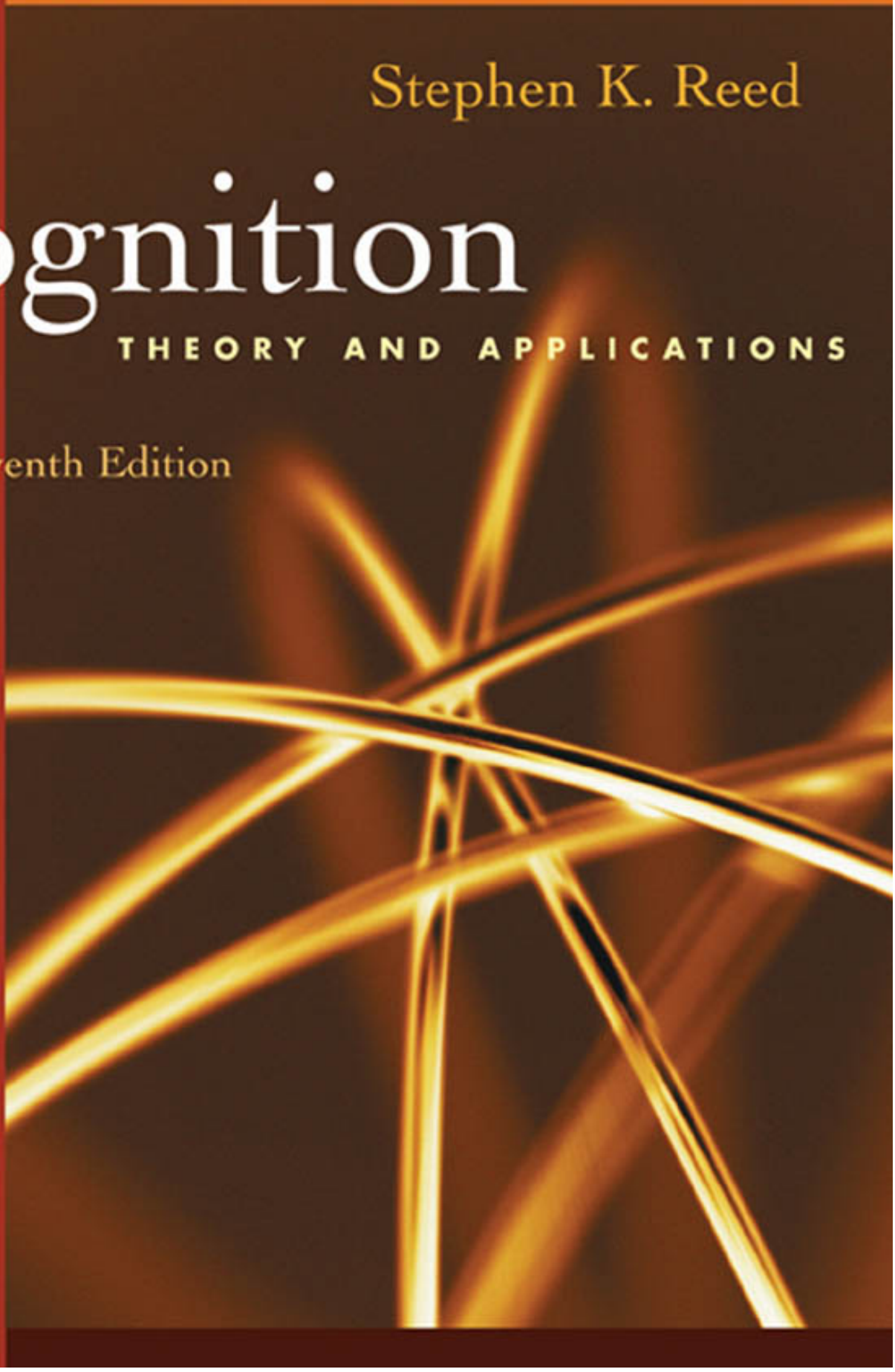
Stephen K. Reed

Cognition

THEORY AND APPLICATIONS

Seventh Edition



10

Language

Language comes so naturally to us that it is easy to forget what a strange and miraculous gift it is. We humans are fitted with a means of sharing our ideas, in all their unfathomable vastness.

—Steven Pinker (1999)

The discussion of semantic memory in the previous chapter emphasized associations among words. We are now ready to consider how words can be combined to form sentences. One possible theory is that this combination occurs by associations. We could argue that, just as *robin* is associated with *bird*, the words in a sentence can be associated with each other. The problem with this view of language is that there are so many ways words can be combined that we would have to learn an infinite number of associations in order to form sentences. An alternative theory is that we learn a **grammar**—a system of rules that is capable of producing sentences. Ideally, the rules of a grammar should generate all the sentences of a language without generating any strings of words that are not sentences.

grammar A set of rules for producing correct sentences in a language

This brings us to a definition of language. A **language** is a collection of symbols and rules for combining these symbols, which can be used to create an infinite variety of messages. This definition has three critical aspects. First, language is **symbolic**: We use spoken sounds and written words to represent and communicate about the world around us. The symbols are arbitrary— there is no built-in relation between the look or sound of the words and the objects they represent. Second, language is **generative**: A limited number of words can be combined in an endless variety of ways to generate an infinite number of sentences. Third, language is **structured**: By following grammatical rules, we can produce grammatical sentences.

language A collection of symbols and rules for combining symbols, which can express an infinite variety of messages

symbolic The use of symbols, such as spoken or written words, to represent ideas

generative The capability to produce many different messages by combining symbols in different ways

structured The organization imposed on a language by its grammatical rules

Our goal as communicators is to express meaning as sound, but this does not occur in a single step. Instead, we can use an assembly line metaphor for constructing sentences from the modules that are shown in Figure 10.1 (Pinker, 1999). Notice that the speaker, represented at the bottom of the diagram, has beliefs and desires that she wishes to express through language. The listener, represented at the top of the diagram, listens to the sound patterns to understand the speaker. But for this to occur correctly, both the speaker and listener must be skilled at using the five modules shown in Figure 10.1. How we accomplish this is the topic of this chapter.

Let's begin with a specific example, shown in Figure 10.2. You have already learned in the previous two chapters about the usefulness of hierarchies so it may not surprise you that language is hierarchical. At the top of the hierarchy is a sentence that can be broken down into phrases based on the grammatical rules. The grammatical rules partition the sentence into a *noun phrase* ("The strangers") and a *verb phrase* ("talked to the players"). The phrases are composed of words, which can be partitioned into **morphemes**—the smallest units of meaning in a language. For spoken sentences, the morphemes can be further partitioned into *phonemes*—the basic sounds of a language.

morpheme The smallest unit of meaning in a language

The next section provides a brief overview of these three aspects of comprehending and producing sentences: grammar, meaning, and sound.

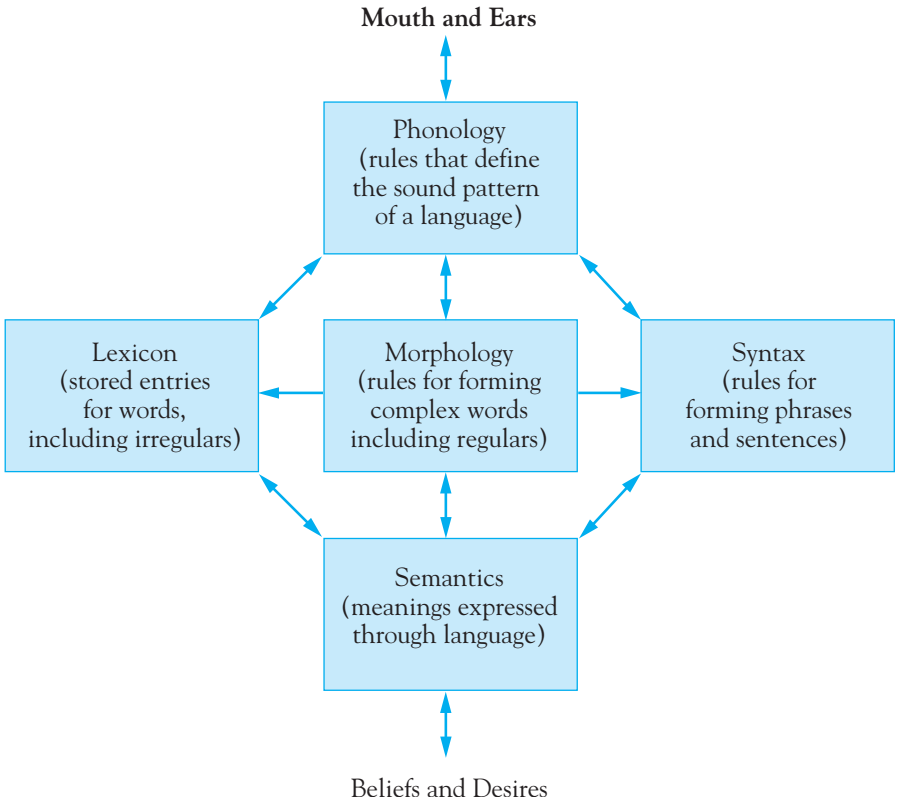


FIGURE 10.1 *Components for producing sentences*

SOURCE: From *Words and rules: The ingredients of language*, by S. Pinker, p. 23. Copyright 1999 by Steven Pinker. Used by permission.

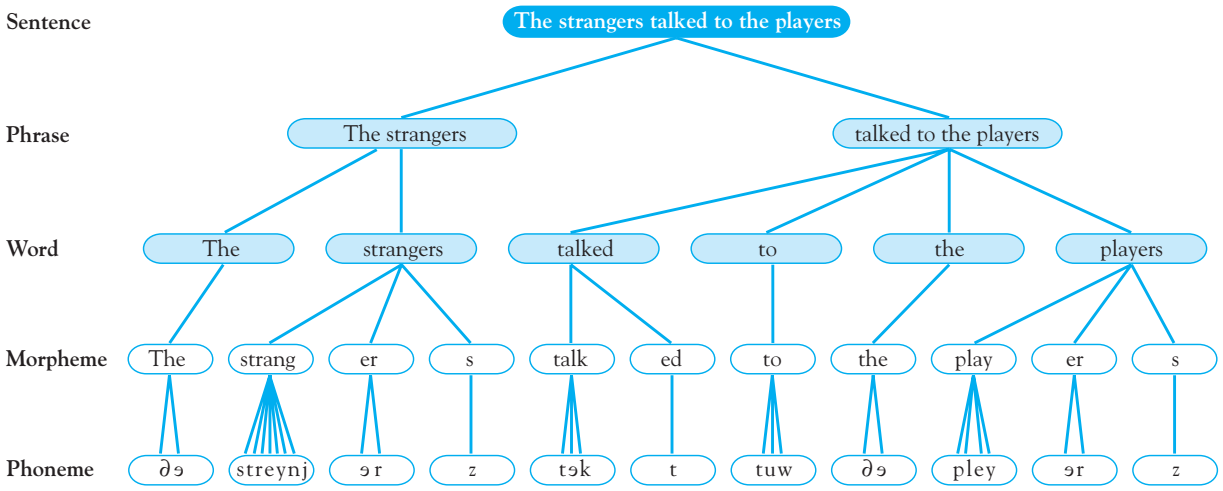


FIGURE 10.2 *An example of a sentence partitioned into phrases, words, morphemes, and phonemes*

SOURCE: From *Child development: A topical approach*, by A. Clarke-Stewart, S. Friedman, and J. Koch, p. 417. Copyright 1985 by John Wiley & Sons. Reprinted by permission of John Wiley & Sons, Inc.

Three Aspects of Language

Grammar (Forming Phrases)

One of the important influences on the development of cognitive psychology during the 1960s was the work of linguist Noam Chomsky. Prior to Chomsky's influence on psycholinguistics (the psychological study of language), psychologists had explored the possibility that people could learn a language by learning the associations between adjacent words in a sentence. According to this view, we learn to speak correctly through paired-associates learning—each word in a sentence serves as a stimulus for the word that follows it. In the sentence "The boy hit the ball," the word *the* is a stimulus for the word *boy,* and the word *boy* is a stimulus for the word *hit*. The speaker of a language would therefore have to learn which words could follow any other word in a sentence.

Chomsky (1957) argued that there are several problems with the association view of language. First of all, there are an infinite number of sentences in a language. It is therefore unreasonable to expect that people could learn a language by learning associations between all adjacent words. Consider simply a word like *the*. There are many, many words that could follow *the,* and a person might never learn all of them. When you consider all the possible words that can occur in a sentence and all the words that could possibly follow each word, you can see that this would be a very inefficient way to learn a language.

Another problem with the association view is that it does not account for the relations among nonadjacent words. For example, in the sentence "Anyone who says that is lying," the pronoun *anyone* is grammatically related to the verb *is lying,* but this relation is not revealed if we consider only the relation between adjacent words. The association view in fact ignores the hierarchical structure of sentences in proposing how people learn to speak grammatically correct sentences.

The hierarchical structure of sentences is revealed in the diagrams that you may have constructed in school. Many of us were taught how to break down a sentence into parts. We might begin by dividing a sentence into a noun phrase and a verb phrase, as shown in Figure 10.2, and then divide the noun phrase and verb phrase into smaller units that reveal the grammar of the sentence. After this brief overview, let's take a closer look at these grammatical rules and their relation to the hierarchy in Figure 10.2.

Meaning (Combining Words and Morphemes)

Although I have been emphasizing the grammatical aspects of language, a sentence that is grammatically correct isn't necessarily meaningful. Chomsky's famous example is the sentence "Colorless green ideas sleep furiously." Notice that this is a grammatically correct sentence even though it doesn't make sense. The opposite effect also occurs; we can make ourselves understood to a reasonable extent without producing grammatically correct sentences. I spent

the summer before my junior year in college working in Germany with a student from Sweden. We managed to communicate with each other fairly well in German while violating many rules of German grammar.

This distinction between syntax (grammar) and semantics (meaning) is also evident in language disorders that are caused by brain damage (D. W. Carroll, 1986). A disorder known as **Broca's aphasia** was discovered by and named after a French surgeon who noticed that some patients spoke in halting, ungrammatical speech following a stroke or accident (Broca, 1865). These patients were typically limited to expressing themselves by stringing together single words, as illustrated in the following excerpt from a patient who had come to the hospital for dental surgery:

Broca's aphasia A language disorder attributed to damage in the frontal lobe of the brain

> *Yes . . . ah . . . Monday er . . . Dad and Peter H . . . , and Dad . . . er . . . hospital . . . and ah . . . Wednesday . . .Wednesday, nine o'clock . . . and oh . . . Thursday . . . ten o'clock, ah doctors . . . two . . . an' doctors . . . and er . . . teeth . . . yah.* (Goodglass & Geschwind, 1976, p. 408)

This inability to express grammatical relationships is typically found in individuals who have suffered damage to the frontal regions of the left hemisphere of the brain (an area called *Broca's area,* shown in Figure 10.3).

A few years after Broca's discovery, Carl Wernicke, another surgeon, discovered a different kind of aphasia (Wernicke, 1874), resulting from damage to

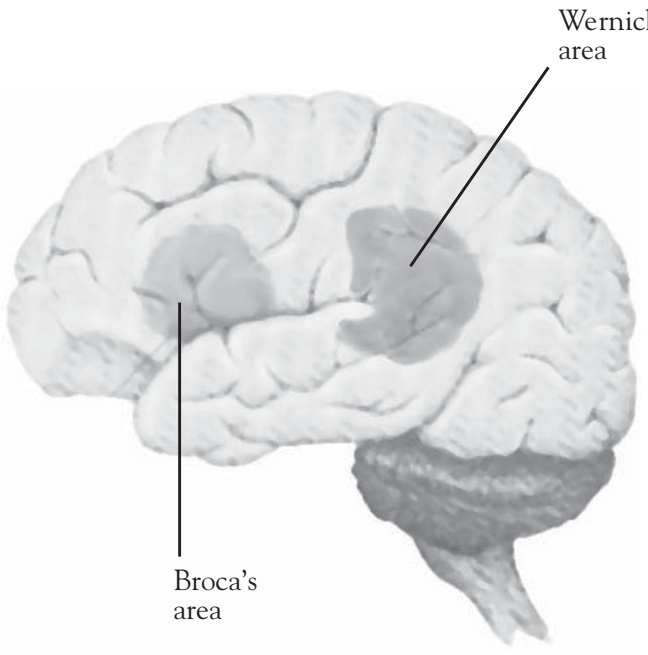


FIGURE 10.3 *A view of the left hemisphere showing the location of two language centers in the brain*

SOURCE: From *Psychology: Themes and variations*, by Wayne Weiten. Copyright 1995, 1992, 1989 by Brooks/Cole Publishing Company, a division of Thomson Learning. Fax 800-730-2215.

Wernicke's aphasia A language disorder attributed to damage in the temporal lobe of the brain

the temporal lobe of the left hemisphere (see Figure 10.3). The speech associated with **Wernicke's aphasia** is more fluent and grammatical but doesn't convey much semantic content:

> *Well this is . . . mother is away her working her work out o'here to get her better, but when she's looking in the other part. One their small tile into her time here. She's working another time because she's getting, too . . .* (Goodglass & Geschwind, 1976, p. 410)

This difficulty with the semantic content of words was confirmed by direct tests of semantic relations (Zurif, Caramazza, Meyerson, & Galvin, 1974). When given three words (such as *husband, mother, shark*) and asked to indicate which two were most similar, Wernicke's aphasics did poorly on the test, in contrast to Broca's aphasics.

More recent evidence based on neuroimaging studies indicates that understanding the meaning and grammar of sentences is more widely distributed throughout the brain than was indicated in the historic studies of Broca and Wernicke. Kaan and Swaab (2002) review this evidence and suggest that different parts of the brain are recruited for different aspects of syntactic processing. For example, they propose that the temporal lobe provides information about both semantic and syntactic information associated with incoming words. Although I have emphasized the distinction between semantic and syntactic processing, normal comprehension uses the meaning of words to indicate information about the grammatical form of the sentence. Later in the chapter we will see how the meaning of words provide clues about grammar.

We can represent the meaning of words by breaking them into morphemes, the smallest units of meaning. Morphemes include stem words, prefixes, and suffixes. The word *unfriendly* consists of the stem word *friend,* the prefix *un,* and the suffix *ly.* Notice that each of these morphemes produces a change in meaning. Adding *ly* to *friend* changes a noun into an adjective. Adding *un* to *friendly* changes the meaning of the adjective.

Other examples are shown in Figure 10.2. The word *strangers* consists of the stem word *strange* and the suffixes *er* and *s*. The first suffix (*er*) converts an adjective into a noun, and the second suffix (*s*) changes the noun from singular to plural. The verb *talked* contains the stem word *talk* and the suffix *ed,* which changes the tense of the verb. Each of these morphemes contributes to the meaning of the entire word.

One advantage of morphemes is that they allow us to generate novel words. A young child who did not know the plural of *stranger,* but knew that plurals are often formed by adding an *s* to the end of a noun, could generate the word *strangers*. If she did not know the past tense of *talk,* but knew that the past tense is often formed by adding *ed* to the end of a verb, she could generate the word *talked*. These rules do not always work (the plural of *deer* is not *deers* and the past tense of *speak* is not *speaked*), but children eventually learn the exceptions (Pinker, 1999).

Sound (Producing Phonemes)

The symbols of a language consist of both written and spoken words. However, as we saw in Chapter 4 when discussing acoustic coding in STM (short-term memory), written words are typically converted into spoken words through subvocalization. Thus, the acoustic aspects of language are important even when we encounter written words.

Before children can understand written sentences by learning to read, they must understand spoken sentences. The first step toward understanding spoken sentences is to be able to discriminate among the basic sounds (phonemes) of a language. This ability is excellent in newborns who are able to discriminate among phonemes in many different languages of the world (Kuhl, 1993). But infants also need to respond to similarity among sounds and to categorize sounds into the phonemic categories that make up their particular language. This presents the same pattern recognition problem that we discussed in Chapter 2, where we emphasized visual patterns. Just as there are variations in people's handwriting that can make visual pattern recognition difficult, there are variations in people's speech that can make speech recognition difficult.

We saw in Chapter 8 that a prototype theory of categorization argues that people classify patterns by comparing them to category prototypes. Work by Kuhl (1993) indicates that prototypes are important in speech recognition and that infants as young as 6 months old have formed prototypes to represent the phonemes in their language. Evidence for prototype formation comes from Kuhl's (1991) research demonstrating that the ability to discriminate sounds within a phonemic category (as if different people pronounced the long-*e* sound) is worse if the category prototype is involved in the discrimination. Adults and 6-month-old infants can more easily discriminate between two nonprototypical sounds than between a prototypical and a nonprototypical sound. Kuhl (1991) uses the metaphor of a "perceptual magnet" to describe the effect. The prototypic long-*e* sound draws similar long-*e* sounds closer to it, making these variations sound more like the prototype.

This magnet effect has several interesting implications. First, we might expect that infants become better at discriminating sounds as they grow older. Wrong—if the sounds belong to the same phonemic category. Forming prototypes of the various phonemes reduces discrimination within a phonemic category because variations of the prototype begin to sound more like the prototype. Notice, however, that this should make it easier to recognize the phonemes.

We might also expect that infants could better discriminate among familiar sounds in their own language than among unfamiliar sounds from a different language. Wrong again—if the sounds belong to the same phonemic category. For example, 6-month-old Swedish infants were better than U.S. infants at discriminating between a prototypic long-*e* sound and other long-*e* sounds, even though this was an unfamiliar sound to them (Kuhl, Williams, Lacerda, Stevens, & Lindblom, 1992). The reason is that the U.S. infants had formed a prototypic long-*e* sound and were therefore victims of the magnet effect, whereas the

Swedish infants had not formed a prototypic long-*e* sound because this sound did not occur in their language. The opposite result occurred for a vowel that occurred in Swedish, but not in U.S. English. American infants were now better in discriminating variations of this vowel from the category prototype.

In conclusion, infants are born with the ability to discriminate among phonemes in many different languages but learn the prototypic speech sounds in their own language. Once the prototypic speech sounds are acquired, it becomes more difficult to discriminate between the prototype and variations of the prototype. In other words, variations of a phoneme caused by differences in pronunciation sound more alike. This makes us look bad on discrimination tests but presumably makes it easier to recognize speech because phonemes sound more like their category prototypes.

Evidence for Hierarchical Organization (Speech Errors)

The hierarchical diagram shown in Figure 10.2 is a convenient representation of the components in Figure 10.1 but is there evidence that people follow this hierarchical organization when producing sentences? The evidence comes from speech errors. As children grow older, they not only recognize speech but learn to produce speech of their own. However, children and even adults can make errors when speaking. Now that we have reviewed the grammatical, semantic, and phonemic aspects of sentences we can see how these three aspects of language can give rise to the kind of errors that occur when we produce spoken sentences. These speech errors, or **slips of the tongue,** are unintended deviations from a speech plan (Dell, 1986). Most of what we know about these slips comes from analyses of errors that were personally heard and noted by investigators. Although such methods may be subject to sampling biases, these collections of speech errors have so many irregularities that it is unlikely that there are systematic biases in the data.

slip of the tongue A speech error

The usefulness of the hierarchical organization shown in Figure 10.2 for representing speech errors is that the errors typically occur within but not across levels in the hierarchy (Dell, 1986). Errors can therefore be divided into *word errors, morpheme errors,* and *phoneme errors,* depending on the size of the linguistic unit involved in the error. Occurrence of errors within these linguistic units is most easily seen in **exchange errors** in which two linguistic units are substituted for each other in the sentence. That is, **word exchanges** are illustrated by the speaker saying "writing a mother to my letter" rather than "writing a letter to my mother." The exchanged words are typically members of the same syntactic category, demonstrating the constraints of grammar on speech. In this case, both *mother* and *letter* are nouns.

exchange error An error in which two linguistic units are substituted for each other during sentence production

word exchange An error in which two words are substituted for each other during sentence production

Morpheme exchanges are illustrated by the speaker saying "slicely thinned" rather than "thinly sliced." Morpheme errors also have categorical constraints; in this case the two stems *slice* and *thin* are interchanged while the suffixes *ly* and *ed* remain in their original position. Just as nouns are interchanged with other nouns or verbs interchanged with other verbs at the word level, stems are interchanged with other stems or suffixes interchanged with other suffixes at the morpheme level.

morpheme exchange An error in which two morphemes are substituted for each other during sentence production

Phoneme exchanges are illustrated by the speaker saying "lork yibrary" for "York library." Once again, there are category constraints on the exchanges. In phoneme errors, initial consonants are exchanged with other initial consonants, final consonants are exchanged with other final consonants, and vowels are exchanged with other vowels.

phoneme exchange An error in which two phonemes are substituted for each other during sentence production

The rest of this chapter focuses on the syntactic and semantic aspects of language. The next section provides a brief description of two kinds of grammatical rules—phrase structure rules and transformation rules. This is followed by a section that presents a general model of sentence comprehension. The comprehension of ambiguous sentences is a particularly interesting area of study because we must resolve the ambiguity in order to understand the sentences. The final section considers the distinction between asserted and implied statements. Findings on how well people can make this distinction offer some applications of research on the understanding of language, particularly in relation to the evaluation of courtroom testimony and advertising claims.

Psychology and Grammar

Phrase Structure Grammar

We have seen that an alternative to representing language as a string of words is representing it as a rule system. For example, we saw in Figure 10.2 that we could divide the sentence into a noun phrase and a verb phrase. We could further subdivide the verb phrase "talked to the players" into the verb *talked* and the prepositional phrase *to the players*. The rules that we use to divide a sentence into its grammatical parts form a **phrase structure grammar** because they reveal how we can partition a sentence into phrases consisting of groups of words.

phrase structure grammar A set of rules for partitioning a sentence into its grammatical units

You should be familiar with phrase structure rules if you have ever diagrammed a sentence. Let's look at the rules used in the sentence diagram in Figure 10.4. The first rule partitions the sentence (S) into a noun phrase (NP) followed by a verb phrase (VP). A second rule states that the noun phrase can be partitioned into a determiner (Det) followed by a noun. A determiner

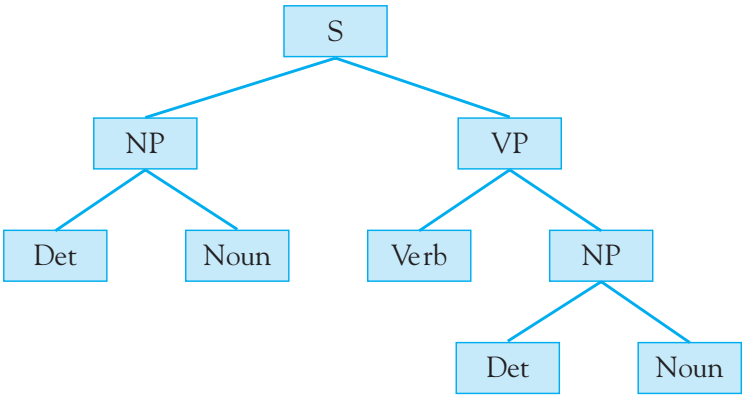


FIGURE 10.4 *A sentence diagram based on phrase structure rules*

consists of the words *a, an,* and *the.* A third rule states that the verb phrase can be partitioned into a verb followed by a noun phrase, which is again broken down into a determiner and a noun. We can now produce sentences by substituting words for the determiners, nouns (such as *boy* and *ball*), and verbs (such as *hit*). For instance:

The boy hit a ball.

The stick hit the boy.

A ball hit a ball.

Although the number of sentences we can produce using this particular grammar is quite limited, the grammar illustrates how sentences can be produced through the application of rules. Creation of additional rules, such as including adjectives in a noun phrase, would allow us to generate a greater variety of sentences.

Transformational Grammar

Chomsky (1957) argued that one limitation of a phrase structure grammar is that it does not reveal how a sentence can be modified to form a similar sentence. For example, how can we change (1) an active statement into a passive statement, (2) a positive statement into a negative statement, or (3) an assertion into a question? Given the sentence "The boy hit the ball," the first change produces "The ball was hit by the boy"; the second change produces "The boy did not hit the ball"; and the third change produces "Did the boy hit the ball?" The modification in each case *transforms* an entire sentence into a closely related sentence. Transformation rules therefore serve a different function than phrase structure rules, which reveal the grammatical structure of a sentence. Chomsky, however, used phrase structure rules in developing his transformational grammar because the transformations are based on the grammatical structure of a sentence.

Consider the transformation of "The boy hit the ball" into "The ball was hit by the boy." The transformation rule in this case is

NP1 + Verb + NP2 → NP2 + *was* + Verb + *by* + NP1

The transformation changes the position of the two noun phrases and inserts additional words into the passive sentence. The passive sentence begins with the second noun phrase ("the ball") and ends with the first noun phrase ("the boy"). It is also necessary to add the words *was* and *by.* Notice that the transformation rule shows how a phrase structure description of a passive sentence can be formed from a phrase structure description of an active sentence.

transformational grammar A set of rules for transforming a sentence into a closely related sentence

The **transformational grammar** proposed by Chomsky in 1957 was an advance over a phrase structure grammar because, in addition to revealing grammatical structure, it showed how sentences could be transformed. Chomsky was not entirely satisfied with the transformational grammar, however, and in 1965 he wrote a second book to correct some of its limitations. The changes that he made were concerned mainly with allowing meaning to play a more important role in the grammar.

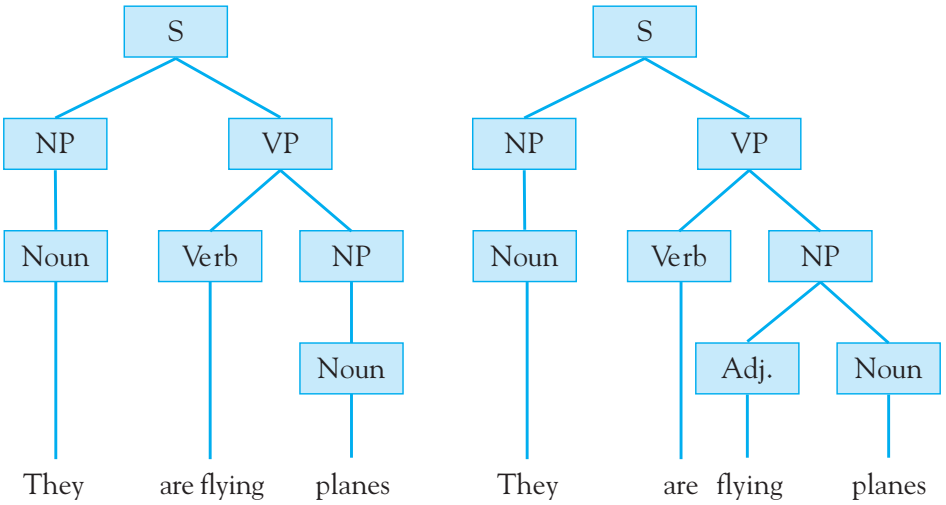


FIGURE 10.5 *Two alternative derivations of an ambiguous sentence*

One reason for exploring the relation between grammar and meaning is that some sentences (called **ambiguous sentences**) have more than one meaning. Do the different meanings reflect different grammatical rules? The answer is that the alternative meanings of *some* ambiguous sentences reflect different phrase structure rules. Consider the sentence "They are flying planes." One interpretation considers *flying* to be part of the verb phrase *are flying*, whereas the other interpretation considers *flying* to be an adjective in the noun phrase *flying planes*. In the first interpretation, *they* refers to someone who is flying planes; in the second interpretation, *they* refers to the planes. A phrase structure grammar can make this distinction because each interpretation has a different derivation (Figure 10.5).

ambiguous sentence
A sentence that has more than one meaning

Assigning a word to the appropriate phrase can have important consequences. As illustrated in "In the News" 10.1, the state of California had to spend considerable time and money to correct the misconception that the word "solely" referred to the phrase "in this state."

There are other ambiguous sentences, however, that cannot be distinguished by phrase structure rules because both interpretations of the sentence produce the same derivation. Consider the sentence "Flying planes can be dangerous." The sentence has the same ambiguity as the previous example. The two interpretations can be revealed by rephrasing the sentence as either "Flying planes is dangerous" or "Flying planes are dangerous." The first interpretation means that flying is dangerous to the pilot; the second means that the planes themselves are dangerous. In both interpretations, however, *flying planes* is the subject of the sentence, so the ambiguity cannot be resolved by appealing to different phrase structure rules.

Chomsky (1965) proposed that, in order to resolve the ambiguity, it is necessary to postulate a level of analysis that directly represents the meaning of a sentence. He therefore modified the transformational grammar to consist of

IN THE NEWS 10.1

Wording on Driver's Licenses Costs State Almost $250,000

Ted Bell

SACRAMENTO—Nobody expected that the phrase "solely . . . in this state" on driver's licenses would lead to the arrest and fining of California motorists by state troopers throughout the nation, at a cost to California taxpayers of almost $250,000.

But that is what has resulted from a bill designed to stop illegal immigrants from using easily obtained California driver's licenses to gain documents such as visas and work permits.

Under SB 946, sponsored by state Sen. Alfred Alquist, D-San Jose, all California driver's licenses issued after July 1 were printed to include the following notice: "This license is issued solely as a license to drive a motor vehicle in this state; it does not establish eligibility for employment, voter registration or public benefits."

The problems arose when some law-enforcement agencies in other states interpreted the word "solely" to mean the licenses restrict the operation of a motor vehicle to California only—instead of a license just for operating a motor vehicle, said Department of Motor Vehicles spokesman Bill Madison. . . .

The state agency then began mailing letters to anyone who had received a new license or renewal since July. Each letter had a portion to be snipped off and kept with the license—with new language.

Subtracting the offensive "solely" and "in this state," the disclaimer reads: "This license is issued as a license to drive a motor vehicle; it does not establish eligibility for employment, voter registration or public benefits." Approximately 833,000 of the letters were mailed at a cost of $249,000, Madison said.

SOURCE: From "Wording on driver's licenses costs state almost $250,000," by Ted Bell, *San Diego Tribune*, October 19, 1995.

surface structure The structure of a spoken sentence

deep structure The underlying meaning of a sentence

two levels: the **surface structure,** directly related to the sentence as it is heard, and the **deep structure,** directly related to the meaning of the sentence. The only way to resolve the ambiguity of a sentence such as "Flying planes can be dangerous" is to know which of the two deep levels is intended—flying is dangerous to the pilot or the planes themselves are dangerous.

The concepts Chomsky introduced had a major impact on the emerging field of psycholinguistics. Psychologists who were interested in language studied the implications of phrase structure and transformational grammars for theories of how people comprehend and remember sentences. One of the conclusions reached from these studies, and from Chomsky's (1965) analysis, is that it is difficult to study grammar without also studying meaning.

Words as Grammatical Clues

Studying the relation between meaning and grammar is important because producing a grammatical sentence does not guarantee the sentence will be meaningful. This point can be illustrated by adding another verb—*took*—to the rules shown in Figure 10.4. This addition allows us to produce new

sentences like "The boy took the ball" and "The ball took the boy." Although both sentences are grammatical, the second sentence doesn't make much sense. The reason is that the verb *took* usually requires an animate subject—someone who is alive and therefore capable of taking something.

Chomsky (1965) tried to correct this deficiency by placing constraints on which words could be substituted into a sentence. Instead of treating all verbs the same, he argued that some verbs require animate subjects. This restriction is based on the meaning of words. Chomsky's analysis illustrates how the different components in Figure 10.1 can interact with each other. In order to express a meaningful idea (Semantics), the meaning of words in the Lexicon must be appropriately combined with grammatical rules (Syntax). Research by psycholinguists is helping us understand how the meaning of words provides hints as to which grammatical phrases will come next in a sentence.

There is increasing evidence that the meaning of words provide clues about grammatical structure (Carpenter, Miyake, & Just, 1995; MacDonald, Pearlmutter, & Seidenberg, 1994; Trueswell & Tanenhaus, 1994). For example, we use the distinction between animate and inanimate nouns to make guesses about the type of phrase that will follow the noun. This is illustrated by the difference between the following two sentences:

1. The defendant examined by the lawyer turned out to be unreliable.
2. The evidence examined by the lawyer turned out to be unreliable.

Eye movements indicate that readers slow down more in the first sentence than in the second sentence when they encounter the phrase *by the lawyer* (Trueswell & Tanenhaus, 1994). Try to apply Chomsky's analysis to figure out why before reading further.

The answer is that, in the first sentence, readers expect the word *examined* to be the main verb followed by a noun phrase, such as in the sentence "The defendant examined the jury." However, when they read *by the lawyer,* reading slows because their expectation turns out to be incorrect. But if the sentence begins with the inanimate noun *evidence,* our expectation that *examine* is the main verb becomes unlikely because we can't imagine how evidence can examine something.

In this case, the context—whether the sentence begins with an animate or an inanimate noun—influences how easily readers can comprehend the sentence. This example illustrates how a general characteristic of words—whether a noun is animate or inanimate—can serve as a clue for processing a sentence. However, even specific words (such as the verb *remembered*) provide clues about the grammatical structure of a sentence. Consider the following two sentences:

1. John remembered my birthday.
2. John remembered my birthday is coming.

In the first sentence, the word *remembered* is followed by the noun phrase *my birthday.* This sentence could be generated by a simple grammar, like the one shown in Figure 10.4. But the second sentence is more complex. Notice that *my birthday is coming* is another sentence, called a sentence complement.

Text not available due to copyright restrictions

The word *remembered* is more often followed by a noun phrase than by a sentence complement. However, the word *claim* is more likely to be followed by a sentence complement ("Joan claimed the letter belonged to her") than by a noun phrase ("Joan claimed the letter"). Readers' knowledge of these frequency differences helps them process sentences by expecting syntactic structures that are likely to occur (Carpenter, Miyake, & Just, 1995; Trueswell, Tanenhaus, & Kello, 1993). We therefore expect a noun phrase after the word *remember* and a sentence complement after the word *claim*.

In summary, research has shown that the meaning of words conveys information about syntactic structures (Carpenter, Miyake, & Just, 1995; MacDonald, Pearlmutter, & Seidenberg, 1994; Trueswell & Tanenhaus, 1994).This research is helping cognitive scientists design computer programs that can understand sentences, as noted in "In the News" 10.2. Notice that words provide clues because knowledge stored in one component of Figure 10.1 (the lexicon) can help us more quickly recognize the structure of another component (syntax). This interaction between components also occurs for semantics and the lexicon. In this case, recognizing and retrieving the meanings of words is the beneficiary of semantic knowledge, as illustrated in the next section.

Using Semantic Context in Sentence Comprehension

Many words have more than one meaning but this usually does not confuse us because the context in which the word appears provides information about which meaning is appropriate (MacKay, 1966). For example, if a sentence begins with the statement *Although he was continually bothered by the cold,* we would be confused by whether the word *cold* referred to the temperature or to the person's state of health unless the context provided clues. Fortunately, the context usually does provides clues and we will now examine how people take advantage of them.

This discussion will be easier if we first consider Carpenter and Daneman's (1981) general model of the stages involved in sentence comprehension (see Figure 10.6)—stages that we learn more about in this section. The first stage ("fixate and encode the next word") involves pattern recognition. Although I discussed word recognition in the chapter on pattern recognition, I focused on the word superiority effect. We learned that a letter is easier to recognize in the context of a word than when it appears by itself. Similarly, a word is often easier to recognize when it appears in the context of a sentence than when it appears by itself.

The second stage involves retrieving the meaning(s) of the word. Although ambiguous words have more than one meaning, one of the meanings may occur much more frequently than the other. For the sentence "The port was a great success," you most likely associated the word *port* with ships. The less frequent meaning of *port,* a kind of drink, would be less strongly activated unless it were proceeded by a context that suggested this interpretation. Both

meanings would be strongly activated in the sentence "When she finally served it to her guests, the port was a great success." The ship meaning would be strongly activated because it occurs more frequently, and the drink meaning would be strongly activated because it fits the context. By studying readers' eye movements while reading sentences with ambiguous words, Duffy, Morris, and Rayner (1988) concluded that the degree of activation of alternative meanings is influenced by prior context and by the frequency of the alternative meanings.

The selected meaning of the word is integrated with the prior context in the third stage of Carpenter and Daneman's model. If this integration is successful, the reader encodes the next word; otherwise, she tries to recover from the error by reinterpreting the word or the previous context. Let's now look in greater detail at what happens during each of these stages.

Semantic Context and Word Recognition

I mentioned that word recognition is often facilitated by the semantic context. We have all experienced difficulty in recognizing a word when reading illegible handwriting and having to rely on the surrounding words and sentences to help us identify the illegible word. An example of how context can influence word recognition is shown in Figure 10.7. The two sentences contain a physically identical word, yet we have little difficulty identifying the word as *went* in the upper sentence and as *event* in the lower sentence.

Although the effect of context is most obvious to us when we have to struggle to identify a word, it also influences recognition time when we identify words relatively quickly. Usually, context is helpful and facilitates faster word recognition, but it can also slow us down, as is illustrated in the following two sentences: (1) "John kept his gym clothes in a locker." (2) "John kept his gym clothes in a closet." The words *locker* and *closet* are both preceded by a suitable context, but the context creates a strong expectation for the word *locker.* Sentences that create a high expectation for a particular word are called **high-constraint sentences.**

high-constraint sentence A sentence that produces a high expectation for a particular word

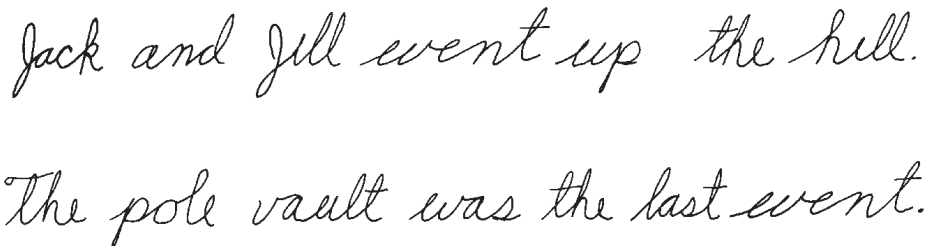


FIGURE 10.7 *Dependence of letter perception on context*

SOURCE: From "The role of semantics in speech understanding," by B. Nash-Webber, 1975, in *Representation and Understanding*, edited by D. G. Bobrow and A. Collins. Copyright 1975 by Academic Press. Reprinted by permission of Elsevier Science.

Schwanenflugel and Shoben (1985) studied the effect of high-constraint sentences on the processing of expected words (*locker*) and unexpected words (*closet*) by using the **lexical decision task** that we discussed in the previous chapter. After reading either a high-constraint context or a neutral context, readers had to decide whether a string of letters was a word. The high-constraint context facilitated recognition of the expected word but interfered with recognition of the unexpected word. People were faster at deciding that *locker* was a word when they received the high-constraint context but were faster in deciding that *closet* was a word when they received the neutral context, consisting of a string of *X*s.

lexical decision task A task that requires people to decide whether a string of letters is a word

The high-constraint sentence caused interference in the latter case because people were expecting a particular word, which did not occur. What would happen if our expectations for a particular word were not as strong? Schwanenflugel and Shoben tried to answer this question by including **low-constraint sentences** in their study. The following two sentences are examples: (1) "The lady was a competent cook." (2) "The lady was a competent chef." The sentences are low-constraint because a lady could be competent in performing many different tasks. However, the first sentence contains an expected word, and the second sentence contains an unexpected word because a lady is more likely to be called a cook than a chef. The results of several experiments indicated that the low-constraint context caused facilitation for both the expected and unexpected words. In contrast to the high-constraint sentences, in which a large facilitation effect occurred for the expected word and a large interference effect occurred for the unexpected word, the low-constraint sentences caused a moderate amount of facilitation for both words.

low-constraint sentence A sentence that produces an expectation for a broader range of words

The study by Schwanenflugel and Shoben (1985) shows that contexts may occasionally have negative, as well as positive, effects. A high-constraint context can slow lexical decisions for unexpected words. One caution, however, in evaluating such studies is the finding that contextual interference is affected by the research methodology used to study contextual effects. Another frequently used procedure, instead of lexical decision, is to measure how quickly subjects can name a word that follows a context. Studies that have used both procedures have revealed that interference effects are more likely to be found in lexical decision tasks than in naming tasks (Stanovich & West, 1983). An important challenge for cognitive psychologists is therefore to show how performance on

such tasks as naming and lexical decision is related to the comprehension that occurs during normal reading (Seidenberg, Waters, Sanders, & Langer, 1984).

Semantic Context and Ambiguous Meanings

After readers or listeners identify words, they still must select the appropriate meaning if the word has multiple meanings. We have previously seen that psychologists like to study comprehension by including ambiguous words in their sentences. It is important to realize, however, that ambiguous sentences are not simply invented by psychologists to study language comprehension. They also frequently occur outside the laboratory, such as in newspaper headlines. Comprehending newspaper headlines is more challenging than comprehending ordinary sentences because space constraints sometimes make it necessary to delete helpful words. Examples of ambiguous headlines include "Teacher Strikes Idle Kids," "Pentagon Plans Swell Deficit," "Department Heads Store Clerk," and "Executive Secretaries Touch Typists." Each headline has more than one meaning. For instance, the headline "Executive Secretaries Touch Typists" could mean that (1) executive secretaries are touch typists or that (2) executive secretaries touch the typists. Most people agree which interpretation of these statements is the intended meaning, but the ambiguity nonetheless slows their comprehension. It takes longer to comprehend an ambiguous headline than to comprehend one of the unambiguous interpretations (Perfetti, Beverly, Bell, Rodgers, & Faux, 1987).

The ambiguity of some newspaper headlines is particularly troublesome because we often lack a context to interpret the headline. The headline is the first sentence we read to find out what the article is about. The reason many potentially ambiguous sentences do not seem ambiguous is that the intended meaning is usually clear from the preceding sentences. If I say that I am bothered by the cold, the preceding sentences should reveal the intended meaning. We might therefore expect that a clarifying context should make it as easy to comprehend ambiguous sentences as unambiguous sentences. An experiment by Swinney and Hakes (1976) supports this hypothesis.

The subjects in their experiment performed two tasks simultaneously while they listened to pairs of sentences. One task asked them to judge how closely they felt the two sentences of each pair were related. This task required comprehension of the sentences. The second task required that they press a button as soon as they heard a word beginning with a specified sound (phoneme). The rationale of this experiment is that people should be slower in responding to the phoneme whenever they are having difficulty in comprehending the sentence. The following pair of sentences is a typical example:

> *Rumor had it that, for years, the government building had been plagued with problems. The man was not surprised when he found several "bugs" in the corner of his room.* (Swinney & Hakes, 1976, p. 686)

The target phoneme in this example occurs at the beginning of the word *corner,* shortly after the ambiguous word *bugs*. To determine whether the

ambiguous word would delay comprehension and therefore detection of the phoneme, Swinney and Hakes compared performance on the ambiguous sentences with performance on unambiguous control sentences. The unambiguous version of the example contained the word *insects* in place of the word *bugs*. Swinney and Hakes found that subjects took significantly more time to detect the phoneme when it followed an ambiguous word than when it followed an unambiguous word.

However, sometimes the ambiguous word occurred in a context that made it clear which meaning of the word was intended. For example:

> *Rumor had it that, for years, the government building had been plagued with problems. The man was not surprised when he found several spiders, roaches, and other "bugs" in the corner of his room.* (Swinney & Hakes, 1976, p. 686)

When the context clarified the meaning of the ambiguous word, people could comprehend the ambiguous word *bug* as quickly as they could comprehend the unambiguous word *insect*. There was no longer any difference in response times to the target phoneme.

We could interpret these results by arguing that only a single meaning of the ambiguous word is activated when the context indicates the intended meaning. This argument has considerable intuitive appeal, but search results suggest that it is wrong. In the previous chapter we saw that when people are asked to decide whether a string of letters is a word, their decision is faster when a word is preceded by a semantically related word, such as *bread* preceded by *butter*. If people consider only a single meaning of an ambiguous word, a word such as *bug* should facilitate the recognition of either *ant* or *spy,* depending on which meaning is activated.

Swinney (1979) tested this prediction by replacing the phoneme-monitoring task with a lexical decision task. He explained to the subjects that a string of letters would appear on a screen as they listened to some sentences, and they were to decide as quickly as possible whether or not each letter string formed a word. He did not mention that some of the sentences and words were related. The letter string, which appeared on the screen immediately after subjects heard the ambiguous word, was contextually appropriate, contextually inappropriate, or unrelated to the meaning of the ambiguous word. A contextually appropriate word appearing on the screen, such as *ant,* was consistent with the meaning of the ambiguous word that was suggested by the context. A contextually inappropriate word, such as *spy,* was consistent with the meaning that was not suggested by the context. An unrelated word, such as *sew,* was consistent with neither of the two meanings.

If the context causes the activation of only a single meaning, it should be easier to recognize only the contextually appropriate word (*ant*). But if both meanings of the ambiguous word are activated, the contextually inappropriate word (*spy*) should also be easier to recognize than the unrelated word (*sew*). The results showed that when the visual test word immediately followed the ambiguous word, both the contextually appropriate and the contextually

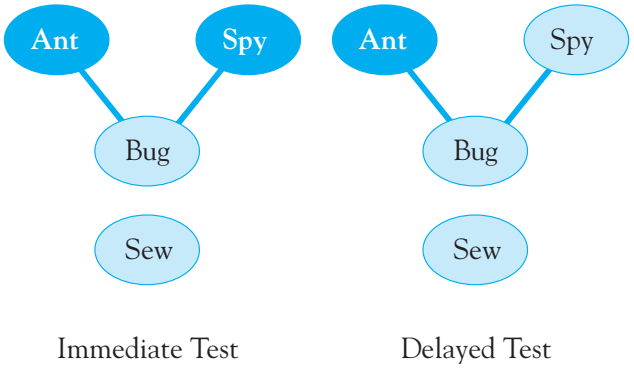


FIGURE 10.8 *Words primed (dark highlight) by spreading activation when tested immediately and after a one-second delay*

inappropriate words were easier to recognize than the unrelated words. But when the test word occurred four syllables (about 750–1000 msec) after the ambiguous word, recognition of only the contextually appropriate word was facilitated (see Figure 10.8).

Swinney's findings suggest that more than one meaning of an ambiguous word is activated even when a prior context indicates which meaning is appropriate. If only one meaning of *bugs* were activated by the phrase "He found several spiders, roaches, and other bugs," it is not clear why it would be as easy to respond to *spy* as to *ant*. However, when the test word occurred four syllables after the ambiguous word, recognition of only the word *ant* was facilitated. It therefore appears that, although both meanings of an ambiguous word are momentarily activated, the context allows the listener to select the appropriate meaning quickly. Selection of the appropriate meaning occurred quickly enough to prevent interference in the phoneme-detection task. As you may recall, there was a slight delay between the ambiguous word and the target phoneme. This was sufficient time to resolve the ambiguity when there was an appropriate context. An appropriate context therefore seems to allow the listener to select the appropriate meaning of a word quickly rather than to prevent more than one meaning from being activated.

Individual Differences in Resolving Ambiguities

Some people are better at resolving ambiguities than others. In fact, the picture we have painted so far is for how good readers resolve ambiguities. The problem for less skilled readers is that they do not quickly resolve which of the activated meanings is the correct one (Gernsbacher, 1993). Like the good readers, both meanings of an ambiguous word are initially activated, but unlike the good readers, both meanings are still active 1 second after encountering the ambiguous word. Less skilled readers are simply less able to **suppress** the inappropriate meaning.

suppress Eliminating inappropriate meanings in a sentence

It would be simpler for everyone if only a single meaning (the correct one, of course) were initially activated. Although this might seem beneficial when the correct meaning is obvious, an advantage of activating multiple meanings is that the clarifying context occasionally does not occur until *after* the ambiguous word. In this case, it would be advantageous to try to keep both meanings active in STM until we gain enough information to select the appropriate one.

See if you can find the ambiguous word in the following partial sentence: "Since Ken really liked the boxer, he took a bus to the nearest. . . ." If you found the ambiguous word, can you resolve the ambiguity by using the sentence context? The ambiguous word is *boxer,* and at this point we don't have enough

information to know whether Ken is interested in a fighter or a dog. The remainder of the sentence resolves the ambiguity by informing us that Ken took the bus to the nearest pet store to buy the animal. Notice, however, that unlike the previous examples in which the clarifying context preceded the ambiguous word, in this case we had to read considerably more of the sentence following the ambiguous word before the meaning became clear.

People's ability to excel in these situations is influenced by the capacity of their working memory (Miyake, Just, & Carpenter, 1994). We saw in Chapter 4 that STM is often used as a working memory in which people both store and process material in STM. In this example we would like to keep active in working memory both interpretations of the word *boxer* until we later encounter information that would enable us to select the correct one. People who have a large **working memory capacity** are able to keep both interpretations active over a longer span than people who have a smaller working memory capacity. The latter group is able to maintain only the more likely (dominant) interpretation and therefore has difficulty resolving the ambiguity when the less likely interpretation proves to be the correct one.

working memory capacity The amount of informatoin that can be kept active in workig memory

Because the word *boxer* is more likely to refer to a fighter than to a dog, people with a small working memory capacity would have difficulty comprehending a sentence in which they later learned that the sentence was about a dog. In this case their integration would be unsuccessful, and they would have to use the **error recovery heuristics** in Figure 10.6. Examples include trying to reinterpret the inconsistent word, checking previous words that might have caused the difficulty, reading on for further information, and elaborating the apparent inconsistency to make it consistent (perhaps Ken was buying a dog at the pet store to give to the fighter).

error recovery heuristic A strategy for correcting comprehension errors

In conclusion, good readers are those readers who are able to initially keep active in working memory both interpretations of an ambiguous word and then quickly select the appropriate meaning as soon as they receive a clarifying context. We have seen two ways in which reading can be impaired. Readers with limited working memory capacity are less able to maintain both meanings in working memory when the clarifying context occurs later, and less skilled readers are less able to quickly suppress the inappropriate meaning when they encounter the clarifying context.

Interpreting Phrases

The model proposed by Carpenter and Daneman (1981) in Figure 10.6 focuses on the encoding and integration of individual words. Research using the lexical decision task examined how prior context influences both the recognition of words (Schwanenflugel and Shoben, 1985) and the determination of the word's meaning (Swinney,1979).

We can now look at a larger unit of analysis such as the noun phrases and verb phrases discussed in the section on grammar. Consider how you understand the sentence:

The college students were taught by lecturers.

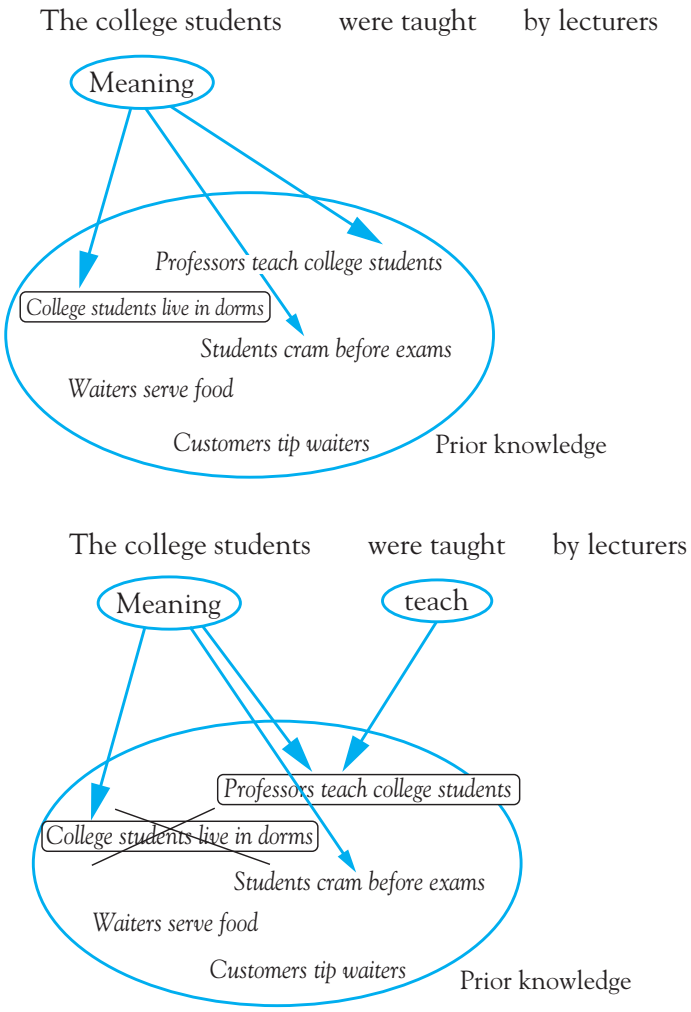


FIGURE 10.9 *Interpretation of phrases for the sentence: The college students were taught by lecturers.*

SOURCE: "Interpretation-based processing: a unified theory of semantic sentence comprehension," by R. Budiu and J. R. Anderson, 2004, *Cognitive Science*, 28, 1–44.

One account is provided by the interpretation-based processing theory (Budiu & Anderson, 2004) that builds on the spreading activation assumptions that were discussed in the previous chapter (Anderson, 1976).

The purpose of the interpretation-based processing theory is to produce syntactic and semantic representations of a sentence and relate the sentence to prior knowledge. For example, the noun phrase 'the college students' activates in the reader propositions about college students such as the ones shown in Figure 10.9. College students (1) live in dorms, (2) are taught by professors, and (3) cram before exams. The proposition with the highest activation is selected for the initial interpretation (assume it is *college students live in dorms*).

However, this interpretation is not supported when the reader encounters the verb phrase 'were taught'. 'Live' and 'taught' are too dissimilar so there is little activation spreading from 'taught' to 'live'. This results in the retrieval of the more promising proposition, *Professors teach college students*, as shown in the lower part of Figure 10.9. This interpretation is confirmed by the similarity of the meanings of 'professors' and 'lecturers'. The theory therefore provides a plausible interpretation of the sentence by discarding invalid interpretations of phrases and making sure that all the interpretations are consistent. The activation of multiple implications of a phrase followed by the selection of the correct one is consistent with the activation of multiple meanings of an ambiguous word followed by the selection of the correct one.

Here's another example of connecting sentences to prior knowledge through spreading activation. Try answering the following question:

How many animals of each kind did Moses take on the ark?

If you answered none, you noticed the inconsistency. It was not Moses, but Noah, who took animals on the ark. Many people fail to notice these inconsistencies (Erickson & Mattson, 1981), which are called the Moses illusion in honor of the previous question. Reder and Kisbit (1991) designed a variation

of this task in which participants knew they would encounter inconsistencies but were required to answer all questions as if there were no inconsistencies. The correct answer is therefore 'two' for the Moses question, but we might expect longer responses when there is an inconsistency.

Budiu and Anderson (2004) hypothesized, based on the assumptions of the interpretation-based processing theory, that the time to answer inconsistent questions would depend on the degree of the distortion. Substituting 'Moses' for 'Noah' is a mild distortion because the concepts 'Moses' and 'Noah' are somewhat similar. Substituting 'Adam' for 'Noah' is a greater distortion because the two concepts are more dissimilar. It should be easier to answer questions in which there is less distortion because spreading activation requires less time to connect similar concepts. The results supported this hypothesis. It took longer to answer the questions as the sentences became more distorted. The interpretation-based processing theory is able to make many other successful predictions about how people interpret sentences but these examples should give you an idea of how the theory works.

Implications of Sentences

Our study of comprehension has thus far been limited to considering how people understand sentences in which information is directly asserted. However, we can also use language to imply something without directly asserting it. It is often sufficient for a message simply to imply an action to convince a listener that the action actually occurred. For example, the sentence "The hungry python caught the mouse" may convince the listener that the python ate the mouse, even though that action is not explicitly stated.

Psychologists have demonstrated that people are influenced by the implications of sentences by showing that subjects falsely recognize implied statements (Bransford, Barclay, & Franks, 1972). Consider how the following two sentences are related:

1a. Three turtles rested on a floating log, and a fish swam beneath them.

1b. Three turtles rested on a floating log, and a fish swam beneath it.

The second sentence is implied by the first sentence because the fish swam beneath the turtles who were on the log. People therefore often falsely recognize the second sentence when they had actually seen the first sentence.

False recognitions are not a problem when the presented sentence does not imply the test sentence, as in the following example:

2a. Three turtles rested beside a floating log, and a fish swam beneath them.

2b. Three turtles rested beside a floating log, and a fish swam beneath it.

This pair of sentences is identical to the first pair except that the word *beside* replaces the word *on*. Because the first sentence no longer implies that the fish swam beneath the log, people are less likely to falsely recognize the second sentence.

The finding that people may not distinguish implications from direct statements can have important consequences. For example, a consumer could be misled by the implications of an advertisement, or a jury could be misled by the implications of testimony. We first consider the effect of implications on courtroom testimony.

Courtroom Testimony

Asking leading questions is one way that implications can influence a person's responses. Loftus designed a procedure to simulate what might occur during eyewitness testimony (for example, Loftus, 1975). The procedure consists of showing people a short film of a car accident and immediately afterward, asking them questions about what occurred in the film. One experimental variation involved phrasing a question as either "Did you see a broken headlight?" or "Did you see the broken headlight?" The word *the* implies that there was a broken headlight, whereas the word *a* does not. The results showed that people who were asked questions containing the word *the* were more likely to report having seen something, whether or not it had actually appeared in the film, than those who were asked questions containing the word *a*.

Another experiment revealed that the wording of a question can affect a numerical estimate. The question "About how fast were the two cars going when they smashed into each other?" consistently yielded a higher estimate of speed than when *smashed* (*into*) was replaced by *collided, bumped, contacted,* or *hit*. These results, when combined with similar findings from other experiments conducted by Loftus and her associates, show that leading questions can influence eyewitness testimony.

Implications can influence not only how a witness responds to questions but what a jury remembers about the testimony of a witness. In another experiment (Harris, 1978), subjects listened to simulated courtroom testimony and then rated statements about information in the testimony as true, false, or of indeterminate truth value. Half of the test statements were directly asserted (for instance, "The intruder walked away without taking any money"), and half were only implied ("The intruder was able to walk away without taking any money"). The test item that the intruder did not take any money would be true for the asserted statement but of indeterminate truth value for the implied statement.

Harris found that people were more likely to indicate that asserted statements were true than that implied statements were true. There was, however, a disturbing tendency to accept implied statements—subjects responded true to 64% of the statements that were only implied. Furthermore, instructions warning people to be careful to distinguish between asserted and implied statements did not significantly reduce the acceptance of implied statements.

The work of Loftus and Harris should be of interest to people in the legal professions. A judge can immediately rule a leading question out of order, but not before the members of the jury have heard the question. Instructions from the judge to disregard certain evidence may not prevent the jurors from considering that evidence when making their decision. More subtle uses of language,

such as use of the word *crash* rather than the word *hit,* may not even be identified as potentially misleading.

Harris has speculated that the distinction between asserted and implied statements may be even harder to make in a real courtroom than in an experimental situation. People in his experiment made their judgments immediately after hearing a 5-minute segment of simulated trial testimony. Members of a jury make their final decision after a much longer delay and after they have heard much more information. It is therefore important to clarify immediately any courtroom statements that are ambiguous regarding whether information was asserted or implied. If the witness is unwilling to assert the information directly—and thus become liable to charges of perjury—the jury should be made aware of the questionable value of that information.

Advertising Claims

The acceptance of implied statements is as important an issue in advertising as it is in courtroom testimony. The Federal Trade Commission makes decisions about deceptive advertising, but deciding what constitutes deceptive advertising is a complex question. The decision may be particularly difficult if a claim is merely implied. Consider the following commercial:

> *Aren't you tired of sniffles and runny noses all winter? Tired of always feeling less than your best? Get through the whole winter without colds. Take Eradicold Pills as directed.*

Note that the commercial does not directly assert that Eradicold Pills will get you through the whole winter without colds—that is only implied.

To test whether people can distinguish between asserted and implied claims, Harris (1977) presented subjects with a series of 20 fictitious commercials, half of which asserted claims and half of which implied claims. The subjects were instructed to rate the claims as true, false, or of indeterminate truth value on the basis of the information presented. Some of the people made their judgments immediately after hearing each commercial, and others made their judgments after hearing all 20 commercials. In addition, half the people were given instructions that warned them not to interpret implied claims as asserted and were shown an example of a commercial that made an implied claim.

The results showed that subjects responded "true" significantly more often to assertions than to implications. Furthermore, instructions were helpful in reducing the number of implications accepted as true. Although these results are encouraging, they are not unqualifiedly positive. First, even in the condition that was most favorable to rejecting implications—the group that had been warned and that gave an immediate judgment after hearing each commercial—people accepted about half the implied statements as true. When the judgments were delayed until all 20 commercials were presented, people accepted as true about as many implied statements as direct statements—even when they had been explicitly warned about implied statements.

Acceptance of implied statements is a problem that exists outside the psychology laboratory. In fact, one of the most frequently accepted implied statements in

Harris's (1977) study was a verbatim statement from a real commercial. Another real commercial, created after Harris's study, angered the National Park Service because it implied that the regular eruptions of Old Faithful are caused by Metamucil.

In the next chapter, on text comprehension, we will continue to study language but at a larger unit of analysis. We will focus less on individual sentences and more on how information is combined across sentences. We will try to determine which variables influence people's ability to comprehend paragraphs and remember what they read.

SUMMARY

A language is a collection of symbols and rules for combining symbols that can generate an infinite variety of sentences. A sentence can be partitioned into grammatical phrases, words, morphemes, and phonemes. Morphemes are the smallest units of meaning and include stem words (friend), prefixes (un), and suffixes (ly). Phonemes are the basic sounds of a language. Newborns have the ability to discriminate among many different speech sounds but lose this ability as they learn to categorize sounds into the phonemic categories of their language. Errors in generating speech are consistent with the hierarchical organization of language. Exchange errors, in which two linguistic units are substituted for each other, occur at the same level in the hierarchy, producing either word exchanges, morpheme exchanges, or phoneme exchanges.

One of the major questions that have fascinated psychologists interested in language is how people learn to speak in grammatically correct sentences. An early view suggested that children learn to associate the adjacent words in a sentence. According to this view, each word serves as a stimulus for the word that follows it. There are several problems with this theory, the major one being that a person would have to learn an infinite number of associations. The alternative view is that a child learns a grammar consisting of rules for generating sentences. The transformational grammar proposed by Chomsky stimulated much research as psychologists investigated how well it could account for the results of language experiments. The grammar consisted of both phrase structure rules for describing the parts of a sentence (such as noun phrase and verb phrase) and transformation rules for changing a sentence into a closely related sentence (such as an active sentence into a passive sentence). Specific words (such as the word *remember)* and general features of words (such as whether the sentence begins with an animate or inanimate noun) provide clues about the grammatical structure of a sentence.

A general model of sentence comprehension involves fixating and recognizing a word, retrieving conceptual meanings that are sufficiently activated by the word and the prior context, integrating one of these meanings with the prior context, testing to determine whether the integration is successful, and recovering from an error if unsuccessful. Psychologists have often used ambiguous sentences to study comprehension and have found that a clarifying semantic context allows the listener to quickly select the appropriate meaning of an ambiguous word, although both meanings have been activated. Individual differences in resolving ambiguities are caused by differences in the ability of readers to keep multiple meanings active in STM until encountering a clarifying context and then quickly suppressing the inappropriate meaning.

An aspect of language that has direct practical applications is the distinction between assertions

and implications. A sentence that only implies some event may have as great an impact as a sentence that directly asserts this event. Making people aware of the distinction between an asserted and an implied statement is particularly important in courtroom testimony. Research using simulated testimony has found that people often do not distinguish or do not remember what information was only implied and what was asserted. Similar results have been found for advertising claims.

STUDY QUESTIONS

By the time we are college students, we are such skilled users of language that we don't usually think about it at all. If you haven't thought about the "parts of speech" lately (or ever), you may need to look them up before you get into this chapter.

1. Make sure you understand the term *morpheme* by thinking of several stem words that you can change the meaning of by adding a prefix and a suffix.
2. What is a grammar? In what sense do all of us "know" English grammar?
3. What are the respective domains of phrase structure grammar and transformational grammar? Or are the two fighting over the same turf?
4. Why are sentences yet another example of hierarchical organization? Do you think this is helpful?
5. Note the various experimental tasks that have been used to study language comprehension. Have you run into any of them before in this course?
6. Many of the words we use can take on separate meanings, but most of the time we don't experience ambiguity. Why, then, is it important to determine how we "disambiguate" words in a sentence?
7. It is intuitively obvious that context facilitates word interpretation, but how may it interfere with interpretation? How has the influence of context been studied experimentally?
8. What causes individual differences in resolving ambiguities? Can you think of an example in your life in which an ambiguity created a misunderstanding?
9. Be sure you understand the meaning of *imply* and *implication* versus *assertion*. Test yourself by inventing a sentence that asserts an event or state of affairs and then change it so it merely implies the same thing. Write out the sentences.
10. Since the interpretation of both courtroom testimony and advertising copy may be manipulated misleadingly, should educators specifically warn students to be aware of implied statements? What else could be done about the problem?

The following experiment that relates to this chapter may be found at: ***http://coglab.wadsworth.com.*** Answer the questions in the CogLab Student Manual as required by your teacher for this experiment.

CogLab

Categorical Perception: Discrimination

KEY TERMS

The page number in parentheses refers to where the term is discussed in the chapter.

ambiguous sentence (253)
Broca's aphasia (247)
deep structure (254)
error recovery heuristic (263)
exchange error (250)
generative (244)
grammar (244)
high-constraint sentence (258)
language (244)
lexical decision task (259)
low-constraint sentence (259)
morpheme (244)
morpheme exchange (250)
phoneme exchange (251)
phrase structure grammar (251)
slip of the tongue (250)
structured (244)
suppress (262)
surface structure (254)
symbolic (244)
transformational grammar (252)
Wernicke's aphasia (248)
word exchange (250)
working memory capacity (263)

RECOMMENDED READING

Steven Pinker's (1994) book, *The Language Instinct*, provides a very readable introduction to the many facets of language. An easy introduction to the early theoretical contributions of Chomsky is a book by Lyons (1970). Lasnik (2002) reviews Chomsky's more recent contributions to transformational-generative grammar but the work is very technical. Keenan, MacWhinney, and Mayhew (1977) found that their colleagues often could remember the exact words of statements that had high emotional content, although usually only the general meaning of sentences was remembered (Sachs, 1967). Gernsbacher and Faust (1991) showed that the ability to quickly suppress inappropriate meanings is an important skill in a variety of comprehension tasks. Chapters by Carpenter, Miyake, and Just (1995) and by McKoon and Ratcliff (1998) and Clifton and Duffy (2001) in the *Annual Review of Psychology* contain an overview of studies on language.