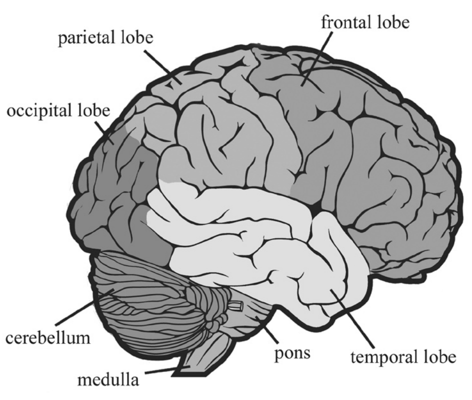
7 Language, Biology and Learning

The relationship between language and the brain is an area of major interest to many linguists. There is much debate about whether or not humans have an innate faculty for language or whether it is more a matter of humans having a powerful and complex brain which responds effectively to the linguistic data it encounters. As evidence for what the relationship between the brain and language entails, brought into the discussion are research on the brain itself, on language development, and on animal communication, areas that we will delve into in this chapter.

7.1 The brain and language

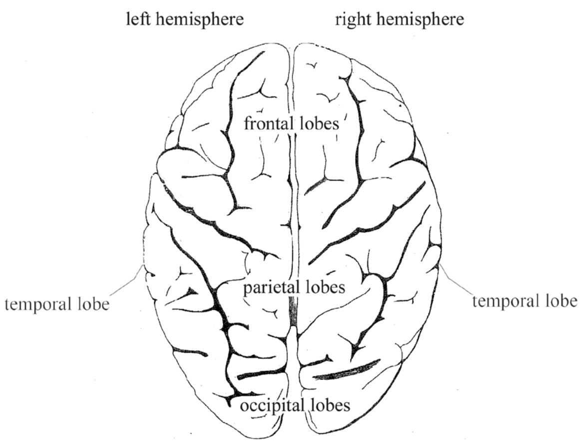
An intriguing question is that of where language is located in the brain.[1] The human brain, like that of other large mammals, contains a cerebral cortex, which is the outer layer of the cerebrum. The cerebral cortex is a vital site for key abilities, such as memory, attention, thought, and consciousness, and, of course, language. The cerebral cortex is divided into two halves called the cerebral hemispheres, which are connected by the corpus callosum, a thick band of millions of nerve fibers. The right hemisphere controls functions on the left side of the body, and the left hemisphere those on the right side. Each hemisphere is divided into four lobes: frontal, parietal, occipital, and temporal. These divisions are marked by the gyri (or ridges) and sulci (or fissures) that characterize our brains. Each of the lobes is responsible for different functions:

Figure 7.1: Cerebral cortex



1. For a complete overview of the brain and language, see a website designed by Bruno Dubuc *The Brain from Top to Bottom*, at http://thebrain.mcgill.ca/flash/index_d.html (choose the desired level, and click on 'From thought to language').

Figure 7.2: Cerebral cortex: superior view



the frontal lobe for reasoning, problem-solving and emotions; the parietal lobe sensory processing related to touch, temperature and pain, as well as visuo-spatial processing; the temporal lobe for processing of sound and smell, as well as memory; and the occipital lobe for visual processing.

We have not yet mentioned where language is located in the brain. Indeed, if we have some kind of innate language faculty, which Noam Chomsky (1965) hypothesized might be thought of as a *language acquisition device*, we would expect some region of the brain to have a more notable relationship with language. The science of **neurolinguistics** studies the neural mechanisms in the brain that are related to the acquisition and use of language, and neurolinguists are interested in what happens in the brain as we learn, comprehend and produce language. The field has its origins in studies from the nineteenth century of patients who suffered some form of brain damage called **aphasia**, a neurological term used to refer to a language disorder caused by brain lesions which have been brought about for any number of reasons, such as strokes, tumors, infections, and traumas like accidents and gunshot wounds.

On April 11, 1861, at the general infirmary of Bicêtre where he worked, Paul Broca, a Parisian neurologist, met Leborgne, a patient who had been admitted because of a gangrenous leg. Leborgne displayed excellent language comprehension; however, his speech production was severely impaired. In fact, he would only repeat the syllable 'tan' to anything he was asked, which he accompanied with gestures in order to express himself. Later that year, Leborgne died, and Broca performed an autopsy, discovering brain damage in the left hemisphere, at the junction of frontal, parietal, and temporal lobes. A few months later, Broca encountered a second patient, Lelong, an

84-year-old man who had suffered a stroke. He could only say five words, 'oui' ('yes'), 'non' ('no'), 'tois' (by which he meant 'trois' – three – which he said for all numbers) 'toujours' ('always') and 'Lelo' (to refer to himself). An autopsy revealed damage in a similar area of Lelong's brain. Thus Broca confirmed that language production belongs to the left side of the brain, as damage to this front part of the left hemisphere (now known as **Broca's area**) resulted in loss of speech. Not all patients of expressive aphasia, or Broca's aphasia, lose speech completely, but they speak haltingly and with great effort, as exemplified by this exchange:

> *Examiner:* What brought you to the hospital?
> *Patient:* Yeah … Wednesday, … Paul and dad … Hospital … yeah … doctors, two … an' teeth. (Goodglass 1993: 81)

Some years later, Carl Wernicke, a German neurologist, studied patients who had difficulty understanding what was said to them. They spoke fluently, not with the halting speech of Broca's aphasics, but with normal flow and intonation, yet their speech was full of nonsense words. As the cause of this type of speech, Wernicke identified lesions in the left rear parietal/temporal lobe, an area now known as **Wernicke's area**. This type of aphasia is known as Wernicke's aphasia (or receptive aphasia or sensory aphasia). A patient diagnosed with Wernicke's aphasia constructed the following in telling a story about a picture:

> Well this is .... mother is away here working her work out o'here to get her better, but when she's looking, the two boys looking in other part. One their small tile into her time here. She's working another time because she's getting, too. (Cookie theft picture description, in Martin *et al.* 2007: 434, from Carroll 1999)

Figure 7.3: Broca's and Wernicke's areas

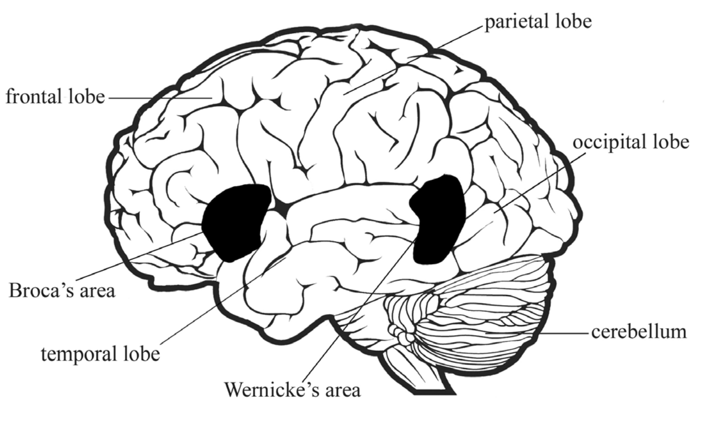


Figure 7.2 shows the parts of the brain which correspond to Broca's and Wernicke's areas. Based on the research by Broca and Wernicke, it was thought for some time that Broca's area was related to speech production, and that Wernicke's area was the seat of speech comprehension. Since that time, vast amounts of research on aphasia[2] have modified these views. For example, Broca's aphasics tend to speak in **agrammatic** forms; that is they have problems planning and producing syntactically correct sentences.[3] **Agrammatism** can present itself in a variety of ways. Speech production may be telegraphic, with many function words left out. Aphasics may leave off verb endings, or use only infinitives, with no inflected verbs in their sentences. Obviously, the language of the aphasic will have an effect on the type of agrammatism. In Chapter 4, we saw that the Semitic languages inflect via transfixes, and an Arabic aphasic may have difficulty using the correct tense marker, e.g. they may confuse 'katab' (he wrote) for 'ktub' (he writes). Patients with damage to Broca's area who are hard of hearing and who use sign language show problems in coordination of signs (while bimanual non-linguistic tasks may not be problematic, providing more evidence for the relationship between Broca's area and language). Broca's, or non-fluent, aphasics also can lose the ability to understand thematic roles (Chapter 4), or the relationship between participants and processes (Chapter 3). So they may have difficulty understanding who did what to whom, especially in the case of passive sentences ('The girl was chased by the boy') or cleft sentences ('It was the girl who chased the boy'). Thus, over the years, a revised version of aphasia damage came to be accepted, which is that damage to Broca's area results in syntactic difficulty, while damage to Wernicke's area results in loss of the ability to use and understand lexis meaningfully.

Broca's area is found in the left hemisphere of most right-handed people, and this area is larger than the corresponding area in the right hemisphere. Some left-handed people with damage to the corresponding area in the right hemisphere suffer the same types of aphasia as their right-handed counterparts, suggesting that their Broca's area develops in the right side of the brain. It is also worth pointing out that lesions in Broca's area are accompanied by weakening, and in some cases paralysis, on the opposite side of the body. Thus, Broca's aphasics have great difficulty with writing, if they can write at all, and their writing shows the same agrammatisim as

2. For a history of the study of aphasia, see Ahlsén (2006). For an overview of neurolinguistics, see Ingram (2007).
3. Dr. Aniruddh Patel, whose research focuses particularly on music and the brain, has discovered that Broca's aphasics also show difficulty in processing the syntax of music. See http://vesicle.nsi.edu/users/patel/Patel_2003_Nature_Neuroscience.pdf

their speech. Wernicke's aphasics, on the other hand, can write, although their written production is much like their spoken production: fluid, but full of nonsense words.

Much of the research done on aphasics up until fairly recently was clinical; patients were studied for their symptoms and responses to treatment, and autopsies were used to reveal the parts of the brain affected. Advances in medicine have broadened the opportunities to study the brain and its functions. For example, in the Wada test, sodium amobarbital is used to anesthetize the side of the brain under study (and the opposite side of the body in correspondence). The procedure is named after a Canadian neurosurgeon, Juhn Atsushi Wada, who invented it in order to test which side of the brain in epileptic patients was dominant for language and memory functions, in order to avoid disturbing these functions during surgery. During the test, patients are asked to read words, identify objects, pictures, numbers and shapes, and answer questions about what they see. If the patient has difficulty in or cannot respond to the questions, then we can assume that the side of the brain which has been put to sleep is that which is dominant for those functions. Through Wada testing, researchers have been able to ascertain that indeed a vast majority of right-handed people and a good portion of left-handed people have their major language functions in the left hemisphere. Physiologists label this hemisphere the categorical hemisphere (Ganong 2005: 273), as it is dominant for categorization and symbolization, as well as verbal memory and rational thought. The other hemisphere is called the representational hemisphere, and it is more concerned with visuospatial relationships, musical ability, and memory for shapes, as well as with insights and imagination.

Brain imaging techniques, such as positron emission tomography (PET), functional transcranial Doppler sonography (fTCD), functional magnetic resonance imaging (fMRI), and Near-Infrared Spectroscopy (NIRS), offer fascinating opportunities to study what happens in the brain when we use language in healthy subjects as well as in patients. Using these imaging techniques, researchers have been able to determine which portions of the brain are most active during various language tasks. For example, research by Laura-Ann Petitto and her team at University of Toronto Scarborough,[4] using Near-Infrared Spectroscopy (NIRS), demonstrate that 3-month-old babies show activity in Broca's area in the left hemisphere when hearing linguistic sounds, but not when exposed to non-linguistic stimuli, such as a flashing black and white checkerboard image.

4. See http://www.utsc.utoronto.ca/~petitto/lab/projects1.html

At the same time, findings emerging from these imaging techniques indicate that the classical view of Broca's and Wernicke's areas is too simple and contained to convey the richness of activity in various parts of the brain, as well as the variety amongst individuals as to which parts of the brain show activity.[5] This is not to say that Broca's and Wernicke's areas are not vital for language production and comprehension, as they obviously are, but rather to point out that much more of the brain than initially thought is involved in language. In 2003, a group of researchers (Dronkers *et al.* 2007) published an article based on the results of MRI scanning of Leborgne and Lelong's brains (which Broca had carefully preserved). The scans show that the lesions suffered by these two men extended significantly into medial regions of the brain, including the superior longitudinal fasciculus, which is a pair of long bundles of neurons that connect the front and the back of the cerebrum. Other research has shown that also involved in language are subcortical structures, or structures which are located deeply below the cerebral cortex, such as the basal ganglia, which are involved in many functions, including cognitive processes and the planning and programming of voluntary movement. Philip Lieberman (2009) highlights the importance of the basal ganglia in aphasia, which never occurs unless there is damage to the ganglia and connecting neural matter.

Lieberman (2009) also writes on fascinating research into the FOXP2 gene, a gene closely related to the basal ganglia and to language. The FOXP2 gene produces a protein which helps to regulate other genes, and which is vital for the development of the brain, lungs and intestines. While it is not the only gene involved in everything that needs to develop in our bodies and our brains for language to exist in a fully functional way, it certainly plays an important role. It was discovered during investigation of a family (called the 'KE family') in England. Early research showed that half of the members of this four-generational family had difficulty with morphosyntactic features relating to number, gender and tense, leading to early speculations that they lacked some kind of grammar gene. However, Faraneh Vargha-Khadem and her team of researchers (1995) pointed out that the difficulties these family members have go beyond these features into other aspects of grammar, and further include highly defective articulation of speech sounds, as well as difficulty with lip/tongue movements such as swallowing, blowing,

5. For a fascinating glimpse into the brain at work, see a video of Dr George Ojemann, Department of Neurological Surgery at the University of Washington School of Medicine, doing neurosurgery on an awake patient under local anesthesia, during which he maps the patients' cortical organization for language. Note: the video is not for the squeamish! http://www.youtube.com/watch?v=EeP14mM2UU8

and sucking (e.g. eating an ice cream cone). MRI and PET scans revealed a reduction in the size of the caudate nucleus, a part of the basal ganglia which is important for motor coordination and for processing information to send to other areas of the brain. In the affected family members, Broca's area was also smaller, and highly activated when doing speech tasks. Then, in 2001, genetic researchers (Lai *et al.* 2001) announced the discovery in all of the affected family members of a mutation of FOXP2.

Wada's test and brain imaging techniques have also contributed to a greater understanding of the role of both hemispheres in language comprehension and production. While the left hemisphere is thought of as the dominant one in terms of language, especially syntax and semantics, the right hemisphere certainly has a role to play. Neuropsychologists Kirsten Taylor and Marianne Regard (2003) display results from experiments which show that the right half of our brain is key in understanding metaphor and deciphering pictographic symbols, and also plays an important role in other semantic functions. A group of researchers at Ghent University, led by Dr Guy Vingerhoets (American Psychological Association, 2003), used fTCD to measure blood-flow velocity on participants who were asked to focus either on the content of what was said or on the emotions as they listened to a set of sentences. The research team found that, when participants were asked to focus on *what* was said, blood-flow velocity went up significantly on the left side of the brain. When participants paid greater attention to *how* something was said, i.e. to whether the tone of voice was happy, angry, sad, etc., velocity also went up significantly on the right side of the brain. Of course, blood-flow velocity remained high on the left side in these instances, as the left side of the brain is needed to process the meaning, and, according to the researchers, to be able to provide a word for the emotion. Studies of patients who have lesions in the right hemisphere lend further support for the role of that side of the brain in providing contextual, metaphorical and emotional meaning to language. Furthermore, in studies of Mandarin speakers, cognitive neuroscientist Sophie Scott and her research team[6] found that the right temporal lobe was activated when hearing words spoken in Mandarin, something that did not happen in the same way for speakers of English when hearing words spoken in English. This difference may be due to the importance of focusing on pitch in a tone language such as Mandarin.

Other evidence for the relationship between the brain and language has come from children who have had a hemispherectomy, a procedure which is recommended in cases of severe seizures and other brain disorders. In this procedure, one of the hemispheres of the cerebral cortex is removed, leaving

6. See 'Chinese "takes more brainpower"' at http://news.bbc.co.uk/2/hi/health/3025796.stm

in place the basal ganglia, thalamus and brain stem. While this surgery has a life-long effect on the ability to move the limbs on the opposite side of the body of the hemisphere that is removed, case after case show that other functions, such as memory and language, can be taken over by the intact hemisphere, and, indeed, some of those functions may have already been taken over by the healthy hemisphere before surgery. There is the case of a boy, Alex, who at the age of eight and a half years had his left hemisphere removed. Up until the time of surgery, he had not developed speech, could only understand single words and simple commands, and his attempts to communicate were through gestures. However, after having the surgery, his language development improved drastically, and 'by age 10, could converse with copious and appropriate speech' (Rémillard and Cohen 2006: 194), including a number of long words. However, Alex, like other patients with an isolated right hemisphere, still has problems with some areas of comprehension related to more complex syntactic structures, suggesting the dominance of the left hemisphere for syntax. At the same time, the plasticity of the brain allows the right hemisphere to develop language fluency. Indeed, some of these children have gone on to graduate from college and lead the kinds of successful lives which call on complex uses of language.

What we can glean from the above discussion is that perhaps, rather than suggesting that the brain *has* a language organ, the brain has the ability to *be* a language organ. The size of our brains and the number and speed of neural connections allows for intricacy and complexity of motor movements as well as for categorical perception and greater working memory, which are key bases for language use and production, as well as for the development of language. We turn now to how language develops from before infancy and beyond.

7.2 First language acquisition

7.2.1 Child language development

EXERCISE 7.1

Make a list of the kinds of things you said as a small child; you might want to ask those involved in your upbringing what they remember.

EXERCISE 7.2

If you have been involved in the upbringing of a child from birth, make a list of aspects of his or her language development that you have observed.

Researchers on infant language, based on observational data from a great number of language environments, agree on the path followed by most babies who show normal development. In terms of the language input that they receive, babies are surrounded by language, even before they are born. From inside the womb, they are sensitive to the melodies of the voices they hear. As newborns, their interaction with their caregivers involves the latter using what is known as **child-directed speech**, features of which include high pitch, exaggerated intonation, repetition, short phrases, and a sing-song rhythm. It is difficult to know how babies perceive the language that is directed at them, but studies show that from a very early age they can distinguish familiar voices and are sensitive to the emotional cues expressed via the intonation contours of the streams of sound they hear.

Furthermore, babies are capable of **categorical perception**; that is, from sets of phenomena which are actually characterized by continuous flow, such as changing emotions expressed on a person's face or a stream of speech sounds, babies can perceive distinctions in discrete categories. This ability to perceive via categories is tested through a variety of methods, such as HASP (or High Amplitude Sucking Method), in which babies are observed to suck harder when they hear a novel sound,[7] or the Head Turn Preference Procedure,[8] where head turning indicates attention to a familiar phenomenon. Testing shows that babies can distinguish between voiced and voiceless sounds as early as between 1 and 4 months of age. They also can distinguish vowels that are phonemic in the language in which they are raised from the age of 4–6 months, with phonemic consonant recognition coming somewhat later. In fact, by 10–12 months babies have discovered the complete, finite set of sounds of the language(s) they are surrounded by, and can no longer distinguish speech sounds that are not phonemic in their language(s), something they do at younger ages.[9] Indeed, at 4 months, with exposure to sign language, babies are capable of discriminating non-sounded linguistic units, an ability which they are not capable of at 14 months if they have not had exposure to signs. As early as 7 months, babies can recognize words such as *dog* within sentences.

In terms of their linguistic production, new research suggests that babies cry in melodic patterns which are affected by the first language environment. A group in Germany, led by Birgit Mampe (2009), taped 30 French and 30 German babies crying, and analyzed their cries for melody contours. They

7. See http://psych.rice.edu/mmtbn/language/sPerception/infantsucking_h.html
8. See http://psych.rice.edu/mmtbn/language/sPerception/infantHeadturn_h.html
9. See http://www.utsc.utoronto.ca/~petitto/LLD2006.pdf

discovered that the French babies produced cries with a rising melody contour, while the German babies produced cries with a falling melody contour. In addition to cries, babies also produce grunts, coos and sighs during their first months, which are taken as bases for interaction by their caregivers. Then, **babbling** begins at around 5–6 months, lasting for some 6–8 months. A fascinating aspect of babbling is that the sounds are made not to indicate some need; rather, babies seem to find pleasure in babbling for the sake of it. Furthermore, many caregivers respond to babbling as if it were initiation of a social exchange in their interactions with their babies, so they respond by verbalizing to the baby, leading the baby to babble more in response. Indeed, the sounds of babbling are 'language-like'; they tend to be open syllables, or consonants followed by vowels, with no ending consonant. Also, baby babble takes on prosodic features of the surrounding language in terms of intonation, stress and pitch. Studies show that babbling is also influenced by the surrounding language. That is, a baby raised in a French-speaking environment and a baby raised in an English-speaking environment will babble using a number of similar sounds, yet at the same time, and especially over time, there are sounds which distinguish one babbler from the other. With some degree of regularity, adults can recognize the first language environment when listening to tapes of babbling babies. At the same time, the early stages of babbling involve producing sounds which are not always part of the surrounding language environment, an ability which babies lose in the later stages of babbling. Caregiver interaction plays a role in this process of discovering the sounds of one's language. In English, during the babbling stage, people invariably hear the baby saying 'goo-goo ga-ga', while similar sounds will cause Spanish caregivers to assume that the baby is saying 'ajo' (which means 'garlic'). In each case, the caregivers will repeat the sounds as *they* hear them back to the baby, thus reinforcing the learning of the sounds the caregivers impose upon the babble. Also in these later stages, around 8–12 months, babies who are deaf stop babbling vocally. However, manual babbling occurs in babies who are exposed to sign language, whether deaf or hearing.

Sometime during the babbling stage, the **one-word stage** sets in. This stage begins in the latter part of the first year or early in the second year. Single words are used to express feelings and demands, and often the words are phonetically different from the word used between adults of the language, such as, in English, *binkie* (for 'blanket'), or *shooshie* (for 'cookie'). Furthermore, small children will regularize, for example, irregular plurals, such as *foots* for *feet*. The number and range of words used and meanings expressed by children in the one-word stage are relatively limited, mainly to who and what inhabit the world of the child, including words relating to people, clothing, food, toys, animals, vehicles and sounds.

During the **two-word stage**, which begins at some point during the second year, usually around 18 months, children begin to put words together in semantically and syntactically coherent strings, although without inflections for number, person or tense, such as *more milk*, *me go* or *allgone doggie*. Children at this stage tend not to use function words (see Section 4.1.2); thus their language is referred to as 'telegraphic speech'. One line of research amongst linguists who study child language development involves outlining the range of semantic functions expressed by children at the different stages of development, in terms of thematic roles (Chapter 3; Chapter 4); Roberta Golinkoff and Kathryn Hirsh-Pasek (2000: 151) provide a typology of meanings expressed (when context is taken into account), such as 'possessor+possessed' (e.g. *mommy sock*), agent + action (e.g. *car go*), and object + location (e.g. *sweater chair*), expanding slightly on a typology first put forth by Roger Brown (1973).

Then, sometime after the two-word stage has set in, the language of children explodes into developing at a rapid rate. Initially, children continue using telegraphic speech, leaving out function words, as with the two-word stage. (*Nini want that; Cathy build house*). From about the age of 2 onwards, children use an increasingly varied array of syntactic structures. Data from children speaking in English (Peccei 2006: 20–26) demonstrate developmental pathways through acquisition of, amongst other structures, plural *–s*, past tense markers, verb phrase complexity, noun phrase complexity, interrogative structures, and so on. Cross-linguistic research shows differences in age and order of mastery of different syntactic structures, yet, at the same time, whatever the language, by around the age of 5, children have pretty well mastered the syntax of their language. Of course, language development does not stop there; nor, indeed, does it ever stop, as human language development is a life-long process.

Furthermore, child language development does not involve simply an inventory of phonemes, syntactic structures and vocabulary.[9] Discourse development also occurs, as children learn to engage in increasingly appropriate pragmatic uses of language, as well as in how to take turns in conversation (including signaling cues for transition relevant places, see Section 2.5.2), uses which are, of course, culturally bound. Indeed,

9. See Jean Stillwell Peccei (2006) for a full account of the 'what' of child language development. Peccei also includes a range of activities for investigating child language development.

much interaction with caregivers in English-speaking countries involves the latter telling children when to say 'please' and 'thank you', to 'ask nicely', not to interrupt, and to wait their turn. As early as the age of 2, toddlers can infer communicative intent; for example, if they hear an adult use an excited tone of voice in a given context, they can infer that a new word must refer to an object that has appeared in the context while the adult was away (Johnston 2005). In addition to the spoken language, most cultures in the present developed and developing world, literacy is an important aspect of language development; caregivers will often read to their children, and schools devote many hours a week to the task of promoting increasing ability to the reading and writing of increasingly complex texts throughout the schooling years.

7.2.2 Critical period hypothesis

Is there an age after which it is difficult to learn language if it has not yet been learned? The **critical period hypothesis**, promoted by Eric Lenneberg (1967), suggests that there is an optimal period of time for language acquisition to occur, especially in terms of grammatical structures. It is thought that the age after which acquisition becomes well nigh impossible, in the case of no or highly limited exposure to language, is around puberty. This hypothesis is difficult to test, principally for the obvious reason that it is not ethical to experiment with children, and it is not common to find a child who has not been exposed to language. A famous case is that of Genie (not her real name), a child who was raised in California to parents who locked her in a room from about the age of a year and a half. She was beaten by her father if she tried to speak, and, finally, at the age of 13 her mother left her husband, taking Genie with her. At that time, Genie had a vocabulary of around 20 words. She then went through a succession of foster care situations, and was the subject of research by linguists and psychologists, during which time she was taught spoken and sign language. While Genie advanced quite well with respect to expanding her repertoire of vocabulary, Susan Curtiss, who did her PhD research on Genie, concluded that Genie had great difficulty with syntax. Curtiss stresses that Genie did learn some morphosyntactic regularities of English, such as she knew to attach *–ing* to verbs and not nouns. However, Genie would say things like 'Applesauce buy store' (for 'Buy applesauce at the store') and 'Man motorcycle have' (for 'The man has a motorcycle') (Curtiss 1988: 83). At the same time, she did not learn to use pragmatic aspects of discourse, such as greetings, discourse markers, or vocatives. Given that Genie's case is not one solely of isolation from language, but also of emotional abuse and neglect, it is difficult to use her case as an example of a critical period for language development.[10]

Hemispherectomies in children and adolescents provide evidence that, during the developmental years (in one case, a 16-year-old girl), the brain has the plasticity to allow the right hemisphere (in the case of right-handed children) to take over the functions usually attributed to the left hemisphere, as remarkable language recovery has occurred in a number of these cases; however, in the case of adult hemispherectomy, aphasia always occurs. This difference in the ability of language development to take place suggests that there is a period after which language development becomes more difficult, especially with respect to syntactic structures; the reason may be because the brain loses plasticity in adulthood.

7.2.3 Theoretical perspectives on child language development

One theory of child language acquisition which has dominated much of the research in the field and which has been greatly influenced by the work and thinking of Noam Chomsky is that we are born with an underlying faculty which allows for the acquisition of basic grammatical relations and categories. Chomsky calls this faculty the **Language Acquisition Device** (LAD). Some call this the **innateness hypothesis**,[11] and it is based on the assumption that the grammar we end up acquiring goes far beyond the actual language that we are surrounded by, i.e. children are exposed to an impoverished stimulus, and out of that they acquire a sophisticated set of syntactic and morphological rules. Thus, the brain must have some kind of predisposition (or 'hardwiring' as it is sometimes called) for the acquisition of human language, some kind of innate grammatical knowledge. A correlation of this theoretical stance is that there must be a number of basic properties shared by all human languages, a notion which is captured in the Chomskyan tradition through the concept of Universal Grammar (see Chapter 8, *Formal Linguistics*, by Amaya Mendikoetxea). Those who support this theoretical stance are interested mainly in how children acquire (the terms 'acquisition' and 'acquire' are preferred over 'learning' and 'learn') syntactic structures. They argue that children do not acquire the fully-fledged syntactic system of

10. See Jones, Peter E. (no date) Contradictions and unanswered questions in the Genie case: a fresh look at the linguistic evidence. Available: http://www.feralchildren.com/en/pager.php?df=jones1995 for a critique of Curtiss' work with Genie.
11. Chomsky (2000) states that the innateness hypothesis is *not* his; in fact, he cannot imagine what it might refer to. He does argue for the LAD, or some 'Faculty of Language' (FL), an innate mental ability for language.

the language by imitation or reinforcement;[12] nor do they acquire it through carefully structured input from their caregivers who work at correcting errors in the children's output. The language environments in which children are exposed to language vary widely, and yet children ultimately acquire the syntactic system of the language(s) of their community. Furthermore, if children learned by imitation or reinforcement, then what they would be acquiring is a set of forms, rather than a set of grammatical rules; however, it is clear that children internalize their own rules along the way before internalizing those of the adult language system. Children produce words and forms which they have not heard adults say, forms such as *goed* and *feets,* and continue to produce them even after attempts at correction. In sum, the rapid rate at which children acquire a highly complex system of communication from the rather less than complete and representative language they hear suggests that humans are born with some kind of innate language faculty.

However, there is opposition to this view of language acquisition. Some researchers argue that there is no such thing as 'poverty of the stimulus'. Dwight Atkinson (2002) summarizes research that suggests that children experience between 12,000 and 15,000 hours of intensive contact with their caregivers over their early years. Also, some disagree with the very existence of the LAD. Research by, for example, Jenny Saffran, at the Infant Learning Laboratory at the University of Wisconsin-Madison,[13] suggests that the human brain has powerful statistical learning mechanisms that make language learning possible. That is, the brain has the potential to detect patterns in experiential data of all types, linguistic and non-linguistic, and to remember and learn from those patterns. Saffran and colleagues (1996) point out that all organisms, in order to survive, must be able to extract information quickly from their environments during their development. Some species have evolved complex neural mechanisms which allow them to develop adaptive behaviors regardless of the environment; that is, they have evolved mechanisms which are independent of the learning environment, as is the case with bat echolocation. Children obviously needs environmental input to develop language, as children who are not exposed to language, such as Genie, fail to develop it; thus human language

12. Note that Chomsky's early work on language was a reaction to behaviorist approaches, which suggested that children were born as blank slates, and that language was, in essence, a learned set of behaviors.
13. See http://www.waisman.wisc.edu/infantlearning/publications.htm for a full list of publications, most of which are available online.

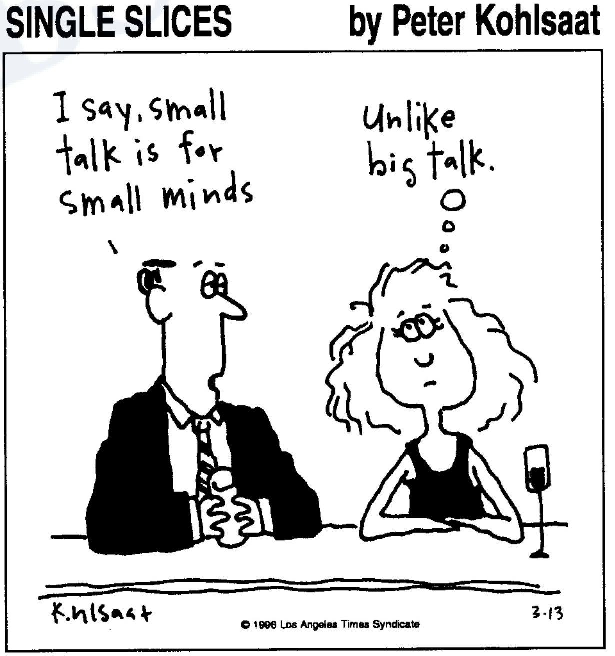
is experience-dependent. Language acquisition research influenced by the Chomskyan tradition has downplayed (though not denied) that aspect of how we acquire language, and has given more importance to the presence of a language faculty, or language acquisition device, which would count as an experience-independent mechanism for language learning. Both theoretical perspectives acknowledge the need for both experience-independent and experience-dependent mechanisms, in other words, nature and nurture, in human language development; at the same time, the difference is more than simply the degree to which more importance is placed on one or another, as the Chomskyan tradition posits a language faculty as part of the human genetic endowment, while the statistical learning theorists suggest that part of the human genetic endowment is actually that humans are whizzes at finding statistical regularities in data such as language.

Saffron and her colleagues support their statistical learning theory with a number of studies, such as that of word segmentation, an aspect of language that must be learned; that is, babies are not born knowing that *pretty* and *baby* are words, while *tyba* is not. They suggest that there are certain statistical probabilities in languages with respect to phonotactics, or the possibilities for combining phonemes, as well as for combining syllables, and that children are exposed to these over and over through child-directed speech.[14] Basing experiments on babies' penchant for focusing on novel phenomena, Saffron played recordings of strings of nonsense syllables, combined into 'words' in regular ways, to babies, and then played recordings of 'words' and 'non-words' from the strings. The 8-month-old babies demonstrated longer listening times for the non-words, or part-words. In sum, the babies heard as novel the non-words, or part-words, but not those that fit the pattern of the 'words', suggesting that they had 'learned' to recognize patterns for the 'words' in the strings. Saffran further argues that this kind of learning based on recognition of units via statistical coherence takes place over other units of human action sequences, such as sequences of tones or visual patterns.

The theoretical stance on language development of Saffran and colleagues brings to mind that of researchers in corpus linguistics (see Chapter 8, *Corpus Linguistics*, by Michaela Mahlburg). Gordon Tucker (2007: 240) argues: 'A very basic fact of language is that speakers are constantly confronted with expressions that they have encountered, either fully or in part, in their

14. For example, the probability that *pre* is followed by *ty* is roughly 80% in speech to young infants: however, given that *ty* is word final, and can thus be followed by any number of syllables starting another word, the probability that *ty* is followed by ba, as in pretty baby is roughly 0.03% in speech to young infants.

previous linguistic experience'. While Tucker, like Saffran, is not arguing for language learning as a set of behaviors, he similarly argues that there are probabilities in our language use which set up expectations for what will follow what, what will occur after a certain word or set of words. Michael Hoey's (2005; no date) theoretical view of language development is that of **lexical priming**, which suggests that 'Every word is primed for use in discourse as a result of the cumulative effects of an individual's encounters with the word' (Hoey 2005: 13). That is, lexical priming refers to the expectation that we come to have of certain words and phrases to be used in company with other words (**collocation**), and in certain grammatical environments (**colligation**); furthermore, words have certain semantic and pragmatic associations. As we hear words and phrases (or 'chunks') used over and over, we come to form hypotheses about the ways we can use them, hypotheses which can bear out in our use of the words or not. You might hear the term *bachelor pad* but not *spinster pad*, for instance, as the first set of words are collocates, but the second are not. These more probabilistic views of language do not deny its creativity, but rather suggest that it is somewhat constrained by patterns of use, patterns which the human brain is adept at storing and drawing on for further use.



M. A. K. Halliday has influenced a great amount of research into child language development from a broader perspective than that of a focus on sounds, structures and words, or solely on the development of phonology and lexico-grammar. This research, based on systemic functional linguistic theory (see Chapter 3), focuses on how children, through social interaction, learn language, including its communicative functions. Thus, the developmental picture looks different than that sketched out in Section 7.2.1 in terms of *what* develops. Halliday (1975/2004) suggests that babies first operate on a two-level system of meaning; that is, one expression form is connected with one meaning, with no intervening system of morphology, syntax or vocabulary. At the same time, these **protolinguistic** signs are not combined together to create further meanings; rather, their functional meaning holds constant,[15] and they express meanings connected to basic needs or emotions. Several communicative functions can be gleaned from how babies use them, such as the instrumental function (*I want* – achieving goods and services), the regulatory (*do as I tell you* – to control the behavior of others), the interactional (maintain contact with others), and the personal (to express individuality and self-awareness). Thus, for Halliday (1975/2003: 33) 'the child has a linguistic system before he has any words or structure at all', as, by linguistic system, he includes functions as well as morphology, syntax and vocabulary.

Usually between 16 to 18 months, babies start the transition toward a three-level system, consisting of sounds which are words which have meanings. Claire Painter (2009), who has researched child language development within this theoretical perspective, explains that the broader metafunctions of language (see Chapter 3) emerge initially through intonation: that is, a child might use the same word to refer to the same thing (the ideational function) using different intonation patterns to signal a different interpersonal meaning (e.g. a statement or a demand). That is, young children begin to differentiate the ideational and interpersonal meaning via intonation, perhaps using a rising/level tone (see Chapter 2) to express 'I want' or a falling tone for 'I notice'. For example, *shooshie* might mean 'I want a cookie' or 'give me that cookie' or 'there's a cookie' or 'Mommy, take a bite of this cookie'. Children continue to develop the language system, as they grow in their ability to dialog with those who surround them, expressing mood choices (see Figure 1.1 in Chapter 1) and transitivity (see Chapter 3) initially via protostructures ('Daddy no', 'me go'), and ultimately developing the full system of the language(s) which they are surrounded by.

15. This lack of ability to combine meanings in novel ways is a major difference with adult language.

7.2.4 Bilingual language development

EXERCISE 7.3

Before reading this section, review Section 7.2 and consider how the information included there might apply to a child brought up with more than one language.

What happens in the case of a child who is brought up in an environment where more than one language is spoken? This situation is the case for most of the world's population. Studies on newborns suggest that babies are born with a preference for the language they heard spoken while still in the womb, and babies born to mothers who spoke two languages show equal preference for the two languages (Werker *et al.*, 2009). In terms of their brain development, according to William Ganong (2005: 274), fMRI reveals that children who learn two languages early in life use the same portion of Broca's area in linguistic tasks in both languages, while individuals who learn a second language as adults used an adjacent but separate portion of Broca's area from that of their first language for tasks in the second language. Also, a review of research on bilingual language development by Fred Genesee and Elena Nicoladis (2006) leads to the conclusion that there are certain aspects of language development which seem to hold constant whether children are brought up in a monolingual or bilingual environment, such as the onset of babbling, first words, and rate of vocabulary growth. Peter Bodycott (1993) shows the same systematic development of protolinguistic functions as those outlined by Halliday (see Section 7.2.3) in a bilingual child, and Genesee and Nicoladis (2006) also summarize findings that show that in terms of pragmatic abilities, bilingual children develop in similar ways to monolingual children.

At the same time, there are some differences. For example, in terms of recognition of phonemic vs. phonetic distinctions, as mentioned in Section 7.2.1, monolingual children stop recognizing phonetic distinctions which are not phonemic roughly by the end of their first year; however, the bilingual child takes longer (Genesee and Nicoladis, 2006). Genesee and Nicoladis also report that 11-month-old bilingual children did not distinguish between words and non-words in a head-turn study in which monolingual babies did. Janet Werker (2009) and her colleagues provide results of tests showing that bilingual babies take longer to distinguish between similar sounding words, which may be because bilinguals need to work out the phonetic inventories of two languages; some sound differences may be phonemic in one language and not in the other, resulting in a more complex learning environment.

Furthermore, the bilingual child exhibits code-mixing and transfer effects from one language to another. For example, Elisa, brought up by an English-speaking mother and a Spanish-speaking father, during her language development would at times mix the two in terms of phonology and syntax. For example, at the one-word stage, her protolinguistic sign for 'I want water' was [awatə], which sounded like a combination of 'agua' and 'water', thus ensuring that whichever caregiver was attending to her would respond to her need. When she was 6 years old, after being out in the sun, she looked in the mirror and pronounced 'I have my nose red', thus effectively using Spanish syntax (*Tengo la nariz roja*) but with English words. Diana, brought up in the same circumstances, would ask 'Can I touch the piano?', for 'Can I play the piano?', thus transferring a lexical item directly from the Spanish '¿Puedo tocar el piano?'

However, while there may be some initial delays in certain aspects of language development, these delays are not significant in their ultimate development. Even with respect to their early development, research by Laura Petitto and colleagues[16] and by Werker and her colleagues (2009) strongly suggests that bilingual children work out the systems of the languages they grow up with from the time they begin their development, whether it is across two spoken language or across two different modalities (i.e. signed and spoken language). In addition to providing the benefits of the ability to converse in more than one language and to understand the world through two linguistic and cultural perspectives, bilinguals also get a boost to the brain, as those who are brought up with another language (with a learning onset before the age of 5) have an altered brain structure, with increased gray matter.[17]

7.3 Second language development

> EXERCISE 7.4
>
> What experience have you had learning a second language? What do you think is the best way to learn another language?

16. See http://www.utsc.utoronto.ca/~petitto/LLD2006.pdf
17. Mechelli *et al.* (2004).

There is a great deal of controversy over the extent of our ability to learn another language after the initial childhood period of language development. Indeed, one controversial question is whether or not a critical period exists for second language learning. Michael Long (2005) argues that only by starting out as young children can people attain native-like proficiency levels, with different ages for different domains of language. For example, he suggests that a 'native-like' accent is impossible if first exposure to the language does not occur before the age of 12 (even the age of 6 for many people). The same is the case for lexical and collocational abilities: individuals who start learning a language after their mid-teens (again, for some people, after the age of six) will have persistent errors in the use of lexical items in terms of collocation and semantic extension. Finally, effective learning of syntax and morphology ends in the mid-teens.

At the same time, there is evidence that older learners are actually more effective than younger learners at certain aspects of second language development. Jasone Cenoz provides results from research in the Basque country which show that students who started learning English in the sixth grade of primary school at the age of 11 (16 years old at the time of the study) did better on a battery of tests than did students who had had the same number of hours of instruction but had started learning English in the third grade, at the age of 8 (13 years old at the time of the study). Cenoz suggests that this difference can be attributed to the greater cognitive maturity of the older students. Thus, one point of controversy is actually what we mean when we talk about learning another language. Often adults can achieve a very high level of literacy in another language, for example literary scholars or scientists from other language backgrounds who must write in English.

As with other aspects of language development, another key point of controversy is whether or not differences in ability to achieve is due more to nature or to nurture. Long suggests that older learners *cannot* achieve in ways that younger learners can, which would seem to provide support for a biological, or experience-independent, cause, such as a critical period. Much of the research in the field of second language acquisition (SLA) aligns itself with this more cognitive stance, in line with Chomsky's view of first language acquisition. Also as with first language acquisition, researchers in SLA look for common patterns in acquisition of various language structures in terms of phonology, morphology and syntax.

On the other hand, there are those who are more interested in researching other aspects of language learning which are more related to social interaction and environment. For example, in order to explain differences in attainment, some point to motivation and amount of contact with the new language between older and younger learners (e.g. Marinova-Todd *et al.* 2000), which are more experience-dependent factors. Older learners have a language through which they are accustomed to interacting and communicating, and thus the motivation to learn another language can be low. Furthermore, their interactions with and through the second language may be limited to a few hours a week in a classroom. Dwight Atkinson (2002) finds the SLA focus very limiting, as it is centered on what happens in the head and not on what happens in the world. It focuses on structural correctness as a measure for language achievement, ignoring the social interactional nature of language. He suggests that we should conceive of second language learning as both social and cognitive, which would mean that the enterprise of second language learning would need to include discourse and pragmatic concerns, as well as structural ones. In this sense, we can think of users of a second language who retain their first language accent when speaking the second language, and have errors in vocabulary and morpho-syntax, yet who are highly successful in their communicative uses of the second language. Our use of language also helps mark our identity, and thus not every second language learner sets their goals at 'native-like' fluency and accuracy.

7.4 Animals and language

EXERCISE 7.5

How would you define human language in a way which distinguishes it from all other forms of animal communication? That is, what defining traits separate human language from other forms of animal communication?

Conversations on human language, what it is and how human biology is configured to learn and produce it, often lead to comparisons with animal communication. The debate about whether or not animals have 'language' or could learn language is as lively as the rest of the debates about language, biology and learning. Once again, those debates rest in large measure on defining what language is, as for many language is what makes us humans different (for some, superior) to other species. There certainly are interesting parallels between human and animal communication in terms of aspects of language (dialects, functions, syntax) and in terms of brain configurations. There are obvious differences as well, in terms of how and what can be communicated.

7.4.1 Bees and dialects

David Crystal (2007) reports on research by Karl von Frisch into bee communication. Bees communicate to other bees in their hives by carrying out a series of movements, which von Frisch calls bee 'dancing'. When a bee discovers a food source, it returns to the hive and does a dance. If the food source is relatively close by, the bee does a round dance, circling alternately left and right. If the food source is farther away, the bee does a waggle dance, which involves moving in a straight line for a short distance, wagging its body from side to side; it then returns to the starting point via a semi-circular path and repeats the straight line movement, this time returning via a semi-circular path in the opposite direction. The pace of the dance indicates the proximity of the source: the farther away the source is, the fewer cycles per minute. The direction of the source is indicated by the direction of the line in which the bee waggles in relationship to the position of the sun. Von Frisch then carried out experiments with Austrian honeybees and Italian honeybees. There were differences between the two bee groups in terms of the shape of the dance; while the Austrian honeybees only danced in a circle, Italian bees did so only for short distances, using a 'sickle-shaped' dance for intermediate distances. Like the Austrian bees, the Italians did the waggle dance for longer distances; however, their tempo was slower than the Austrians. Because of this difference, when Austrian bees were put into the same hive as Italian bees, they misjudged the distance of the food source as indicated by the Italian bee dance, and looked for it farther away than it actually was. This misunderstanding across bee cultures led Von Frisch to suggest that bees have different dialects, influenced by their environment perhaps because of the size of the swarm and the coldness of the climate. This difference amongst bees suggests that their dance is not entirely innate, and also points towards the possibility of pattern recognition as necessary for learning how to communicate in other species.

7.4.2 Starlings and recursion

> **EXERCISE 7.6**
>
> Is the sentence 'People people cheat cheat' a syntactically acceptable sentence?

Research done at the University of Chicago and the University of California San Diego (Gentner *et al.* 2006) suggests that the species of bird *Sturnus vulgaris*, or the common European starling, uses recursion, a feature of human language, in fact, for Chomsky, **the** defining feature of human language, 'the only uniquely human component of the faculty of language' (Hauser *et al.* 2002: 1569). Recursion is the ability for one element of language to recur within an element of the same type; for example, at the level of the clause, we can embed clauses within clauses within clauses *ad infinitum*, such as 'This is the boy who loves the girl that bought the book that was written by the man that loves the girl that …'. We can also embed nominal groups within nominal groups, as in 'A room with a view of the church in the square'. The researchers recorded a single male starling's 'rattles' and 'warbles, and then combined them into 16 artificial songs, all of which followed one of two patterns. One of the patterns followed a 'finite-state' rule, which adds sounds only to the beginning or the end of a string. For example, the simple song '1 rattle + 1 warble' (or *ab*) could have added to it another rattle+warble (*abAB*). The other pattern followed a 'context-free' rule, which allows for sounds to be inserted into the middle of a string, so a rattle+warble could be inserted into the middle of *ab* for *aABb*. The researchers taught 11 adult birds to distinguish between the two sets. After thousands of trials, most of the starling subjects learned to distinguish the patterns; they had not simply memorized different patterns, as they could distinguish between the two types even in the case of entirely new sequences of rattles+warbles. The birds even treated differently 'ungrammatical' strings, or sequences which did not follow either set of established rules. Thus, the researchers argue that the birds learned a set of rules, and could apply those rules to new situations, showing that other animals share the ability for pattern recognition with humans. Also, they argue that the ability to classify sequences based on recursion is not uniquely human.

Recursion as the defining trait of human language also received a blow from Daniel Everett, a linguist who has worked the Pirahã people in Brazil, and who demonstrates that their language does not feature recursion. At the same time, the starlings in Gentner *et al.*'s research could have relied on counting sequences, rather than on detecting a recursive meaningful pattern. Even for humans, this kind of recursion is difficult to process, as, for example, in the phrase 'people people cheat cheat' (or 'people that people cheat also cheat'). These objections to Gentner *et al*'s research come from Ray Jackendoff, Mark Liberman, Geoffrey Pullum, and Barbara Scholz in a letter to the *Linguist List,*[18] a letter which they had written to *Nature,* where

18. http://www.linguistlist.org/issues/17/17-1528.html

Gentner *et al.*'s study was published, but which *Nature* declined to publish. Jackendoff *et al.* argue that what is unique to human language, rather than solely recursion is 'a very large learned vocabulary consisting of long-term memory associations between meanings and structured pronunciations plus varied phrasal syntax'. For others who research the ability for apes to learn human language, however, even that definition is too restrictive.

7.4.3 Apes and human language

Much of the debate about human language vs. animal communication centers on the genetic make-up and communicative abilities of primates. There have been a number of researchers who have focused their studies of language on chimpanzees and bonobos, given their common ancestry and closeness of DNA structure. Humans, chimps and bonobos descended from a single ancestor species some 6 or 7 million years ago, and the DNA match between these apes and humans is between 98% and 99%. Obviously, the differences are important, as evidenced by human achievements in art, literature, science, to mention only a few areas, as well as by differences in susceptibility to diseases such as AIDS and Alzheimer's. At the same time, there are similarities and differences in our brain structure and genetic make-up.

We saw earlier in this chapter that part of human language learning includes the ability to recognize patterns and the ability of perceive categories. Apes also can detect relational similarities amongst objects and can distinguish categories. Tests on apes have shown the ability to distinguish between consonant sounds, for example. William Ganong (2005: 273) points out that the brain of apes is similar to that of humans in terms of the presence of specialization of the hemispheres, with one, usually the left, showing specialization for categorical perception; this similarity in brain functional organization between humans and apes suggests that categorical perception existed before the emergence of human language. William Hopkins, a primate neuroanatomist at Emory University in Atlanta, has led research which shows that in bonobos, gorillas and chimpanzees, the left and right hemispheres of the brain show the same asymmetry as human brains do in the area corresponding to Broca's area; that is, this area in the left hemisphere of these animals is larger than the corresponding area on the right. Hopkins and his team (Hopkins *et al.*, 2008) further showed that this area is activated in chimps when they are involved in communicating through gestures, suggesting that the neurological substrates underlying language production in the human brain may have been present in the common ancestor of humans and chimpanzees. At the same time, the size and trajectory of the arcuate fasciculus, which connects various areas in the brain related to language, in humans differs from that of apes, meaning that there are more network fibers which play a role the language abilities of humans.

Furthermore, the FOXP2 gene, mentioned in Section 7.1 exists in other vertebrates as well as in humans, although the differences in the gene across species means that inserting the human version into mice causes a change in their brains in terms of synaptic plasticity; that is, the mice brains showed increased activity in connections between nerve cells with the human FOXP2 version of the gene (Lieberman, 2009). Another major difference between animals and humans is the human vocal apparatus; even if we transplanted a human brain into an ape, the ape would not be able to speak because of the positioning of their larynx, which is higher than that of humans. Thus, the human pharynx is longer than that of apes; also humans have a more flexible tongue. These differences mean that humans can produce a wide variety of vowels and consonants, which apes cannot. The position of the human larynx also means that we have the unfortunate ability to choke on our food, which leads Lieberman (2009: 802) to point out that, during our evolution 'a human tongue would be worse than useless unless the hominid in question also had cortico-basal ganglia circuits capable of executing the rapid, complex motor gestures that are necessary to produce articulate speech'. It is also worth noting the incredible trade-off that an increase in the ability to produce different kinds of sounds into more complex and meaningful strings gave us if it came with the price of accidental choking.

Because of the similarities between apes and humans, it is not surprising that apes have been a focal point of research into the ability of animals to learn language. Early experiments with chimps involved using behavior modification techniques in teaching chimps sign language. In these experiments, chimps such as Washoe and Nim Chimpsky were taught signs from American Sign Language over and over, and when they produced a sign similar to the target, they were rewarded. Much of this research was later used as a basis to deny that apes had the ability to produce anything even resembling human language, as chimps were thought to simply produce the signs they had been taught upon the presence of certain stimuli, as might be expected with behavioral modification. Indeed, an important understanding here is that of indexical vs. symbolic signs. Indexical signs connect one sign with one meaning, such as is the case in the protolinguistic signs of babies (see Section 7.2.1). So, for example, vervet monkeys will make a certain type of call if an eagle is sighted and another type of call if a leopard is approaching. For each there is one call equal to one meaning (Benson *et al*. 2005), and the initial understanding of chimp capabilities with language were seen to be limited to this type of sign indexicality. Human language goes beyond the indexical to the symbolic, in that it is a system, comprised of a set of symbols and a set of rules (or grammar – our morphosyntax) which governs the way in which these symbols are combined; the symbols of human languages can be combined in creative ways to convey new information. There are many researchers who argue that humans are the only species who communicate symbolically.

However, monkey calls are shown to exhibit more complexity than simple indexicality. For example, Diana monkeys and Campbell's monkeys also each produce eagle alarm calls, and Diana monkeys actually respond to Campbell's monkey calls by producing their own eagle alarm calls – they cannot reproduce the Campbell's calls, but they can interpret them to then issue their own calls. Furthermore, the Campbell's monkeys also produce what are known as 'boom' calls, which signal that a predator is near, but not yet close enough for danger. The Diana monkeys interpret this as well, and issue reduced alarm calls, unless, of course, the boom call is followed by an alarm call. Benson *et al*. connect these different ways of responding to the different metafunctions of language (see Chapter 3). In other words, the monkeys are using their communication system ideationally (by representing different kinds of experience), interpersonally (by initiating, sustaining or responding), and textually (by constructing salience through signaling new information through boom or alarm calls, or by moving from given to new information through boom^alarm calls). The system is limited to a fixed and small number of calls; however, Benson *et al*. suggest that a strong candidate for an evolutionary prerequisite to human language is the ability to differentiate between indexical signs, and then to combine them in different ways.

Work with bonobos also points to another important prerequisite to human language, which is that of social interaction. Apes are extremely social animals, as, of course, are humans. Thus contexts in cases where apes, especially bonobos, have been brought up interacting with humans show different outcomes than simple learning of indexical signs, produced upon demand. The work led by Susan Savage-Rumbaugh at the Language Research Center at Georgia State University as well as at the Great Ape Trust housed at Iowa State University has shown some extraordinary strides in communication between bonobos and humans, and has convinced even some highly skeptical scientists.[19] The bonobos at the center, such as Kanzi

19. For a fascinating explanation of Dr Stuart Shankar's experience in moving from skepticism to support for Savage-Rumbaugh's work, the podcast at http://www.podfeed.net/episode/BSP-7+Bonobos+with+Dr.+Stuart+Shanker/1914323 is well worth listening to.

and Panbanisha, understand more complex syntax, and have combined language using a lexigram board, with gestures, facial expressions and gaze, in ways which allow them to create novel meanings. Benson *et al.* report on one conversation, involving a good deal of pronominal reference, including reference to Kanzi who is in another room, in which Panbanisha is able to interpret what is happening, showing that she is able to rely on clues in the discourse itself, and not just those available in the immediate context. Social interaction, as we saw at the beginning of Chapter 5, was vital for the survival of our ancestors, and for the development of language. Claire Painter writes about the 'interpersonal first' factor in the development of language in babies, and perhaps this factor plays a role as well in an increase in the ability of the bonobos to interact in more meaningful ways with their caregivers.

The debates included in this section and this chapter show a central question in linguistics: what is language? For some, it is defined mainly by its structural properties, its phonology, morphology and syntax, while for others, language is defined also by its communicative and interactional properties, by its functions. The differences in defining the object of study, language, lead to a wide variety of approaches for linguists to take when examining language, when describing it and when putting those descriptions to use in further analysis. These different approaches are taken up in Chapter 8.

7.5 Chapter outcomes

After having read this chapter carefully, discussed with others the content, and carried out the exercises, you should assess your ability to:

- ✓ Briefly define neurolinguistics.
- ✓ Explain the importance of aphasia to neurolinguistics.
- ✓ Explain the significance of Broca's and Wernicke's research to an understanding of the relationship between the brain and language.
- ✓ Give examples of the kind of agrammatism associated with lesions to Broca's area.
- ✓ Explain the broad differences in functions of the left and right hemispheres of the cerebral cortex.
- ✓ Describe the features of child-direct speech.
- ✓ Explain categorical perception and its relationship to language development.
- ✓ Describe each of the phases of child language development (babbling, first-word stage, two-word stage, telegraphic speech), including typical duration and age of onset.

- ✓ Explain what develops in child language development (phonologically, morphosyntactically, lexically, semantically/pragmatically).
- ✓ Discuss the critical period hypothesis.
- ✓ Compare and contrast in broad terms different theoretical perspectives on child language development: Chomsky's genetic endowment position, the statistical learning position, and lexical priming.
- ✓ Compare and contrast in broad terms an approach to language development which focuses on formal development (of phonology and lexico-grammar) of language to one which focuses on functional development of language.
- ✓ Compare and contrast language development in monolingual children with that of development in bilingual (or multilingual) children.
- ✓ Discuss some of the issues involved in the debates about whether younger or older learners are better at learning a second language.
- ✓ List some of the similarities and differences between humans and animals with respect to aspects of language (dialects, pattern recognition, recursion, indexicality).

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