertoire of behaviours to denote aggression (Pierotti & Annett, 1994). Most of them, such as striking or grabbing other gulls, and pursuits on the ground with upraised wings, are non-arbitrary. But these gulls also turn away from an opponent and uproot grass with their beaks to display aggression. There is nothing about grass-pulling *per se* that inevitably connects it with aggression. It appears to be an arbitrary signal. The moral: never invite two Western gulls to a garden party. They’ll fall out and make a terrible mess of your lawn.

Our final star feature is displacement. This simply refers to our ability to talk about things beyond our immediate situation. Human conversation can be displaced to matters that are remote in both time and space. I can talk about events past and future, near and far. I am not confined to talking about my immediate context. In contrast, consider once again the gibbon danger cry (poor gibbon, we really must get him to a place of safety). The danger signal is only triggered by the sight of an actual predator that is physically present. The gibbon cannot make any signal informing fellow gibbons that, say, they ‘spotted a leopard about half a mile south of here three hours ago’. Nonetheless, danger signals triggered by the sight of a leopard can persist.
some time after the leopard has disappeared from view. Does that count as displacement? It is debatable. Other animals show more definite signs of displacement in their communication. Most famous in this regard are Karl von Frisch's bees.

Von Frisch (1954) observed that when a bee discovers a good source of nectar, it communicates this information to other bees via a special 'waggle dance' (see Figure 2.2). The dance is performed vertically on a honeycomb and comprises a simple figure of eight pattern drawn around a central straight line. During the straight line part of the run, the bee waggles its abdomen before turning left or right. The duration of the waggle phase corresponds to the distance of the food from the hive. Meanwhile, the angle at which the bee departs from the vertical, relative to the sun, during the straight line part of the dance corresponds to the direction of the food source. Amazingly, the bee alters the angle of its dance to accommodate the changing angle of the sun throughout the day. Bees therefore communicate both the direction and distance of food sources to other bees, a clear case of displacement. Karl von

Figure 2.2 The wagging dance of the honey bee

Frisch won the Nobel Prize for his ingenious work on the bee dance in 1973, and was never short of honey for tea. For our purposes, we can observe that, once again, one of Hockett’s design features is not the exclusive preserve of human language. At the same time, it is worth reflecting that displacement is very rare in the animal world. And the kind of displacement we observe in bees, while very impressive, is easily outstripped by our own accomplishments. We can talk about anything remote from our current location, whereas bees are confined to food sources within flying distance of the hive. They cannot, for example, tell other bees how high a particular food source is. And humans can talk about things remote in time as well as space, and even things that are remote in the sense of being entirely imaginary. The flexibility and range of the displacement witnessed in human language is massively greater than anything an animal communication system can offer.

Discussion point 1.2: Defining language

We have considered four of Hockett’s design features in some detail. In Box 2.1 you will find the complete set. For each one of the 16 design features, consider the questions below. You might want to split this task among different groups.

- Can you think of any animal communication systems that have a similar feature?
- If the answer is yes, do animals nevertheless differ from humans in the way they exploit this feature?
- Would human language still be language without this feature?

Now review the entire set of features, comparing notes with other groups:

- Which, if any, of Hockett’s design features are essential to the definition of language?
- Could any of the features be dropped? If so, why?
- What, if any, features would you add to the list?

Returning to our original question – do animals have language? – the answer is clearly ‘no’. Animal communication systems share many of their core features with language, but the overlap is highly selective. Bees might show displacement in their communication. But the extent of the displacement they are capable of is strictly limited. Moreover, bees do not use the vocal-auditory channel. They do not demonstrate creativity. Their communication is not arbitrary (there is a direct relation between the angle of the bee dance and the source of nectar). And so on. There are qualitative differences between animal communication and human language in this selective approach to the full menu of design features. But there are quantitative differences also, often quite dramatic. Humans exploit the potential of the design features to a much greater extent than animals. The ‘words’ found in gibbon communication could be listed on a single page. Set this against the multiple volumes of the *Oxford English Dictionary*: the contrast in our mutual exploitation of semanticity is then readily apparent.

Animals may not have language, but there is a second question we can ask in our exploration of the biology of language: Do animals have the potential to acquire language? If so, Hockett’s feature of cultural tradition would be the only factor standing in the way of animals and language. Whatever its biological basis, humans clearly do pass on many aspects of language from one generation to another, including the vast
and arbitrary **lexicon** that must be learned by every child. If language is a cultural artefact, much like fire or clothing, then it might be possible to introduce it to animals. After all, there are several highly impressive cognitive achievements which do not emerge spontaneously in human beings, but which we nevertheless have the capacity to acquire. Consider mathematics or music. Perhaps animals simply need the right opportunities. If an animal could be taught language, then the argument that language is the sole province of human beings would collapse. It would also be much more difficult to argue that language **per se** is coded for in the human (but not any animal) genome. In fact, a parade of animals, including chimpanzees, gorillas, grey parrots, dogs and dolphins, *have* signed up for Language School. We shall consider how well they got on in the next section.

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### Teaching words to animals

The strong, silent types: Gua and Viki

If you want to teach an animal to talk, it makes sense to try one of our more intelligent neighbours in the animal world. Not only is the attempt more likely to succeed, the calibre of conversation is likely to be better than with less bright animals. What would you talk about with a crayfish or a beetle? Accordingly, most efforts to teach language have been directed towards our close evolutionary cousins, the great apes, including chimpanzees, gorillas and orang-utans (see also Herman, Richards & Wolz, 1984, on artificial language learning in dolphins). The first serious effort to teach an animal a natural language was made in the 1930s by a couple who raised a female chimpanzee, named Gua, like a human infant (Kellog & Kellog, 1933). Gua was dressed in nappies, fed with a spoon and spoken to continuously. The Kellogs reported that Gua came to understand about 70 different words, but never actually spoke herself. Another chimpanzee, Viki, did produce three words: *mama*, *papa* and *cup*. She pronounced them ‘softly, and hoarsely, but quite acceptably’ (Hayes & Hayes, 1951: 107). But her initial usage was not meaningful and even when Viki did later use, for example, *cup* to request a drink, she tended to confuse her words when excited. Moreover, there was no evidence that these words were used by Viki to refer exclusively to the objects denoted in English. These three words represent the sole outcome from three years of intensive training.

It turns out that too much was expected of Viki and Gua, because the physical act of producing speech is beyond them. The vocal apparatus of chimpanzees differs in a number of important ways from our own. In particular, the human larynx (containing the vocal cords) is positioned further down in the neck than in a chimpanzee, creating a space above (called the pharynx). The human infant resembles the chimpanzee in this regard. But the infant larynx descends from about 4 months onwards. Together with the angle of the human airway and the proportions of the tongue, the position of the human larynx permits us to produce a range of speech sounds not possible for the chimpanzee (Lieberman, 1992). These include the vowel sounds, /æ, i, u/, found in all human languages, and the consonants, /g, k/ (see Appendix 2, Pronunciation Guide, at the back of the book). A further difference between chimpanzees and humans
is that only humans can seal off the nasal cavity during vocal production, allowing us to produce both nasal sounds, like /m, n/, when the cavity is open, and oral sounds like /b, d/, when it is closed. Given the physical limitations, therefore, chimpanzees were never likely to start chattering.

### Sign language

The human vocal apparatus is not the only medium for expressing ourselves. As noted above, deaf people have developed numerous different manual sign languages that bypass the need for speech. And primates, including chimpanzees, gorillas and orang-utans have all proved to be manually dextrous enough to communicate through the use of gesture. The first of the signing apes, Washoe, was born some time in 1965 and started learning an adapted version of American Sign Language (ASL) at about 10 months of age.

Washoe’s teachers were Beatrice and Allen Gardner (later joined by Roger Fouts) and the programme of instruction they initiated was designed to teach Washoe a series of words designated by signs. Different methods were attempted. At first, an object would be pointed out to Washoe. The trainer would then make the appropriate ASL sign and try to shape Washoe’s hands to produce the same sign. Another method was to use operant conditioning which involves rewarding a behaviour that occurs spontaneously (Skinner, 1957). Operant conditioning depends on the learner making the connection between production of a particular response and the reward that follows. (Behaviours can also be discouraged on the same principle via punishments in place of rewards.) When Washoe produced a gesture that approximated to an ASL sign, she was rewarded with food or tickling. Further rewards would be dependent on Washoe producing a gesture that more closely matched the desired sign. This method is an iterative process that gradually encourages the learner to converge on the precise form of the target behaviour, an ASL sign. We should emphasize that deaf children acquiring ASL do not acquire signs in this way (Goldin-Meadow, 2003). In particular, they are not reliant on rewards. More generally, the way in which chimpanzees acquire words seems to be qualitatively different from the way in which children go about it (see Chapter 6).

By 36 months of age, Washoe was credited with knowing 85 separate signs (Gardner & Gardner, 1969). Her vocabulary eventually rose to 132 signs after four years of training (Fouts & Fouts, 2004). Washoe’s use of signs was noteworthy in two respects: (1) spontaneity; and (2) generalization. First, Washoe did not always need to be prompted to use signs, once they had been learned, but could do so spontaneously. And second, she sometimes generalized their use to a range of objects and events around her. The ability to generalize is an important aspect of reference, allowing us to apply a word to all members of a category. The word apple can be applied to all apples – red, green, large, small – not just one particular object in my fruit bowl. This is because the word apple is used to refer to a category of objects. We will consider how children tackle generalization of word meanings in Chapter 6. For the moment, we can note that chimpanzees are able to generalize their use of words beyond the immediate context in which they are learned.
Lexigrams

Sign language is not the only medium available for teaching language to apes. The page you are reading now demonstrates the potential to represent linguistic information visually via printed symbols (letters). And while no chimpanzee has been taught to read and write, efforts have been made to use visual symbols (called ‘lexigrams’) that represent whole words (Savage-Rumbaugh, Murphy, Sevcik, Brakke, Williams & Rumbaugh, 1993). The chimpanzee is presented with a keyboard containing numerous different symbols constructed from different combinations of shapes and colours. By pressing one of the symbols, a speech synthesizer produces the spoken version of the word. The greatest success with the lexigram keyboard has been achieved with bonobo (or pygmy) chimpanzees, a species that is noted both for high intelligence and prolific sexual activity (de Waal, 1995). Kanzi, a male bonobo born in 1980 was exposed to lexigrams from the age of 6 months. Four years of effort had previously gone into trying to teach Kanzi’s adoptive mother, Matata, how to use the lexigram keyboard, but to no avail. Kanzi, on the other hand, did much better, acquiring signs by observing his mother’s training sessions. Kanzi’s first ten words were orange, peanut, banana, apple, bedroom, chase, Austin, sweet potato, raisin and ball. Kanzi would get on well with Jamie Oliver.

In the more popular end of the scientific press, Sue Savage-Rumbaugh is reported as claiming that Kanzi can recognize and use 348 different lexigram symbols (Raffaele, 2006). More astonishing, in the same article it is claimed that Kanzi understands more than 3,000 spoken English words. We will consider Kanzi’s comprehension of spoken English below, but these figures have not been corroborated and are, in all likelihood, highly inflated. For one thing, this figure seems to be based simply on the number of words that Kanzi was exposed to. That is a far (ape) cry from systematically testing comprehension of each word in isolation. More reliable estimates point to a stark contrast in the size of ape and child vocabularies. While apes seem to peak at a few hundred words, the language learning child soon dwarfs this figure.

The vogue for teaching apes to talk was at its height in the 1970s, and there was a point during that decade when it looked as though language could no longer be seen as the sole preserve of human beings. If apes can acquire words and combine them into novel utterances, one might assume (as the vast majority of their trainers did assume) that they had conquered language. But there are several factors that must temper this enthusiasm. Firstly, the word learning of apes is slow and effortful compared to children. Children can acquire words on a single exposure, a process known as fast mapping (Carey, 1978; see also Chapter 6). This contrasts with the efforts of Kanzi and another bonobo, Panbanisha, who required in the region of 32–65 exposures to learn each new word (Lyn & Savage-Rumbaugh, 2000). What is more, the bonobos were tested within one hour of training for signs of comprehension. In consequence, it is not clear how long the bonobos’ learning lasted, whereas for the child, of course, words can be lodged in the mind for the duration of one’s life. Word learning in the chimpanzee is clearly a laborious task that they do not take to naturally. The motivation is often driven by reward – food, play, toys – rather than a desire to communicate meanings and hold a conversation either with their trainers or each other. In addition, the categories of words acquired are confined almost exclusively to objects and actions, with none of the
wide variety of semantic categories witnessed in human vocabularies (Seidenberg & Petitto, 1979). But even on the most sceptical interpretation, we must still allow that chimpanzees have the capacity to acquire words. The arbitrary nature of words, their semanticity, and their use in displaced communication have all been reliably observed.

Barking up the wrong tree: A talking dog

Before we move on to consider the holy grail of language learning – grammar – let’s consider how dogs and parrots have tried to get in on the word-learning act. Kaminski, Call and Fischer (2004) recently reported that Rico, a border collie dog, acquired the meanings of more than 200 items and can successfully retrieve named objects four weeks after the original training session. Moreover, it is argued that Rico is capable of the fast mapping mentioned above. In particular, Rico seemed to be using the exclusion learning sometimes witnessed in young children (Heibeck & Markman, 1987). Given an array of objects, for which the names of all but one are already known, children infer that a novel word must refer to the single nameless object on display. Thus, if a two-year-old is shown a ball, an apple and a whisk and is asked to retrieve the whisk, they can do so, even if, previously, they only knew the labels ball and apple. Kaminski et al. (2004) claim that Rico can do this too, reporting an accuracy level of 37 correct trials out of 40. It is unlikely that Rico simply has a novelty preference, because he is also able to retrieve familiar objects as well as new ones. As Bloom (2004: 1609) remarks, ‘for psychologists, dogs may be the new chimpanzees’. But Bloom also sounds a note of caution (see also Markman & Abelev, 2004). In particular, Rico has so far demonstrated his ability in highly specific routines in which he fetches an object in response to a command from his owner in return for a reward (food or playing). We need to know now if Rico can respond to words spoken by other speakers. And we also need to know if Rico is doing more than responding to an entire situation ('fetch X'). There is a difference between a simple association between two items (a word and an object) and the act of reference. This observation was made in the nineteenth century by Taine (1877: 254) who remarked: ‘There is nothing more in this than an association for the dog between a sound and some sensation of taste’. In contrast to this kind of associative learning, Bloom (2004) points out that, for the two-year-old child, the word sock does not mean ‘fetch the sock’ or ‘go to the sock’. Instead, the child appreciates that the word refers to a category of objects and can be used to talk about different socks, request a sock, or notice the absence of one. It remains to be seen how human-like Rico’s knowledge of words is. That he can reliably associate a sequence of speech sounds with a particular object is at least well established.

Alex, the non-parroting parrot

Even more startling than Rico is the case of Alex, an African grey parrot, bought from a pet shop in 1977 when he was about one-year-old. For 30 years, until his death in September 2007, Alex was involved in a programme of research that transformed our view of animal learning (Pepperberg, 2006). While Rico can understand
English commands, Alex can both understand and speak himself, making use of parrots' celebrated vocal mimicry skills. Alex could label 50 different objects, including seven colours and five shapes, as well as being able to discriminate different quantities up to and including six. Alex learned via the so-called Model/Rival technique in which he first observes two humans, one ‘training’ the other, with success being rewarded by receiving the object that is being named. Alex thus observes and competes with a human being for the objects being labelled. Rewarding Alex with the actual object proved far more successful than providing something extrinsic to the learning situation, like food. This is different from Rico, of course, who must have to watch his weight, given the number of snacks on offer.

We can see, then, that both dog and parrot learned labels for objects in ways that differ quite fundamentally from the way a young child learns words. Pepperberg (2006: 78) asserts that Alex ‘demonstrates intriguing communicative parallels with young humans, despite his phylogenetic distance’. In assessing this claim, we should perhaps focus on the judicious use of the word ‘parallel’. Alex’s use of his 50-word vocabulary bears some resemblance to that of a young child. But the route he took to get there is very different and his mental representation of words is also very likely quite different to that of a human learner. Shown a wooden block, Alex can correctly answer a range of different questions about it, including: ‘What colour?’, ‘What shape?’ ‘What matter?’ (wooden) and ‘What toy?’. But each answer has to be trained separately. When different attributes, like colour and shape, are presented together, learning does not take place. In this situation, Griffin, another parrot answers with an object name, like ‘cup’, when asked ‘What colour?’. In contrast, the young child can integrate the different attributes of an object into a coherent network of interrelated meanings.

Animal grammar

Combining words

As soon as a language learner begins to combine two or more words together into single utterances, it becomes possible to broach the issue of grammar. And it is here, perhaps, that the real battles have been fought in what the Gardners ruefully refer to as the ‘chimp-language wars’ (Gardner & Gardner, 1991). We can start by confirming that chimpanzees do produce multi-word sequences. Washoe came out with phrases like *gimme tickle* (‘come and tickle me’), *open food drink* (‘open the fridge’) and *sweet go* (‘let’s go to the raspberry bushes’). Moreover, this language learning feat is not confined to Washoe. Several other primates have been observed producing sign combinations, including other chimpanzees (Terrace, 1979; Asano, Kojima, Matsuzawa, Kubota & Murofushi, 1982), a gorilla (Patterson, 1978; Patterson, Tanner & Mayer, 1988) and an orang-utan (Miles, 1983).

Rivas (2005) analysed a large corpus of signing behaviour from five chimpanzees and reports that 33 per cent of their output comprised two or more signs. The question that then follows concerns rule-governed behaviour. Are words being
combined in a systematic way that conforms to the rules of grammar? The easiest way of tackling this question is to look for consistency in the way words are combined. Some combinations look promising in this regard, for example, *eat apple* and *drink coffee*. Children’s earliest two-word utterances look very similar: *Mommy letter*, *finger stuck*; and *empty garbage*. In both ape and child, we can see that the basic word order of English has been preserved, even though there are several words (and bits of words) missing. Thus, *eat apple* might be glossed as *I want to eat an apple*, while *finger stuck* might be more fully rendered as *my finger is stuck*. So far so good. But whereas the child maintains the correct word order throughout their language learning, chimpanzees are far less reliable. For example, although Kanzi had a preference for the correct word order, he was nevertheless quite happy to switch words around: *bite tomato* alternating with *tomato bite*. Nim, meanwhile, switched with even less regard for English word order. For example, *eat Nim* occurred 302 times, compared with 209 instances of *Nim eat*. Across a range of chimpanzees, object and action signs tend to occur in initial position, with request markers like *that*, *there*, and *good* occurring in final position. This makes sense if one considers that the crux of a message, a particular object or action that is being requested, is most salient to the chimpanzee and hence more naturally takes first position in an utterance. Hence, the order of words is dictated by pragmatic, rather than syntactic, factors. In other cases, two-word combinations seem to be completely haphazard in a way that child utterances are not: *chase toothbrush; flower peekaboo; sodapop brush; drink gum*. Longer combinations look even less like English sentences:

Multi-sign combinations made by chimpanzees (Rivas, 2005)

- nut brush toothbrush
- cheese drink Tatu
- flower gimme flower
- banana toothbrush that
- flower drink gum toothbrush
- drink there brush clothes

As the signing sequences increase in length, they rely increasingly on repetition:

Four-sign sequences by Nim (Terrace, 1979)

- eat drink eat drink
- drink eat drink eat
- Nim eat Nim eat
- me Nim eat me
- Drink eat me Nim
- eat Grape eat Nim

Anyone would think the poor ape was being deprived of food. Maybe if he learnt to ask nicely, he’d have more success. But it would seem that this feat is beyond both Nim and all other chimpanzees. The longer the sequences, the more repetitious the ape becomes. Hence no extra meanings are being conveyed in longer utterances, and any semblance of regularity or consistency is diminished. Rivas (2005) reports one sequence of 22 signs from a chimpanzee, and while he does not spell it out, two sequences, each comprising 16 signs are detailed:
Sixteen-sign sequences by Washoe and Nim (Rivas, 2005)

Washoe:
- flower
- hurry
- flower
- hug
- go
- flower
- book
- flower
- gimme
- flower
- gimme
- flower
- hug
- hurry
- drink
- gimme

Nim:
- give
- orange
- me
- give
- eat
- orange
- me
- eat
- orange
- give
- me
- you

What we see, then, is a complete lack of regard for the niceties of grammar. And this is the case even when, arguably, the demands placed on chimpanzees are considerably curtailed in comparison with young children. This is because Washoe, Nim, Kanzi and the rest have never been taught morphology, the aspect of grammar concerned with the internal structure of words (see Chapter 7). Thus Nim could only ever produce the bald utterance Nim eat, not having been exposed to the subtleties of Nim is eating or Nim ate. In other ways, too, the language that chimpanzees have been exposed to constitutes a stripped down version of a fully fledged natural language. Given that the linguistic demands placed on them have been reduced in this way, one might have expected more from the learning they did undertake. But even with much of the grammatical clutter brushed to one side for them, chimpanzees clearly cannot acquire even basic aspects of grammar like consistent use of word order.

Comprehension of spoken English by Kanzi

Before we finally give up the ghost, we should take into account the distinction between production and comprehension. So far our emphasis has been on the language that chimpanzees can produce themselves. But we might also consider what they can understand. Perhaps the neuromotor co-ordination required to produce signs or press lexigram symbols obscures the chimpanzee’s true level of linguistic competence. It is certainly well known that young children experience a lag between comprehension and production. Two-year-olds generally understand far more words than they can actually utter themselves (Griffiths, 1986; see also Chapter 6). It is conceivable, then, that chimpanzees are in the same boat. Accordingly, Savage-Rumbaugh et al. (1993) tested Kanzi’s ability to follow complex instructions, issued in spoken English. Recall that Kanzi’s language learning was always, in a sense, bilingual, involving exposure to both lexigrams and spoken English. Typical instructions are shown below:

Instructions followed by Kanzi

- Go to the microwave and get the shoe
- Give the monster mask to Kelly
- Turn the flashlight on
- Give the big tomato to Liz
- Take the ice back to the refrigerator

Savage-Rumbaugh et al. (1993) report an overall success rate of 71 per cent in Kanzi’s ability to carry out instructions of this kind. But the criteria for judging success are extremely liberal. More to the point, there is no evidence that Kanzi can understand every word addressed to him. And the basis on which he acts can very often be
ascribed to pragmatic factors, rather than his interpretation of grammatical rules to get at meaning. For example, if you hand me a flashlight I will probably turn it on, because that's what one does with flashlights. If I hear *Give the big tomato to Liz*, I would only need to know the words *tomato* and *Liz* to guess that these two 'objects' should be married up. As it happens, Kanzi took two tomatoes of different sizes, and gave them both to Liz. This response was scored as ‘Partially Correct’, even though the intention of the sentence was to distinguish between large and small exemplars of a category (*tomato*). Using a stricter definition of ‘correct’, where Kanzi performs the requested action immediately, and where we include only blind trials in which the instructor is out of sight, Kanzi’s success rate drops to 59 per cent. And, as noted, this success may be achieved, in large measure, without a knowledge of grammar. Instructions can often be carried out correctly from an understanding of one or two individual word meanings. Overall, then, the work on Kanzi’s comprehension does not lend any extra confidence to the idea that apes can acquire grammar.

The linguistic limitations of animals

Research on ape language dwindled fast in the 1980s, largely in the wake of the scepticism expressed by Terrace (1979) a ‘chimp insider’ who set in motion an increasingly acrimonious debate (for example, Lieberman, 1993; Wallman, 1992, 1993). In consequence, it is difficult to find a balanced approach to this topic, so reader beware. Nativists tend to be extremely dismissive of apes’ linguistic abilities (for example, Pinker, 1994) while others, especially ape researchers, tend toward excesses in the opposite direction (for example, Savage-Rumbaugh et al., 1993). In fact, both sides of the argument have some merit. Apes have demonstrated abilities that no-one would have dreamed of a century ago. As we have observed, they are capable of acquiring information about individual words. In so doing, some of Hockett’s (1963) defining features of language have been assailed. Chimpanzee words show semanticity, arbitrariness and, sometimes, displacement. And the essential symbolic function of words appears to be within the grasp of chimpanzees. There has even been at least one case of cultural transmission, where one chimpanzee (Kanzi) has learned words from another chimpanzee (his mother), rather than from a human trainer. At the same time, though, we should be clear that chimpanzee word learning does not have the same flavour as that of a child engaged in the same task. It is slow, effortful, and very limited in scope. And the lexical knowledge that the chimpanzee acquires is far less rich than that attained by the human child. Children acquire information about the grammatical categories of individual words, including information about what *kinds* of words can go together in words and phrases (for example, the *article* *the* is followed by a *noun* in English, as in *the dog*, *the biscuit*, and so on). Beyond word learning, no animal has succeeded in acquiring grammar, not even the star turn, Kanzi. And with respect to the *purpose* of language, it is also apparent that no non-human animal really gets it. No amount of intensive training will ever induce a chimpanzee to express an opinion, ask a question, or phone a friend for a chat. Their use of language is almost tool-like, an instrument used to obtain food or some other desired goal. There is no compunction on the part of a chimpanzee to engage in conversation.
Maybe we have been asking too much of our primate cousins. The Hayes wanted Viki to speak, while the Gardners wanted Washoe to sign like a deaf person. The methods of training chimpanzees did improve with each attempt, most notably with the lexigram keyboard introduced by Savage-Rumbaugh. However, it is one thing to adapt the medium of communication to chimpanzee tastes – it is quite another to consider how suitable the learning task was in the first place. The aim has been to teach language to a primate – words and grammar – the whole kit and caboodle. In this respect, we have certainly expected too much of chimpanzees. Weiss and Newport (2006: 247) point out that ‘this paradigm disadvantages primates in that it requires them to acquire a heterospecific (another species’) system of communication’. The fact that chimpanzees can acquire any aspects of language at all is therefore surprising and leads us to suspect that some similarities do exist across species in the way that linguistic information is processed. We will pursue this idea further in the next section.

Is speech special?

Categorical perception in infants and primates

As noted, efforts to teach Language (with a capital L) to chimpanzees faded away with the twentieth century, the last major attempt being Savage-Rumbaugh et al. (1993). However, comparative research has been reinvigorated by a change of direction. This new line of enquiry, pioneered by Marc Hauser, examines the extent to which basic psycholinguistic mechanisms, in particular, the rapid, automatic processing of speech sounds, are shared across species. Very early in life, human infants demonstrate an ability to process speech in a very adult-like manner. In particular, infants discriminate between different speech sounds, or phonemes, in a categorical manner (Eimas, Siqueland, Jusczyk & Vigorito, 1971; see Box 2.2). For example, the phoneme /p/ can be pronounced in many different ways. But we do not perceive any of these differences. Our perceptual systems place all the different /p/s in a single box (or category) marked /p/. We will examine categorical perception in much more detail in Chapter 5. For the moment, we maintain the focus on our comparison between humans and non-humans.

The discovery of categorical perception in 1971 pointed to a language-specific, uniquely human, inborn ability. However, it was not long before human infants were placed in an unlikely menagerie that included chinchillas, macaques, budgerigars and even Japanese quails. These animals, too, can make categorical phonemic distinctions, a finding which suggests a general property of avian and mammalian auditory systems (Kuhl & Miller, 1975; Kuhl & Padden, 1983; Dooling & Brown, 1990; Kluender, 1991). This finding seems rather odd at first, because only humans have speech. Why would chinchillas need to distinguish /p/ from /b/? Kuhl (2004) suggests that, in evolution, categorical perception for sound came first. As language evolved, it exploited a domain-general auditory capacity that is shared with other animals. The processing of sound for communication might then have become more specialized. Of note, adults use different brain regions for processing speech versus non-speech sounds (Vouloumanos, Kiehl, Werker, & Liddle, 2001). But then again, monkeys recruit
different brain regions for processing communicative calls versus other kinds of auditory stimulus. Moreover, monkey calls are processed in regions of the left hemisphere that correspond well with brain regions used by humans for speech processing (Poremba, Malloy, Saunders, Carson, Herscovich & Mishkin, 2004).

### Box 2.2

**Phonemes and the Notation for Speech Sounds**

In order to represent the speech sounds in words (the *phonemes*), there is a special notation system. Phonemes are not the same as letters, but confusingly, there is some overlap in the notation systems. Some phonemic symbols look like ordinary English letters (for example, /p, b, t/) while others require symbols that are not found in the conventional alphabet (for example, /ɛ, æ/).

The easiest way to identify a phonological representation is through the use of slash brackets. Thus, the word *cat* can be spelled with the letters c-a-t, or represented phonemically as /k æ t/ within slash brackets. Observe the use of /k/ to represent what is often called a ‘hard C’ in English. The use of /k/ to represent this phoneme allows us to distinguish the hard C in *cat*, /k/, from the ‘soft C’ in *ceiling*, /s/ . And it also allows us to recognize that the words *cat* and *king* start with the same sound, or phoneme, /k/, despite the idiosyncrasies of the English spelling system.

Note also that the vowel in *cat* is represented by the symbol /æ/. Vowel sounds, in particular, tend to have curious symbols, not found in the English alphabet, but this can apply to consonants also. For example, in *king*, the final sound is spelled –NG (yes, it’s one sound, not two). The phonemic symbol for this phoneme is /ŋ/.

The full range of possible human speech sounds is encompassed within a single notation system known as the International Phonetic Alphabet (IPA) (see the website listing at the end of Chapter 5). The IPA system allows any word from any language to be transcribed, providing an accurate record of how to pronounce it. A simplified version, listing the phonemes of English, is provided in Appendix 2.

But humans and non-humans are not identical when it comes to speech processing. First, although animals perceive speech categorically, animal phoneme boundaries are different from those perceived by humans in about one third of cases studied so far (Sinnott, 1998). Second, it has been argued that infants have a preference for listening to speech over other sounds. For example, newborn infant brains respond more strongly to samples of infant directed speech than they do to the same samples played backwards (Peña, Maki, Kovačič, Dehaene-Lambertz, Koizumi, Bouquet & Mehler 2003). Infant preferences have also been examined by manufacturing synthetic sound samples that resemble speech on several dimensions. These include the fundamental frequency (which provides information on pitch), duration, pitch contour, amplitude and intensity (Vouloumanos & Werker, 2007). Given a choice between real speech and the non-speech analogue, infants preferred human speech. But despite the strenuous efforts to come up with a speech-like alternative for infants to listen to, Rosen and Iverson (2007) point out that the simulation of voice pitch
remains very crude. It is very difficult to establish whether infants prefer speech over other sounds. This follows from the difficulty in constructing a sound stimulus that has the qualities of speech without actually being speech. But unless we can create good analogues of speech, we have no way of testing, in a rigorous controlled fashion, for an infant speech preference. Speech may be something that infants focus on very early in life due to a massive amount of exposure.

But there is a third way in which speech can be seen as special. Human infants demonstrate categorical perception effortlessly, whereas it takes many thousands of training trials of supervised learning (operant conditioning) to induce categorical perception in animals. We must also set this great learning effort against the fact that ‘humans do not just make one-bit discriminations between pairs of phonemes. Rather, they can process a continuous, information-rich stream of speech’ (Pinker & Jackendoff, 2005: 207). It seems that once again we have an example of overlap (not identity) between human and animal cognition: animals can process speech sounds in a way that is analogous to human perception. The contrast lies in the facility with which humans execute the processing and learning of linguistic stimuli. This observation echoes our conclusions (above) about vocabulary learning in chimpanzees. It all comes much more naturally to us. There may not be anything inherently special about speech as an acoustic experience, but there is certainly something special about what we do with speech in the development of a linguistic system. This point has been underscored recently by Marcus, Fernandes and Johnson (2007) who showed that infants learn rules more easily from speech stimuli than from non-speech stimuli (though see Saffran, Pollak, Seibel & Shkolnik, 2007, for contrasting evidence). Overall, the picture is somewhat mixed. There is evidence that speech is processed differently from other acoustic signals from very early on in life. At the same time, there are signs that some animals can also process speech categorically. Some animals also dedicate brain regions to communicative calls corresponding to brain regions that humans use for speech processing. We may not yet be able to declare unequivocally that speech is special to humans, but clearly, what we do with it, in terms of processing and learning, is special.

Beyond categorical perception, recent comparative research has also examined our ability to process and remember information from extended sequences of speech. Infants can learn to recognize particular syllable patterns that occur repeatedly within a long, uninterrupted sequence of syllables (Saffran, Aslin & Newport, 1996). For example, an infant can learn to recognize the sequence golabu within a longer sequence, like the following:

padotigolabupadotibidakutupirotupirogolabubidaku

This remarkable ability is often referred to as statistical learning and provides one key to explaining how young children begin to isolate individual words from the torrent of speech assailing their ears. How do infants do this? Why is it called statistical learning? We shall return to these questions in Chapter 5. For the moment, we want to know if animals also possess the ability to recognize specific, word-like
sequences of speech. For those of you who have to go out now, the answer is yes. For those of you who can stay a little longer, we must qualify that yes: humans and primates are similar, but not identical.

In one respect, cotton-top tamarin monkeys perform like human infants (Hauser, Newport & Aslin, 2001). They can isolate predictable syllable sequences (nonsense words, like golabu) from a continuous stream of speech. Two basic processing abilities therefore seem to be shared between humans and monkeys. First, there is the ability to distinguish one syllable from another and treat them as elementary units. Second, we share an ability to keep track of the serial order in which those syllables occur, together with information about which syllable sequences co-occur regularly. However, subsequent research points to subtle differences between human adults and tamarins (Newport, Hauser, Spaepen & Aslin, 2004). Syllables might not, in fact, be the basic unit of analysis. Accordingly, this later study teased apart two factors in the speech stream that could be used as the basis for learning about the serial order of word-like sequences. The first was the syllable (for example, go, la, bu) and the second was the phoneme, either consonants (for example, /g, l, b/) or vowels (for example, /o, æ, u/). When we listen to a continuous stream of speech, do we pay attention to whole syllables or individual phonetic segments? The answer seems to be that humans prefer phonemes, while tamarins have a penchant for syllables. Both monkeys and adults were exposed to 21 minutes of continuous speech, of the padotigolabu kind. Humans did well at identifying words (predictable stretches of speech) when the stimuli contained predictable relations between either consonants or vowels. The tamarins did well when the predictability of the stimuli lay either in the syllable structure or in the vowels. Vowels are sometimes described as the nucleus of the syllable and it might be argued that vowels and/or syllables are relatively large, holistic units of speech. In contrast, humans can cope with the more fine-grained phonetic distinctions to be found between different consonants. The basis for this cross-species difference is not entirely clear yet, but the fact that it exists is important in helping explain the human facility for language.

Back to grammar: Infants versus monkeys

The new approach to comparative learning has recently ventured into the domain of grammar (Saffran, Hauser, Seibel, Kapfhamer, Tsao & Cushman, 2008). Concordant with this new approach, the task presented to learners is highly focused. No attempt was made to teach the whole of Grammar (with a capital G) as in Savage-Rumbaugh et al. (1993). Instead, a language was constructed with very simple grammatical rules. The aim was to see if tamarins (yes, tamarins again – Marc Hauser must buy in bulk) can acquire any kind of rule characteristic of human language. The focus was on so-called predictive dependencies, whereby the presence of one word can be used to predict the presence of another in a phrase. For example, the presence of an article like the means we can predict fairly certainly that a noun (nematode, perhaps) will follow, either directly (the nematode) or very soon (the white nematode). Articles do not occur by themselves. But whereas I can predict a noun from the presence of an article, the reverse is not true. Nouns can occur with or without an article (I like nematodes; My friend
named his baby Nematode; and so on). Saffran et al. (2008) constructed two artificial, miniature languages, one with, and one without, predictive dependencies. Following training, they found that 12-month-old infants could distinguish between grammatical and ungrammatical sentences from the Predictive language, but not from the Non-predictive one. Tamarins, meanwhile, performed in a similar fashion to human infants, but only on simple dependency relationships. When the complexity of test materials was increased, tamarins dropped out of the race, leaving human infants out in the lead. We find another example, therefore, of subtle differences between humans and non-humans that have very large ramifications. Tamarins are capable of learning simple rules, even rules that look language-like. But the degree of complexity is strictly limited. In this vein, another study has found that rats can learn a simple rule (Murphy, Mondragon & Murphy, 2008). The rule determines the order of two kinds of element (A and B) in three-element sequences. Rats can distinguish AAB from ABA sequences. Overall we can see that animals are capable of learning rules, even the kinds of rules that appear in human language. They are strictly limited, however, with regard to the complexity of the rules that can be acquired.

The language faculty: Broad and narrow

In our day trip to the zoo, the overriding interest has been in discovering what, if anything, is special about language. A recent approach to this issue divides the faculty of language into two components: broad and narrow (Hauser, Chomsky & Fitch, 2002). The faculty of language – broad (FLB) embraces the biological capacity that we have, as human beings, to acquire language. FLB is one of the defining characteristics that distinguishes human beings from other animals. At the same time, much of the biological capacity underpinning the broad faculty is assumed to derive from shared origins with animal communication. For example, parts of the human conceptual system, in particular those aspects of cognition that allow causal, spatial and social reasoning, are present in other animals, especially other primates (Buttelman, Carpenter, Call & Tomasello, 2007). The mechanisms of FLB, therefore, are shared with other animals, ‘in more or less the same form as they exist in humans, with differences of quantity rather than kind’ (Hauser et al., 2002: 1573). Embedded within FLB, as a subset, is the faculty of language – narrow (FLN). FLN comprises just those phenomena that are unique, both to language and to human beings.

What does FLN consist of? The answer is an open question. Some authors, like Pinker and Jackendoff (2005) argue that there are numerous aspects of language that are uniquely human, including: speech perception; speech production; phonology; words; and grammar. They acknowledge that, for several of these phenomena, animals display an ability to learn at least something. But Pinker and Jackendoff emphasize the gulf that generally exists between humans and non-humans. The speed and facility of human learning goes way beyond any animal achievement, and the full complexity of what can be learned also leaves animals way behind in the slow lane. Pinker and Jackendoff (2005) emphasize that many aspects of human conceptual understanding would be impossible without language. These range from seemingly simple concepts
like a week, to the possibility that numbers could not exist without language. The narrow faculty of language does not look so very narrow on this view.

Other authors have a much more restricted view of FLN. Hauser et al. (2002) predict that a single property of grammar, known as recursion, belongs in the narrow part of the language faculty. Recursion is a rule that calls itself, allowing a structure to be embedded within a structure of the same type (see Box 2.3). We have seen that animals can process and learn combinations of linguistic units. But recursion is one kind of combination that may be special to language and, at the same time, may be beyond the realm of animal learning. What evidence supports the idea that recursion alone belongs in the narrow part of the language faculty? Hauser et al. (2002) argue that recursion is not found in any other animal communication system. In fact, this point has been contested recently. Gentner, Fenn, Margoliash and Nusbaum (2006) argue that the songs of European starlings possess recursive qualities. The main plank of Hauser et al.’s argument is that pretty much every aspect of language shares at least some of its biological bases with aspects of animal communication systems. The empirical evidence in support of this idea is, currently, rather thin on the ground. Moreover, recursion may not be found in every human language. Everett (2008) reports that it is lacking from the Amazonian language, Pirahã. Given the general lack of empirical support, it is not surprising that the ‘recursion only’ hypothesis has proven highly controversial (see also Chapter 8 on the contents of Universal Grammar).
To understand recursion, we first need a few basics concerning the rules of grammar. Words combine to make phrases and phrases combine into sentences in a rule-governed way. In English, I can combine two words like *the* and *hobbit* to produce an acceptable phrase: *the hobbit*. If I switch the order around, the phrase is no longer grammatical: *hobbit the*. Our grammatical phrase (*the hobbit*) can function as a unit: we can move it around as though the two words were glued together and drop it into different positions within a sentence (though not just in any old position): *The hobbit in my garden likes toast. Or I just met the hobbit of my dreams*. The important thing about our phrase is that the two words, *the* and *hobbit*, are particular kinds of words. *The* belongs to the category of *determiner* (which also includes *a* and *some*), while *hobbit* belongs to the category of *noun* (to which we can add many thousands of other nouns, like *computer, water and truth*).

Traditionally, our phrase would be described as a *noun phrase*, and the rule for making noun phrases of this kind would be:

\[
\text{Noun Phrase} \rightarrow \text{Determiner} + \text{Noun}
\]

More recent treatments argue that our phrase, *the hobbit*, is better described as a *determiner phrase* (Radford, Atkinson, Britain, Clahsen & Spencer, 1999; although see Matthews, 2007). But fortunately, our demonstration of syntactic rules is not affected by this twist.

Recursion is special kind of procedure, in which a category (like *noun phrase*) is embedded within itself. For example, in English, we can use recursion to embed one *relative clause* inside another. A relative clause is like a mini-sentence, tucked inside another sentence and is often introduced by *that, which* or *who*, as in: *I like the hobbit who won the race*. This relative clause is part of a larger noun phrase (*the hobbit who won the race*). We thus have two different kinds of noun phrase. One is fairly simple (*the hobbit*), while the other is more complex (*the hobbit who won the race*). Our complex noun phrase can be captured by the following rule:

\[
\text{Noun Phrase} \rightarrow \text{Noun Phrase} + \text{Relative Clause} \\
\text{the hobbit} + \text{who won the race}
\]

Now we get to the nub of recursion. Observe that we have a simple noun phrase, *the race*, (*determiner + noun*) embedded within the relative clause. If we choose, we can take this latter noun phrase and expand it with our second rule (*noun phrase + relative clause*). For example: *I like the hobbit who won the race that started in the park*. In principle, we can repeat this process *ad nauseum*, or more properly, *ad infinitum*. Recursion thus allows us to take our limited palette of rules and produce an infinite number of sentences, in a potentially endless cycle. This is because the input to the rule (in our case, noun phrase) also features in the output. Thus, one can always add a new clause: *I like the hobbit who won the race that started in the park that once had a bandstand that*... and so on.
So that's the long and the short of it. Or rather, the broad and the narrow. The distinction between FLB and FLN may have some mileage for conceptualizing the human faculty of language. At present, there are clearly some rather strong disagreements as to which aspects of language should be allocated to each component, broad versus narrow. And therefore, there remain disagreements about what, if anything, is unique to humans about language. That no non-human acquires language spontaneously we can all agree on. There is also broad agreement that some aspects of language can be acquired by animals, but in a different way to human infants. The huge effort chimps expend on acquiring a few dozen words is one example of this difference. Recent comparative research has also shown that humans and primates share some basic mechanisms for processing speech, albeit with certain differences. The linguistic gulf between humans and other animals is not as wide as might have been expected. But there remain clear differences, both in terms of what aspects of language can be acquired and how they can be acquired.

In a Nutshell

- Language, talk and communication are distinct concepts: the central question concerns animals' capacity to acquire language.
- Animal communication systems overlap in various ways with language. But animal communication remains strictly limited in key ways, including its lack of creativity, semanticity, arbitrariness and displacement.
- Numerous attempts have been made to teach language to animals, including chimpanzees, gorillas, orang-utans, dolphins, dogs, parrots and cotton-top tamarin monkeys.
- Chimpanzees, dogs and parrots are capable of acquiring words, at least with regard to the pairing of a word form with a concrete concept. Animal vocabularies do not exceed a few hundred items.
- Animals cannot acquire grammar. Chimpanzees can combine words into multi-word utterances, but there is no sign that they do so in any consistent, rule-governed manner.
- Recent research examines the extent to which basic psycholinguistic mechanisms are shared. In particular, research has focused on the ability to process and learn from rapid sequences of speech sounds.
- Cotton-top tamarins can perceive phonemes and identify word-like units in continuous speech. The way they do so may differ somewhat from humans. Some phoneme boundaries differ and, whereas monkeys identify whole syllables as the unit of analysis, humans prefer phonetic segments.
- A recent way of conceptualizing language draws a distinction between broad and narrow components of the language faculty (FLB and FLN). One controversial view claims that FLN comprises a single feature, the grammatical property of recursion (Hauser et al., 2002). On this hypothesis, all other aspects of language belong in FLB and the mechanisms that support them are shared with animals.
**further reading**

This is the article that started a recent furore about what is, and is not, special about language. The authors suggest that a single property of grammar (recursion) is unique to humans. Other properties of language are shared, to some extent, with animals.

And this is the furore that was started. Pinker and Jackendoff reply to Hauser et al. (2002), arguing that numerous aspects of language are special to humans.

**websites**

- **Washington University Chimpanzee and Human Communication Institute**: http://www.cwu.edu/~cwuchci/index.html
This website provides interesting background information on Washoe, the first chimpanzee to acquire a human sign language and other members of her extended family. There is a link through to the numerous publications that have come out of language learning research on these chimpanzees by Allen and Beatrix Gardner and Roger Fouts.

- **The Alex Foundation** http://www.alexfoundation.org
Dedicated to the most famous talking parrot in the world. Even though he died in September 2007, his legacy lives on in an organization dedicated to the advancement of study on the cognitive and linguistic abilities of parrots.