goal is blocked, an aggressive drive is induced that motivates behavior to injure the object—or the person—causing the frustration. While research has shown that aggression is not an inevitable response to frustration, it certainly is one of them. When one child takes a toy from another, the second is likely to attack the first in an attempt to regain the toy. In the late 1980s, some adults frustrated by interminable traffic jams on hot Los Angeles freeways began shooting at one another. Fortunately, adults usually express their aggression verbally rather than physically; they are more likely to exchange insults than blows.

Direct aggression toward the source of frustration is not always possible or wise. Sometimes the source is vague and intangible. The person does not know what to attack but feels angry and seeks an object on which to vent these feelings. Sometimes the individual responsible for the frustration is so powerful that an attack would be dangerous. When circumstances block direct attack on the cause of frustration, aggression may be *displaced:* The aggressive action may be directed toward an innocent person or object rather than toward the actual cause of the frustration. A man who is reprimanded at work may take out unexpressed resentment on his family. A student, angry at her professor for an unfair grade, may blow up at her roommate. A child frustrated by experiences at school may resort to vandalism of school property.

Apathy and Depression

Although a common response to frustration is active aggression, the opposite response of withdrawal and apathy is also common. If the stressful conditions continue and the individual is not successful in coping with them, apathy may deepen into depression.

The theory of **learned helplessness** (Seligman, 1975) explains how experience with aversive, uncontrollable events can lead to apathy and depression (see also Chapter 7). A series of experiments showed that dogs placed in a shuttle box (an apparatus with two compartments separated by a barrier) quickly learn to jump to the opposite compartment to escape a mild electric shock delivered to their feet through a grid on the floor. If a light is turned on a few seconds before the grid is electrified, the dogs can learn to avoid the shock entirely by jumping to the safe compartment when signaled by the light. However, if the dog has had a previous history of being in another enclosure in which shocks were unavoidable and inescapable—in which nothing the animal did terminated the shock—then it is very difficult for the dog to learn the avoidance response in a new situation when it is appropriate. The animal simply sits and endures the shock in the shuttle box, even though an easy jump to the opposite compartment would eliminate discomfort. Some dogs never learn, even if the experimenter demonstrates the proper procedure by carrying them over the barrier. The experimenters concluded that the animals had learned through prior experience that they were helpless to avoid the shock and so gave up trying to do so, even in a new situation. This learned helplessness was difficult for the animals to overcome (Overmeier & Seligman, 1967).

Some humans also appear to develop learned helplessness, characterized by apathy, withdrawal, and inaction, in response to uncontrollable events. Not all do, however. The original learned helplessness theory has had to be modified to take into account the fact that some people become helpless following uncontrollable events, but other people are invigorated by the challenge that such events pose (Wortman & Brehm, 1975). This modified theory will be discussed in the section on personality style.

The original learned helplessness theory is useful, however, in helping us to understand why some people seem to give up and take it when exposed to difficult events. For example, the theory has been used to explain why prisoners in Nazi concentration camps did not revolt against their captors more often: They had come to believe that they were helpless to do anything about their captivity and thus did not try to escape. Women caught in marriages with a battering husband frequently do not try to escape. These women often say that they feel helpless to do anything about their situations because they fear what their husbands would do if they tried to leave, or because they do not have the economic resources to support themselves and their children.

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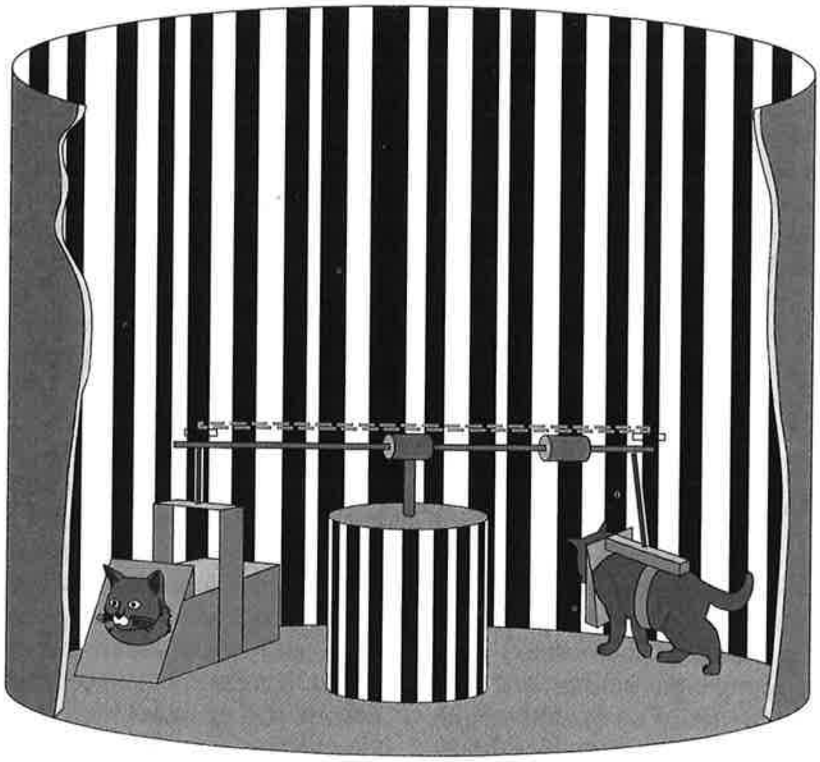
FIGURE 5-32

Importance of Self-Produced Movements *Both kittens received roughly the same visual stimulation, but only the active kitten had this stimulation produced by its own movement.* (After Held & Hein, 1963)



effect on perception. For evidence of such effects, we need only consider our ability to recognize common objects. The fact that we can more readily recognize a familiar object than an unfamiliar one—a dog versus an aardvark, for example—must certainly be due to learning (because had we been reared in an environment rich in aardvarks and sparse in dogs, we could have recognized the aardvark more readily than the dog).

PERCEPTUAL-MOTOR COORDINATION When it comes to coordinating perceptions with motor responses, learning plays a major role. The evidence for this comes from studies in which subjects receive normal stimulation but are prevented from making normal responses to that stimulation. Under such conditions, perceptual-motor coordination does not develop.

For example, in one classic study, two dark-reared kittens had their first visual experience in the "kitten carousel" illustrated in Figure 5-32. As the active kitten walked, it moved the passive kitten riding in the carousel. Although both kittens received roughly the same visual stimulation, only the active kitten had this stimulation produced by its movement. And only the active kitten successfully learned sensory-motor coordination; for example, when picked up and moved toward an object, only the active kitten learned to put out its paws to ward off a collision.

Similar results have been obtained with humans. In some experiments people have worn prism goggles that distort the directions of objects. Immediately after putting on these goggles, a person temporarily has trouble reaching for objects and often bumps into things. If a person moves about and attempts to perform motor tasks while wearing the goggles, he or she learns to behave adaptively. The person is learning to coordinate his or her movements with the actual location of objects rather than with their apparent locations. On the other hand, if the person is pushed in a wheelchair, he or she does not adapt to the goggles. Apparently, self-produced movement is essential to prism adaption (Held, 1965).

In summary, the evidence indicates that we are born with considerable perceptual capacity. The natural development of some of these capacities may require years of normal input from the environment; hence, environmental effects early in development are often more indicative of innate than learned processes. But there clearly are learning effects on perception as well, which are particularly striking when perception must be coordinated with motor behavior.

For example, they might learn that one token refers to "apples" and another to "paper," where there is no physical resemblance between the token and the object. The fact that chimpanzees can learn these references suggests they understand concrete concepts like "apple" and "paper." More impressively, they also have abstract concepts like "same," "different," and "cause." Thus, chimpanzees can learn to use their "same" token when presented either two "apple" tokens or two "orange" ones, and their "different" token when presented one "apple" and one "orange" token. Likewise, chimpanzees seem to understand causal relations. They will apply the token for "cause" when shown some cut paper and scissors, but not when shown some intact paper and scissors (Premack, 1985a; Premack & Premack. 1983).

INSIGHT LEARNING

While many early researchers tried to study complex learning with species far removed from humans (like rats and pigeons), other early researchers assumed that the best evidence for complex learning would come from other primate species. Among these researchers, Wolfgang Köhler's work with chimpanzees, carried out in the 1920s, remains particularly important. The problems that Köhler set for his chimpanzees left some room for insight, because no parts of the problem were hidden from view (in contrast, the workings of a food dispenser in a Skinner box are hidden from the animal's view). Typically, Köhler placed a chimpanzee in an enclosed area with a desirable piece of fruit, often a banana, out of reach. To obtain the fruit, the animal had to use a nearby object as a tool. Usually the chimpanzee solved the problem, and did it in a way that suggested it had some insight. The following description from Köhler is typical:

> Sultan [Köhler's most intelligent chimpanzee] is squatting at the bars but cannot reach the fruit which lies outside by means of his only available short stick. A longer stick is deposited outside the bars, about two meters on one side of the object and parallel with the grating. It cannot be grasped with the hand, but it can be pulled within reach by means of the small stick. [See Figure 7-10 for an illustration of a similar multiple-stick problem.] Sultan tries to reach the fruit with the smaller of the two sticks. Not succeeding, he tears at a piece of wire that projects from the netting of his cage, but that too is in vain. Then he gazes about him (there are always in the course of these tests some long pauses, during which the animals scrutinize the whole visible area). He suddenly picks up the little stick once more, goes up to the bars directly opposite to the long stick, scratches it towards him with the "auxiliary," seizes it, and goes with it to the point opposite the objective (the fruit), which he secures. From the moment that his eyes fall upon the long stick, his procedure forms one consecutive whole, without hiatus, and although the angling of the bigger stick by means of the smaller is an action that could be complete and distinct in itself, yet observation shows that it follows, quite suddenly, on an interval of hesitation and doubt—staring about—which undoubtedly has a relation to the final objective, and is immediately merged in the final action of the attainment of the end goal. (Köhler, 1925, pp. 174–75)

Several aspects of the performance of these chimpanzees are unlike those of Thorndike's cats or Skinner's rats and pigeons. For one thing, the solution was sudden, rather than being the result of a gradual trial-and-error process. Another point is that once a chimpanzee solved a problem, thereafter it would solve the problem with few irrelevant moves. This is most unlike a rat in a Skinner box, which continues to make irrelevant responses for many trials. Also, Köhler's chimpanzees

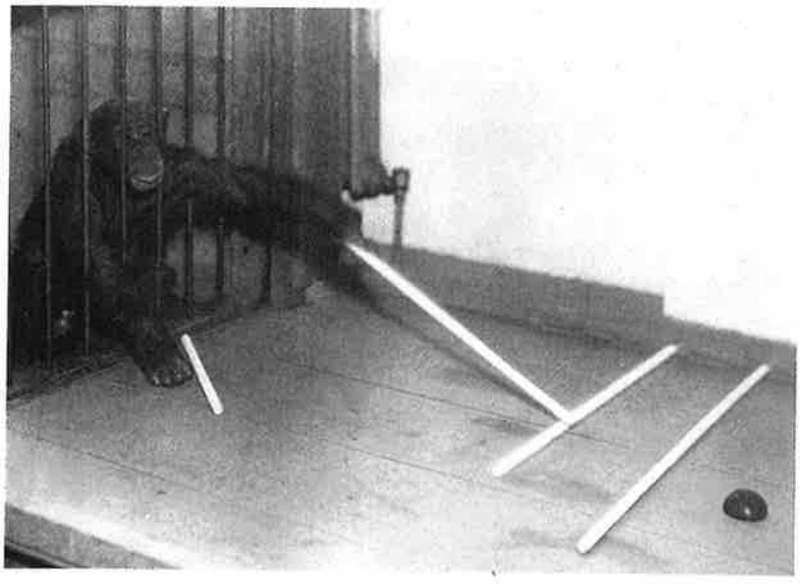


FIGURE 7-10

Multiple Stick Problem *Using the shorter sticks, the chimpanzee pulls in a stick long enough to reach the piece of fruit. It has learned to solve this problem by understanding the relationship between the sticks and the piece of fruit.*

could readily transfer what they had learned to a novel situation. For example, in one problem, Sultan was not encaged, but some bananas were placed too high for him to reach, as shown in Figure 7-11. To solve the problem, Sultan stacked some boxes strewn around him, climbed the "platform," and grabbed the bananas. In subsequent problems, if the fruit was again too high to reach, Sultan found other objects to construct a platform; in some cases, Sultan used a table and a small ladder, and in one case Sultan pulled Köhler himself over and used the experimenter as a platform.

There are, therefore, three critical aspects of the chimpanzee's solution: its suddenness, its availability once discovered, and its transferability. These aspects are at odds with the trial-and-error behaviors of the type observed by Thorndike, Skinner, and their students. Instead, the chimpanzee's solutions may reflect a *mental* trial and error. That is, the animal forms a mental representation of the problem, manipulates components of the representation until it hits on a solution, and then enacts the solution in the real world. The solution, therefore, appears sudden because the researchers do not have access to the chimpanzee's mental process. The solution is available thereafter because a mental representation persists over time. And the solution is transferable because the representation is either abstract enough to cover more than the original situation, or malleable enough to be extended to a novel situation.

Köhler's work suggests that complex learning often involves two phases. In the initial phase, problem solving is used to derive a solution; in the second phase, the solution is stored in memory and retrieved whenever a similar problem situation presents itself. Hence complex learning is intimately related to memory and thinking (the topics of the next two chapters). Moreover, this two-phase structure characterizes not just chimpanzee learning, but also many cases of complex learning in humans. Indeed, it has recently been incorporated into artificial intelligence programs that try to simulate human learning (Rosenbloom, Laird & Newell, 1991).

FIGURE 7-11

Chimpanzee Constructing a Platform *To reach the bananas hanging from the ceiling, the chimpanzee stacks boxes to form a platform.*

PRIOR BELIEFS

Research on animal learning has tended to emphasize the learning of *perfectly predictable* relations. For example, in most studies of classical conditioning, the CS is followed by the UCS 100 percent of the time. But in real life, relations between stimuli or events are usually less than perfectly predictable. The study of associative learning with less than perfect relations has been conducted mainly with humans. Many of these studies have used tasks that are quite novel and that do not make much contact with the learner's *prior beliefs*. In such cases, subjects are very sensitive to the degree of the objective relation

Can Another Species Learn Human Language? Some experts believe that our innate capacity to learn language is unique to our species (Chomsky, 1972). They acknowledge that other species have communication systems but argue that these are qualitatively different from ours. Consider the communication system of the chimpanzee. This species' vocalizations and gestures are limited in number, and the *productivity* of its communication system is very low in comparison to human language, which permits the combination of a relatively small number of phonemes into thousands of words and the combination of these words into an unlimited number of sentences. Another difference is that human language is structured at several levels, whereas chimpanzee communications are not. In particular, in human language, a clear distinction exists between the level of words, or morphemes—at which the elements have meaning—and the level of sounds—at which the elements do not. There is no hint of such a *duality of structure* in chimpanzee communication, because every symbol carries meaning. Still another difference is that chimpanzees do not vary the *order* of their symbols to vary the meaning of their messages, while we do. For instance, for us, "Jonah ate the whale" means something quite different from "The whale ate Jonah"; there is no evidence for a comparable difference in chimpanzee communications.

The fact that chimpanzee communication is impoverished compared to our own does not *prove* that chimpanzees lack the capacity for a more productive system. Their system may be adequate for their needs. To determine if chimpanzees have the same innate capacity we do, we must see if they can learn our language.

In one of the best known studies of teaching our language to chimps, Gardner and Gardner (1972) taught a female chimpanzee named Washoe signs adapted from American Sign Language. Sign language was used because chimps lack the vocal equipment to pronounce human sounds. Training began when Washoe was about a year old and continued until she was 5. During this time, Washoe's caretakers communicated with her only by means of sign language. They first taught her signs by shaping procedures, waiting for her to make a gesture that resembled a sign, and then reinforcing her. Later Washoe learned signs simply by observing and imitating. By age 4, Washoe could produce 130 different signs and understand even more. She could also generalize a sign from one situation to another. For example, she first learned the sign for *more* in connection with *more tickling* and then generalized it to indicate *more milk*.

Other chimpanzees that were studied acquired comparable vocabularies. Some of these studies used methods of manual communication other than sign language. For example, Premack (1983; 1971) taught a chimpanzee named Sarah to use plastic symbols as words and to communicate by manipulating these symbols. In a series of similar studies, Patterson (1978) taught sign language to a gorilla named Koko, starting when Koko was 1 year old. By age 10, Koko had a vocabulary of more than 400 signs (Patterson & Linden, 1981).

Do these studies prove that apes can learn human language? There seems to be little doubt that the apes' signs are equivalent to our words and that the concepts behind some of these signs are equivalent to ours. But there are grave doubts about these studies showing that apes can learn to combine signs in the manner that humans combine words into a sentence. Thus, not only can people combine the words "snake," "Eve," "killed," and "the" into the sentence "The snake killed Eve," but we can also combine the same words in a different order to produce a sentence with a different meaning, "Eve killed the snake." Although the studies reviewed provide some evidence that apes can combine signs into a sequence resembling a sentence, little evidence exists to show that apes can alter the order of the signs to produce a different sentence (Brown, 1986; Slobin, 1979).

Even the evidence that apes can combine signs into a sentence has come under attack. In early work, researchers reported cases in which an ape produced what seemed to be a meaningful sequence of signs, such as "Gimme flower" and "Washoe sorry" (Gardner & Gardner, 1972). As data accumulated, it became apparent that, unlike human sentences, the utterances of an ape are often highly repetitious. Thus, "You me banana me banana you" is typical of the signing chimps but would be most odd for a human child. In the cases in which an ape utterance is more like a sentence, the ape may have simply been

CRITICAL DISCUSSION

BRAIN LOCALIZATION OF LANGUAGE

Given that innate factors play a large role in language acquisition, it is not surprising that regions of the human brain are specialized for language. In a Critical Discussion in Chapter 2 ("Language and the Brain"), we discussed how damage to certain regions of the left hemisphere results in *aphasia,* or language deficits. There we emphasized the relationship between the site of the brain damage and whether the resulting deficit was primarily one of production or comprehension. In the current discussion, we focus on the relation between the site of the damage and whether the deficit involves syntactic or conceptual knowledge.

Recall from Chapter 2 that there are two regions of the left hemisphere of the cortex that are critical for language: *Broca's area,* which lies in the frontal lobes, and *Wernicke's area,* which lies in the temporal region (see Figure 2-9). Damage to either of these areas leads to specific kinds of aphasia.

The disrupted language of a patient with *Broca's aphasia* is illustrated by the following interview in which "E" designates the interviewer and "P," the patient:

E: Were you in the Coast Guard?
P: No, er, yes, yes . . . ship . . . Massachu . . . chusetts . . . Coast Guard . . . years. [Raises hands twice with fingers indicating "19"]
E: Oh, you were in the Coast Guard for 19 years.
P: Oh . . . boy . . . right . . . right.
E: Why are you in the hospital?
P: [Points to paralyzed arm] Arm no good. [Points to mouth] Speech . . . can't say . . . talk, you see.
E: What happened to make you lose your speech?
P: Head, fall, Jesus Christ, me no good, str, str . . . oh Jesus . . . stroke.
E: Could you tell me what you've been doing in the hospital?
P: Yes sure. Me go, er, uh, P. T. nine o'cot, speech . . . two times . . . read . . . wr . . . ripe, er, rike, er, write . . . practice . . . get-ting better.

(Gardner, 1975, p. 61)

The speech is very disfluent. Even in simple sentences, pauses and hesitations are plentiful. This is in contrast to the fluent speech of a patient with *Wernicke's aphasia:*

Boy, I'm sweating, I'm awful nervous, you know, once in a while I get caught up. I can't mention the tarripoi, a month ago, quite a little, I've done a lot well, I impose a lot, while, on the other hand, you know what I mean, I have to run around, look it over, trebin and all that sort of stuff. (Gardner, 1975, p. 68)

In addition to fluency, there are other marked differences between Broca's and Wernicke's aphasias. The speech of a Broca's aphasic consists mainly of content words. It contains few grammatical morphemes and complex sentences and, in general, has a telegraphic quality that is reminiscent of the two-word stage of language acquisition. In contrast, the language of a Wernicke's aphasic preserves syntax but is remarkably devoid of content. There are clear problems in finding the right noun, and occasionally words are invented for the occasion (as in the use of "tarripoi" and "trebin"). These observations suggest that Broca's aphasia involves a disruption at the syntactic stage, while Wernicke's aphasia involves a disruption at the level of words and concepts.

These characterizations of the two aphasias are supported by experiments. In a study that tested for a syntactic deficit, subjects had to listen to a sentence on each trial and show that they understood it by selecting a picture (from a set) that the sentence described. Some sentences could be understood without using much syntactic knowledge. For example, given "The bicycle the boy is holding is broken," one can figure out that it is the bicycle that is broken and not the boy, solely from one's knowledge of the concepts involved. Understanding other sentences requires extensive syntactic analysis. In "The lion that the tiger is chasing is fat," one must rely on syntax (word order) to determine that it is the lion who is fat and not the tiger. On those sentences that did not require much syntactic analysis, Broca's aphasics did almost as well as normals, scoring

imitating the sequence of signs made by its human teacher. Thus, some of Washoe's most sentencelike utterances occurred when she was answering a question; for example, the teacher signed "Washoe eat?" and then Washoe signed "Washoe eat time." Here, Washoe's combination of signs may have been a partial imitation of her teacher's combination, which is not how human children learn to combine words (Terrace et al., 1979).

The evidence considered thus far supports the conclusion that, although apes can develop a humanlike vocabulary, they cannot learn to combine their signs in the systematic way we do. However, a relatively recent study seems to challenge this conclusion (Greenfield & Savage-Rumbaugh, 1990). The researchers worked with a new kind of subject, a pygmy chimpanzee, whose behavior is thought to be more like that of humans than the behavior close to 90 percent correct. But with sentences that required extensive analysis, Broca's aphasics fell to the level of guessing (for example, given the sentence about the lion and tiger, they were as likely to select the picture with a fat tiger as the one with the fat lion). In contrast, the performance of Wernicke's aphasics did not depend on the syntactic demands of the sentence. Thus, Broca's aphasia, but not Wernicke's, seems to be partly a disruption of syntax (Caramazza & Zurif, 1976). The disruption is not total, though, in that Broca's aphasics are capable of handling certain kinds of syntactic analysis (Grodzinski, 1984).

Other experiments have tested for a conceptual deficit in Wernicke's aphasia. In one study, subjects were presented three words at a time and were asked to select the two that were most similar in meaning. The words included animal terms, such as "dog" and "crocodile," as well as human terms, such as "mother" and "knight." Normal subjects used the distinction between humans and animals as the major basis for their selections; given "dog," "crocodile," and "knight," for example, they selected the first two. Wernicke's patients, however, ignored this basic distinction. Although Broca's aphasics showed some differences from normals, their selections at least respected the human–animal distinction. A conceptual deficit is thus more pronounced in Wernicke's aphasics than in Broca's aphasics (Zurif, Caramazza, Myerson, & Galvin, 1974).

Although Broca's and Wernicke's aphasias are the most studied, numerous other kinds of aphasias exist (Benson, Heilman, & Vallenstein, 1985). One of these is referred to as *conduction aphasia*. In this condition, the aphasic seems relatively normal in tests of both syntactic and conceptual abilities, but manifests a severe problem when asked to repeat a spoken sentence. A neurological explanation of this curious disorder is that while the brain structures mediating basic aspects of comprehension and production are intact, the neural connections between these structures are damaged. Hence, the patient can understand what is said because Wernicke's area is intact, and can produce fluent speech because Broca's area is intact, but cannot transmit what was understood to the speech center because the connecting links between the areas are damaged (Geschwind, 1972).

All of the above presupposes the idea that each kind of aphasia is caused by damage to a specific area of the brain. This idea may be too simple: The particular region mediating a particular linguistic function may vary from person to person. The best evidence for such individual differences comes from findings of neurosurgeons who are preparing to operate on patients with incurable epilepsy. The neurosurgeon needs to remove some brain tissue but first has to be sure that this tissue is not mediating some critical function like language. Accordingly, prior to surgery and while the patient is awake, the neurosurgeon delivers small electric charges to the area in question and observes their effects on the patient's ability to name things. If electrical stimulation disrupts the patient's naming, the neurosurgeon knows to avoid this location in the operation. These locations are of great interest to students of language. Within a single patient, these language locations seem to be highly localized. A language location might be less than one centimeter in all directions from locations where electrical stimulations do not disrupt language. But, and this is the critical point, different brain locations have to be stimulated to disrupt naming in different patients. For example, one patient's naming may be disrupted by electrical stimulation to locations in the front of the brain but not by stimulation in the back of the brain, whereas another patient might show a different pattern (Ojemann et al., 1989). If different areas of the brain mediate language in different people, then presumably the areas associated with aphasias will also vary among people.

of the more widely studied common chimpanzee. The subject, a 7-year-old named Kanzi, communicated by manipulating symbols that stand for words. Unlike the case in previous studies, Kanzi learned to manipulate the symbols in a relatively natural way, for example, by listening to his caretakers as they uttered English words while pointing to the symbols. Most importantly, after a few years of language training, Kanzi demonstrated some ability to vary word order to communicate changes in meaning. For example, if Kanzi were going to bite his half-sister Mulika he would signal "bite Mulika"; but if his sister bit him, he would sign "Mulika bite." Kanzi thus seems to have some syntactic knowledge, roughly that of a 2-year-old human.

These results are tantalizing, but they need to be interpreted with caution. For one


Panzee the chimp uses a communication keyboard. Chimpanzees may learn a kind of sign language, as this chimp makes the sign for toothbrush.

thing, so far Kanzi is among the few chimpanzees who have shown any syntactic ability; hence, there's a question of how general the results are. Another matter is that, although Kanzi may have the linguistic ability of a 2-year-old, it took him substantially longer to get to that point than it does a human; also, we do not yet know if Kanzi, or any other chimpanzee, can get much beyond that point. But perhaps the main reason to be skeptical about any ape developing comparable linguistic abilities to a human has been voiced by Chomsky (1991):

> **If an animal had a capacity as biologically advantageous as language but somehow hadn't used it until now, it would be an evolutionary miracle, like finding an island of humans who could be taught to fly.**

IMAGINAL THOUGHT

We mentioned at the beginning of the chapter that, in addition to propositional thought, we can also think in an imaginal mode, particularly in terms of visual images. Such visual thinking is the concern of the present section.

Many of us feel that we do some of our thinking visually. Often it seems that we retrieve past perceptions, or parts of them, and then operate on them in the way we would a real percept. To appreciate this point, try to answer the following three questions:

1. What shape are a German shepherd's ears?
2. What new letter is formed when an uppercase N is rotated 90 degrees?
3. How many windows are there in your parents' living room?

When answering the first question, most people report that they form a visual image of a German shepherd's head and "look" at the ears to determine their shape. When answering the second question, people report first forming an image of a capital *N*, then mentally "rotating" it 90 degrees and "looking" at it to determine its identity. And when answering the third question, people report imagining the room and then "scanning" the image while counting the windows (Kosslyn, 1983; Shepard & Cooper, 1982).

The above examples rest on subjective impressions, but they and other evidence suggest that imagery involves the same representations and processes that are used in perception (Finke, 1985). Our images of objects and places have visual detail: We see the German shepherd, the *N*, or our parents' living room in our "mind's eye." Moreover, the mental operations that we perform on these images seem to be analogous to the operations that we carry out on real visual objects: We scan the image of our parents' room in much the same way we would scan a real room, and we rotate our image of the *N* the way we would rotate the real object.

NEURAL BASIS OF IMAGERY

Perhaps the most persuasive evidence for imagery being like perception would be demon-