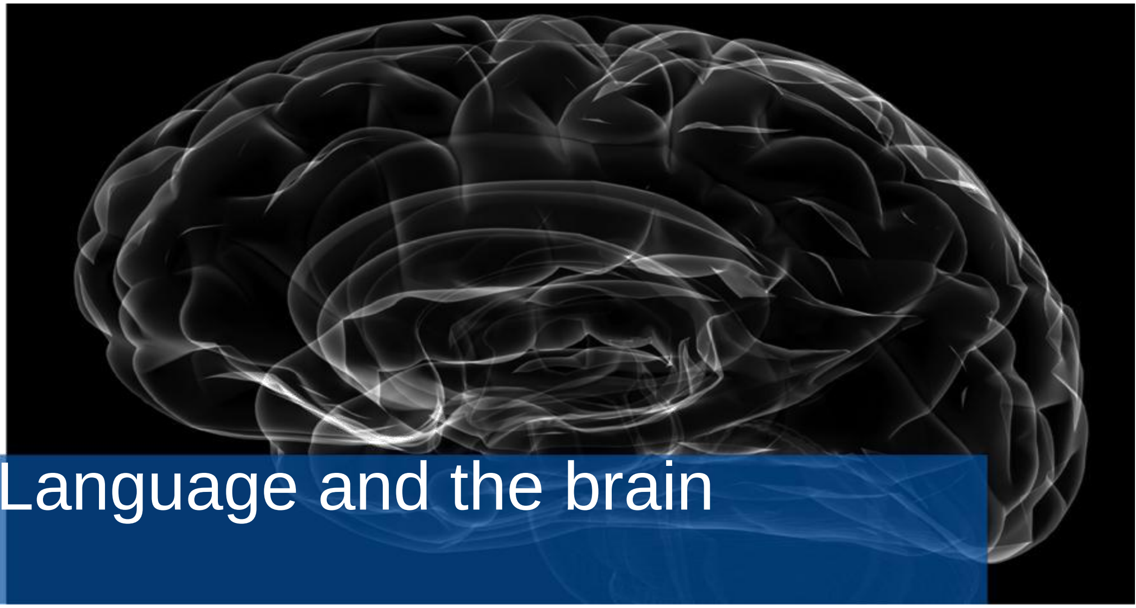
Reference:
George Yule, The Study of Language (4th edition)



12 Language and the brain

I once had a patient who suffered a right hemisphere stroke and fell to the ground, unable to walk because of a paralyzed left leg. She lay on the floor for two days, not because no one came to her aid, but because she kept blithely reassuring her husband that she was fine, that there was nothing wrong with her leg. Only on the third day did he bring her in for treatment. When I asked her why she could not move her left leg, and held it up for her to see, she said indifferently that it was someone else's leg.

Flaherty (2004)

In the preceding chapters we have reviewed in some detail the various features of language that people use to produce and understand linguistic messages. Where is this ability to use language located? The obvious answer is "in the brain." However, it can't be just anywhere in the brain. For example, it can't be where damage was done to the right hemisphere of the patient's brain in Alice Flaherty's description. The woman could no longer recognize her own leg, but she could still talk about it. The ability to talk was unimpaired and hence clearly located somewhere else in her brain.

Neurolinguistics

The study of the relationship between language and the brain is called neurolinguis-tics. Although this is a relatively recent term, the field of study dates back to the nineteenth century. Establishing the location of language in the brain was an early challenge, but one event incidentally provided a clue.

In September 1848, near Cavendish, Vermont, a construction foreman called Phineas P. Gage was in charge of a construction crew blasting away rocks to lay a new stretch of railway line. As Mr. Gage pushed an iron tamping rod into the blasting hole in a rock, some gunpowder accidentally exploded and sent the three-and-a-half-foot long tamping rod up through his upper left cheek and out from the top of his forehead. The rod landed about fifty yards away. Mr. Gage suffered the type of injury from which, it was assumed, no one could recover. However, a month later, he was up and about, with no apparent damage to his senses or his speech.

The medical evidence was clear. A huge metal rod had gone through the front part of Mr. Gage's brain, but his language abilities were unaffected. He was a medical marvel. The point of this rather amazing tale is that, while language may be located in the brain, it clearly is not situated right at the front.

Language areas in the brain

Since that time, a number of discoveries have been made about the specific parts in the brain that are related to language functions. We now know that the most important parts are in areas above the left ear. In order to describe them in greater detail, we need to look more closely at some of the gray matter. So, take a head, remove hair, scalp, skull, then disconnect the brain stem (connecting the brain to the spinal cord) and cut the corpus callosum (connecting the two hemispheres). If we disregard a certain amount of other material, we will basically be left with two parts, the left hemisphere and the right hemisphere. If we put the right hemisphere aside for now, and place the left hemisphere down so that we have a side view, we'll be looking at something close to the accompanying illustration (adapted from Geschwind, 1991).

The shaded areas in this illustration indicate the general locations of those language functions involved in speaking and listening. We have come to know that these areas exist largely through the examination, in autopsies, of the brains of people who, in life, were known to have specific language disabilities. That is, we have tried to determine where language abilities for normal users must be by finding areas with specific damage in the brains of people who had identifiable language disabilities.

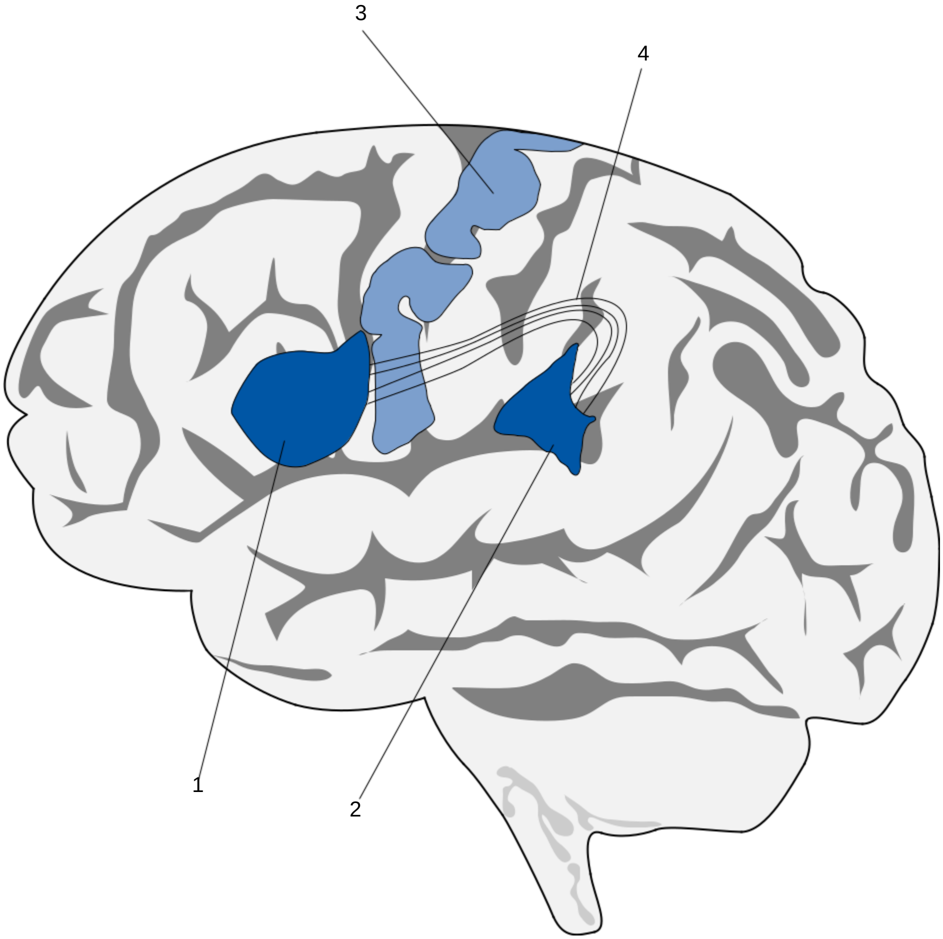


Figure 12.1

Broca's area

The part shown as (1) in the illustration is technically described as the "anterior speech cortex" or, more usually, as Broca's area. Paul Broca, a French surgeon, reported in the 1860s that damage to this specific part of the brain was related to extreme difficulty in producing speech. It was noted that damage to the correspond-ing area on the right hemisphere had no such effect. This finding was first used to argue that language ability must be located in the left hemisphere and since then has been treated as an indication that Broca's area is crucially involved in the production of speech.

Wernicke's area

The part shown as (2) in the illustration is the "posterior speech cortex," or Wernicke's area. Carl Wernicke was a German doctor who, in the 1870s, reported that damage to this part of the brain was found among patients who had speech comprehension difficulties. This finding confirmed the left hemisphere location of language ability and led to the view that Wernicke's area is part of the brain crucially involved in the understanding of speech.

The motor cortex and the arcuate fasciculus

The part shown as (3) in the illustration is the motor cortex, an area that generally controls movement of the muscles (for moving hands, feet, arms, etc.). Close to Broca's area is the part of the motor cortex that controls the articulatory muscles of the face, jaw, tongue and larynx. Evidence that this area is involved in the physical articulation of speech comes from work reported in the 1950s by two neurosurgeons, Penfield and Roberts (1959). These researchers found that, by applying small amounts of electrical current to specific areas of the brain, they could identify those areas where the electrical stimulation would interfere with normal speech production.

The part shown as (4) in the illustration is a bundle of nerve fibers called the arcuate fasciculus. This was also one of Wernicke's discoveries and is now known to form a crucial connection between Wernicke's and Broca's areas.

The localization view

Having identified these four components, it is tempting to conclude that specific aspects of language ability can be accorded specific locations in the brain. This is called the localization view and it has been used to suggest that the brain activity involved in hearing a word, understanding it, then saying it, would follow a definite pattern. The word is heard and comprehended via Wernicke's area. This signal is then transferred via the arcuate fasciculus to Broca's area where preparations are made to produce it. A signal is then sent to part of the motor cortex to physically articulate the word.

This is certainly an oversimplified version of what may actually take place, but it is consistent with much of what we understand about simple language processing in the brain. It is probably best to think of any proposal concerning processing pathways in the brain as some form of metaphor that may turn out to be inadequate once we learn more about how the brain functions. The "pathway" metaphor seems quite appealing in an electronic age when we're familiar with the process of sending signals through electrical circuits. In an earlier age, dominated more by mechanical technology, Sigmund Freud subtly employed a "steam engine" metaphor to account for aspects of the brain's activity when he wrote of the effects of repression "building up pressure" to the point of "sudden release." In an even earlier age, Aristotle's metaphor was of the brain as a cold sponge that functioned to keep the blood cool.

In a sense, we are forced to use metaphors mainly because we cannot obtain direct physical evidence of linguistic processes in the brain. Because we have no direct access, we generally have to rely on what we can discover through indirect methods. Most of these methods involve attempts to work out how the system is working from clues picked up when the system has problems or malfunctions.

Tongue tips and slips

We have all experienced difficulty, on some occasion(s), in getting brain and speech production to work together smoothly. (Some days are worse than others, of course.) Minor production difficulties of this sort may provide possible clues to how our linguistic knowledge is organized within the brain.

The tip of the tongue phenomenon

There is, for example, the tip of the tongue phenomenon in which we feel that some word is just eluding us, that we know the word, but it just won't come to the surface. Studies of this phenomenon have shown that speakers generally have an accurate phonological outline of the word, can get the initial sound correct and mostly know the number of syllables in the word. This experience also mainly occurs with uncommon words and names. It suggests that our "word-storage" system may be partially organ-ized on the basis of some phonological information and that some words in the store are more easily retrieved than others.

When we make mistakes in this retrieval process, there are often strong phonological similarities between the target word we're trying to say and the mistake we actually produce. For example, speakers produced secant, sextet and sexton when asked to name a particular type of navigational instrument (sextant). Other examples are fire distinguisher (for "extinguisher") and transcendental medication (instead of "meditation"). Mistakes of this type are sometimes referred to as malapropisms after a character called Mrs. Malaprop (in a play by Sheridan) who consistently produced "near-misses" for words, with great comic effect. Another comic character in a TV program who was known for his malapropisms was Archie Bunker, who once suggested that We need a few laughs to break up the monogamy.

Slips of the tongue

Another type of speech error is commonly described as a slip of the tongue. This produces expressions such as make a long shory stort (instead of “make a long story short”), use the door to open the key, and a fifty-pound dog of bag food. Slips of this type are sometimes called spoonerisms after William Spooner, an Anglican clergyman at Oxford University, who was renowned for his tongue-slips. Most of the slips attributed to him involve the interchange of two initial sounds, as when he addressed a rural group as noble tons of soil, or described God as a shoving leopard to his flock, or in this complaint to a student who had been absent from classes: You have hissed all my mystery lectures.

Most everyday slips of the tongue, however, are not as entertaining. They are often simply the result of a sound being carried over from one word to the next, as in black bloxes (for “black boxes”), or a sound used in one word in anticipation of its occur-rence in the next word, as in noman numeral (for “roman numeral”), or a tup of tea (“cup”), or the most highly played player (“paid”). The last example is close to the reversal type of slip, illustrated by shu flots, which may not make you beel fetter if you’re suffering from a stick neff, and it’s always better to loop before you leak. The last two examples involve the interchange of word-final sounds and are much less com-mon than word-initial slips.

It has been argued that slips of this type are never random, that they never produce a phonologically unacceptable sequence, and that they indicate the existence of different stages in the articulation of linguistic expressions. Although the slips are mostly treated as errors of articulation, it has been suggested that they may result from “slips of the brain” as it tries to organize linguistic messages.

Slips of the ear

One other type of slip may provide some clues to how the brain tries to make sense of the auditory signal it receives. These have been called slips of the ear and can result, for example, in our hearing great ape and wondering why someone should be looking for one in his office. (The speaker actually said “gray tape.”) A similar type of misunderstanding seems to be behind the child’s report that in Sunday school, everyone was singing about a bear called “Gladly” who was cross-eyed. The source of this slip turned out to be a line from a religious song that went Gladly the cross I’d bear. It may also be the case that some malapropisms (e.g. transcendental medication) originate as slips of the ear.

Some of these humorous examples of slips may give us a clue to the normal work-ings of the human brain as it copes with language. However, some problems with language production and comprehension are the result of much more serious disorders in brain function.

Aphasia

If you have experienced any of those "slips" on occasion, then you will have some hint of the types of experience that some people live with constantly. Those people suffer from different types of language disorders, generally described as "aphasia." Aphasia is defined as an impairment of language function due to localized brain damage that leads to difficulty in understanding and/or producing linguistic forms.

The most common cause of aphasia is a stroke (when a blood vessel in the brain is blocked or bursts), though traumatic head injuries from violence or an accident may have similar effects. Those effects can range from mild to severe reduction in the ability to use language. Someone who is aphasic often has interrelated language disorders, in that difficulties in understanding can lead to difficulties in production, for example. Consequently, the classification of different types of aphasia is usually based on the primary symptoms of someone having difficulties with language.

Broca's aphasia

The serious language disorder known as Broca's aphasia (also called "motor aphasia") is characterized by a substantially reduced amount of speech, distorted articulation and slow, often effortful speech. What is said often consists almost entirely of lexical morphemes (e.g. nouns, verbs). The frequent omission of functional morphemes (e.g. articles, prepositions) and inflections (e.g. plural -s, past tense -ed) has led to the characterization of this type of aphasic speech as "agrammatic." In agram-matic speech, the grammatical markers are missing.

An example of speech produced by someone whose aphasia was not severe is the following answer to a question regarding what the speaker had for breakfast:

I eggs and eat and drink coffee breakfast

However, this type of disorder can be quite severe and result in speech with lots of hesitations and really long pauses (marked by …): my cheek … very annoyance … main is my shoulder … achin' all round here. Some patients can also have lots of difficulty in articulating single words, as in this attempt to say "steamship": a stail … you know what I mean … tal … stail. In Broca's aphasia, comprehension is typically much better than production.

Wernicke's aphasia

The type of language disorder that results in difficulties in auditory comprehension is sometimes called "sensory aphasia," but is more commonly known as Wernicke's aphasia. Someone suffering from this disorder can actually produce very fluent speech which is, however, often difficult to make sense of. Very general terms are used, even in response to specific requests for information, as in this sample: I can't talk all of the things I do, and part of the part I can go alright, but I can't tell from the other people.

Difficulty in finding the correct word, sometimes referred to as anomia, also hap-pens in Wernicke's aphasia. To overcome their word-finding difficulties, speakers use different strategies such as trying to describe objects or talking about their purpose, as in the thing to put cigarettes in (for "ashtray"). In the following example (from Lesser & Milroy, 1993), the speaker tries a range of strategies when he can't come up with the word ("kite") for an object in a picture.

> it's blowing, on the right, and er there's four letters in it, and I think it begins with a C – goes – when you start it then goes right up in the air – I would I would have to keep racking my brain how I would spell that word – that flies, that that doesn't fly, you pull it round, it goes up in the air

Conduction aphasia

One other, much less common, type of aphasia has been associated with damage to the arcuate fasciculus and is called conduction aphasia. Individuals suffering from this disorder sometimes mispronounce words, but typically do not have articulation prob-lems. They are fluent, but may have disrupted rhythm because of pauses and hesi-tations. Comprehension of spoken words is normally good. However, the task of repeating a word or phrase (spoken by someone else) creates major difficulty, with forms such as vaysse and fosh being reported as attempted repetitions of the words "base" and "wash." What the speaker hears and understands can't be transferred very successfully to the speech production area.

It should be emphasized that many of these symptoms (e.g. word-finding diffi-culty) can occur in all types of aphasia. They can also occur in more general disorders resulting from brain disease, as in dementia and Alzheimer's disease. Difficulties in speaking can also be accompanied by difficulties in writing. Impairment of auditory comprehension tends to be accompanied by reading difficul-ties. Language disorders of the type we have described are almost always the result of injury to the left hemisphere. This left hemisphere dominance for language has also been demonstrated by another approach to the investigation of language and the brain.

Dichotic listening

An experimental technique that has demonstrated a left hemisphere dominance for syllable and word processing is called the dichotic listening test. This technique uses the generally established fact that anything experienced on the right-hand side of the body is processed in the left hemisphere, and anything on the left side is processed in the right hemisphere. As illustrated in Flaherty's (2004) description at the beginning of this chapter, a stroke in the right hemisphere resulted in paralysis of the left leg. So, a basic assumption would be that a signal coming in the right ear will go to the left hemisphere and a signal coming in the left ear will go to the right hemisphere.

With this information, an experiment is possible in which a subject sits with a set of earphones on and is given two different sound signals simultaneously, one through each earphone. For example, through one earphone comes the syllable ga or the word dog, and through the other earphone at exactly the same time comes da or cat. When asked to say what was heard, the subject more often correctly identifies the sound that

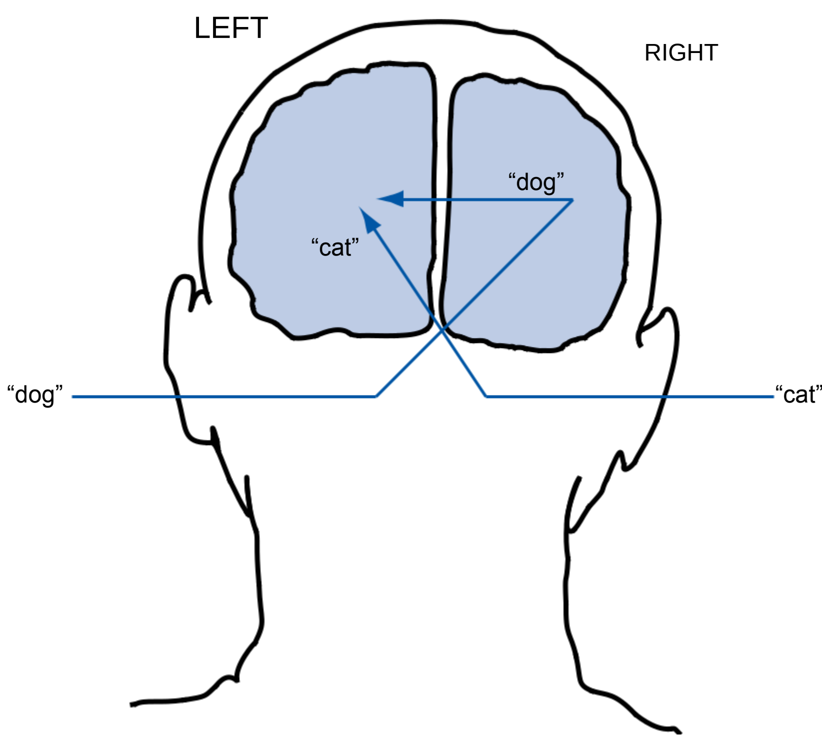


Figure 12.2

came via the right ear. This is known as the right ear advantage for linguistic sounds. The process involved is best understood with the help of the accompanying illustra-tion. (You're looking at the back of this head.)

In this process, the language signal received through the left ear is first sent to the right hemisphere and then has to be sent to the left hemisphere (language center) for processing. This non-direct route takes longer than a linguistic signal received through the right ear and going directly to the left hemisphere. First signal to get processed wins.

The right hemisphere appears to have primary responsibility for processing a lot of other incoming signals that are non-linguistic. In the dichotic listening test, it can be shown that non-verbal sounds (e.g. music, coughs, traffic noises, birds singing) are recognized more often via the left ear, meaning they are processed faster via the right hemisphere. So, among the specializations of the human brain, the right hemisphere is first choice for non-language sounds (among other things) and the left hemisphere specializes in language sounds (among other things too).

These specializations may actually have more to do with the type of processing, rather than the type of material, that is handled best by each of the two hemispheres. The essential distinction seems to be between analytic processing, such as recognizing the smaller details of sounds, words and phrase structures in rapid sequence, done with the "left brain," and holistic processing, such as identifying more general struc-tures in language and experience, done with the "right brain."

The critical period

The apparent specialization of the left hemisphere for language is usually described in terms of lateral dominance or lateralization (one-sidedness). Since the human child does not emerge from the womb as a fully articulate language-user, it is generally thought that the lateralization process begins in early childhood. It coincides with the period during which language acquisition takes place. During childhood, there is a period when the human brain is most ready to receive input and learn a particular language. This is sometimes called the "sensitive period" for language acquisition, but is more generally known as the critical period.

Though some think it may start earlier, the general view is that the critical period for first language acquisition lasts from birth until puberty. If a child does not acquire language during this period, for any one of a number of reasons, then he or she will find it almost impossible to learn language later on. In one unfortunate but well-documented case, we have gained some insight into what happens when the critical period passes without adequate linguistic input.

Genie

In 1970, a girl who became known as "Genie" was admitted to a children's hospital in Los Angeles. She was thirteen years old and had spent most of her life tied to a chair in a small closed room. Her father was intolerant of any kind of noise and had beaten her whenever she made a sound as a child. There had been no radio or television, and Genie's only other human contact was with her mother who was forbidden to spend more than a few minutes with the child to feed her. Genie had spent her whole life in a state of physical, sensory, social and emotional deprivation.

As might be expected, Genie was unable to use language when she was first brought into care. However, within a short period of time, she began to respond to the speech of others, to try to imitate sounds and to communicate. Her syntax remained very simple. The fact that she went on to develop some speaking ability and understand a fairly large number of English words provides some evidence against the notion that language cannot be acquired at all after the critical period. Yet her diminished capacity to develop grammatically complex speech does seem to support the idea that part of the left hemisphere of the brain is open to accept a language program during childhood and, if no program is provided, as in Genie's case, then the facility is closed down.

In Genie's case, tests demonstrated that she had no left hemisphere language facility. So, how was she able to learn any part of language, even in a limited way? Those same tests appeared to indicate the quite remarkable fact that Genie was using the right hemisphere of her brain for language functions. In dichotic listening tests, she showed a very strong left ear advantage for verbal as well as non-verbal signals. Such a finding, supported by other studies of right brain function, raises the possibility that our capacity for language is not limited to only one or two specific areas, but is based on more complex connections extending throughout the whole brain.

When Genie was beginning to use speech, it was noted that she went through some of the same early "stages" found in normal child language acquisition. In the next chapter, we will investigate what these normal stages are.

Reference:
George Yule, The Study of Language (4th edition)

Study questions

What is a more common name for the posterior speech cortex?

Is the use of “fire distinguisher” instead of “fire extinguisher” a spoonerism or a malapropism?

What is aphasia?

Which type of aphasia is characterized by speech like this: speech … two times … read … wr … ripe, er, rike, er, write … ?

What happens in a dichotic listening test?

What is the critical period?

Tasks

We made no distinction between the left and right hemispheres in terms of shape or size, assuming they were symmetrical. However, on closer inspection, there is some asymmetry in the lateralization of the brain. What seems to be the main source of this difference between the physiology of the two hemispheres? Should this difference be treated as support for the phrenology model of human brain function?

What is meant by the “bathtub effect” in descriptions of features of speech errors? Do any examples of speech errors in this chapter illustrate this effect?

In this chapter we focused on the left hemisphere and how it is affected by impairments. What happens to the language of an individual after damage in the right hemisphere?

How would you go about analyzing the following extract from Radford et al. (2009) as more likely to be indicative of agrammatism or paragrammatism? (The speaker is trying to talk about a lady’s shoe.)

> Now there there I remember. I have you there what I thought was the … a lady one. Another. With a very short. Very very clever done. Do that the one two. Go. But there’s the liver. And there is the new. And so on.

The following extract from Buckingham and Kertesz (1976: 21) is discussed in Obler and Gjerlow (1999: 59) as an illustration of “neologistic jargon aphasia.” Can you identify any characteristics of this condition that show up in the language used by this speaker? Is the syntax badly impaired? Are morphological features such as inflections used normally or not? Does the speaker have word-finding difficulties? Would you say that this aphasia is more likely to be associated with Broca’s area or Wernicke’s area? (The speaker is responding to the question, “Who is running the store now?”)

I don't know. Yes, the bick, uh, yes I would say that the mick daysis nosis or chpickters. Course, I have also missed on the carfter teck. Do you know what that is? I've, uh, token to ingish. They have been toast sosilly. They'd have been put to myafa and made palis and, uh, myadakal senda you. That is me alordisdus. That makes anacronous senda.

F What happens in "brain imaging" procedures such as CAT scans, fMRI scans and PET scans that might help in the study of language and the brain?

Discussion topics/projects

I One aphasia patient was asked to read aloud the written words on the left below and, in each case, actually said the words on the right. Is there any pattern to be found in these errors? Does this type of phenomenon provide any clues to the way words may be stored and accessed in the brain?

ambition → career	commerce → business
anecdote → narrator	mishap → accident
applause → audience	parachute → balloon
apricot → peach arithmetic	thermometer → temperature
→ mathematics	victory → triumph

(For background reading, see Allport, 1983, the source of these examples.)

II The story of Genie is full of remarkable episodes. The following extract is from Rymer (1993), quoting Susan Curtiss, a linguist who worked with Genie for many years. How would you explain events like this?

"Genie was the most powerful nonverbal communicator I've ever come across," Curtiss told me. "The most extreme example of this that comes to mind: Because of her obsession, she would notice and covet anything plastic that anyone had. One day we were walking – I think we were in Hollywood. I would act like an idiot, sing operatically, to get her to release some of that tension she always had. We reached the corner of this very busy intersection, and the light turned red, and we stopped. Suddenly, I heard the sound – it's a sound you can't mistake – of a purse being spilled. A woman in a car that had stopped at the intersection was emptying her purse, and she got out of the car and ran over and gave it to Genie and then ran back to the car. A plastic purse. Genie hadn't said a word."

(For background reading, see chapter 17 of Rymer, 1993.)

Reference:
George Yule, The Study of Language (4th edition)

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