Chapter 4

Words and Meaning: From Primitives to Complex Organization

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'Twas brillig, and the slithy toves
did gyre and gimble in the wabe,
All mimsy were the borogroves,
And the mome raths outgrabe.
(Carroll, 1862, p.176)

INTRODUCTION

Most educated adults probably know between 75,000 (Oldfield, 1963) and 150,000 words (Seashore & Eckerson, 1940). These large vocabularies, however, do not contain *brillig* or *gimble*. Nevertheless, we know how to pronounce each of the nonsense words and sense whether each is functioning as a noun or verb or adjective. Do we, then, deduce meaning, however limited, from this passage from “Jabberwocky”? Further, if we can deduce information about fictional words, how much more can we know about real ones? In this chapter, we will address this question by discussing the organization and processing of words and of meanings.

Many people consider words as the building blocks of language; words and combinations of words allow us to symbolize objects and events in the world around us. The study of words and meaning (defined as *semantics* in Chapter 1) has a long and rich history dating back at least to the writings of Democritus (*On Words*) and Plato (*Cratylus*).

One philosophical issue in the study of semantics is how words are bound to their meanings. For words such as *savish* the connection is obvious: the word sounds like the movement of water or draperies that it represents. Not all words have such an obvious connection to their meaning. A cat does not make sounds like [kæt] when it walks, purrs, or eats. Shakespeare remarked “that which we call a rose, By any other name would smell as sweet” (Shakespeare, 1975, p.1020). This famous quote hints at the arbitrary relationship between most words and the concepts to which they refer. Words typically lack the causal connection between sound and meaning that exists in onomatopoeia (for example, *kaboom*), although strong word-meaning links exist because of social convention. That is, we agree to call a humorous story with a punch line a “joke” so that we can communicate with other people who hold the same definition of *joke*. If someone offers to tell us a joke, we do not expect them to give a eulogy.

In this chapter, we use both psychological experiments and philosophical theorizing to obtain answers to questions such as: Where do we store words? How are they organized in our minds, and how do we recognize words that we see or hear? What is
meaning? And how do words relate to meanings? The past two decades of research and
writing on these topics have been particularly productive and have offered partial an-
swers to these questions.

In the sections that follow we will pursue the difficult task of considering words and
meaning separately (after all, we call things "words" because they convey a meaning).
At the end of the chapter, we will link the two domains back together as we explore how
listeners and readers process lexical ambiguity—words that have multiple meanings.

## Words and Meanings:
**Separate but Linked Domains**

Numerous findings, some anecdotal and some empirical, conclude that words and
meanings are related but separate entities. Three lines of argument make this point.
The first, the translation argument, suggests that any given language includes some
words that do not depend on meaning for their existence and some meanings for
which there are no single words. If meanings and words were tightly yoked all of the
time, this could not be true. The second argument for a separation of words and mean-
ings comes from the imperfect mapping illustration, which suggests that a given lan-
guage can have many meanings for a specific word and many different words for a
given meaning. Finally, the third argument for treating words and meanings as sepa-
rate comes from the elasticity demonstration, which illustrates that a word meaning
can change in different contexts. Let us briefly examine each of these arguments.

Most of us have experienced the translation argument. For example, the Yiddish
word, *schlep*, requires a long-winded explanation in English "To move a heavy and usu-
ally bulky item from place to place." Those who have incorporated this Yiddish term into
their vocabularies can talk about "schlepping" a load of books from class to class. Here
we have a good meaning for which English possesses no single word. Similarly, we can
create any number of words that have little meaning. In the poem cited above, *borogroves*
offers one example. (*Borogroves* does have a meaning, according to Humpty Dumpty, but
you'll have to wait until the end of the chapter to find out what it is.) We've all had the
experience of recognizing a word as a word without knowing what it means. Thus,
we can know words for which we have no meanings stored in our brain. For example, many
people are uncertain of the meaning of *churlish* ("coarse, rude, and vulgar"). And many
nonmusicians know that *adagio* is a word without knowing that it means "slowly."

Of the empirical demonstrations of the translation problem, two are particularly
well known. The first comes from a study by Heider, now Rosch (1972), in which she
investigated the language of the Dani, a modern-day Stone Age tribe who live in In-
donesian New Guinea. Their language has only two color terms, *mola*, which design-
ates bright, warm hues, and *mili*, which designates dark, cold hues. Does this limited
color vocabulary imply that the Dani people perceive or recognize only two colors?
No, it appears that the Dani can process more than just how dark or bright colors are.
In fact, Heider's (1972) research on the topic suggested that the Dani people see the color spectrum in exactly the same way that we do. A second celebrated example shows the impoverished English vocabulary for different kinds of snow. Whereas Eskimos have four different root words for snow, *aput* ("snow on the ground"), *quana* ("falling snow"), *pigsirpog* ("drifting snow"), and *gimuqsaq* ("a snow drift"), English speakers have only the lonely word *snow* (Boas, 1911; Pullum, 1990). In short then, the translation argument demonstrates the distinction between words and meanings because, although they are closely related, each can exist without the other.

The *imperfect mapping* illustration also refutes one-to-one mapping of words and meanings. Here we see many different meanings for a single word (ambiguity) and many words for a single meaning (synonymy). Thus, meaning can be marked in any number of different ways with language. One of the best illustrations of word ambiguity comes from the study of jokes and riddles. The success of some jokes hinges on setting up one meaning of a word when another is actually required (Fowles & Glanz, 1977; Hirsh-Pasek, Gleitman, & Gleitman, 1978; Shultz & Horibe, 1974). The following admittedly bad joke makes the point clear:

Doctor: Eyes checked?
Patient: No, they're blue.

The humor (such as it is) derives from the word *checked*, which has two meanings, one referring to the act of looking or examining and the other referring to a perceptual pattern. Experiments on word ambiguity demonstrate that people have multiple meanings available for words at any given time in processing. For example, Simpson (1981) found that in processing ambiguous sentences such as, "We had trouble keeping track of the cost," both meanings of the word—number of items and European nobleman—were called up from subjects' mental dictionary (although this need not be conscious and is demonstrable only through experimental techniques).

The other half of the imperfect-mapping illustration turns on the availability of two or more words for a single meaning, or synonymy. Although some argue against the existence of true synonyms (Clark, 1987), to many of us the words *sofa* and *couch* mean the same thing; so do the words *pail* and *bucket.*

Finally, there is the *elasticity* argument, the demonstration that words can have varied meanings depending on the contexts in which they are found. Some clear examples are adjectives that modify different properties of words in different contexts. A "tall tale" is a story with exaggerated aspects to it, and the adjective *tall* clearly conveys something slightly different than when we describe a man as tall. Likewise, a "light" class load suggests that a student who is taking only a few classes has lots of free time, not that his or her schedule doesn't weigh much, as in a "light" child.

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1 However, some words are more suited to certain contexts, and synonyms alter the meaning of the sentence itself (even if the words are identical in meaning). For example, "name" and "nomenclature" have identical meanings. However, Shakespeare's romantic quip, "A rose by any other name would smell as sweet," loses some of its poetic charge if "A rose by any other nomenclature would smell as sweet." Again, the fact that meanings and words are not exclusively linked to one another leaves room for a separate examination of each domain.
Katz & Fodor, 1963). As these examples clearly show, word meanings sometimes hinge on the words that they appear with and are often context dependent. Thus, meanings and words are not unequivocally yoked.

Taken together, these three arguments suggest that words and their meanings, although closely related, are not identical. Having driven the wedge between these two types of psychological entities, it becomes possible to examine each domain separately. Indeed, within the field of psychology, these two topics have been differently treated. Research has typically studied how words are understood or recognized in speech or reading, whereas the study of meaning has concentrated on how these meanings are stored. In the discussion that follows, we look at the organization and processing of words in the mental lexicon (Greek for "dictionary"), and then ask about the representation of meaning within the mind. For notational clarity, whenever we refer to a specific word, we will italicize that word: *chicken*. Whenever we refer to the meaning of a particular word, we will enclose the meaning in quotation marks: "chicken." Thus, *chicken* refers to the name or word that we use. Presumably, if the English-speaking community decided en masse to change the name to *bukhuk*, no one would be deeply offended. However, changing the name would not change the meaning to which we are referring, it would still be a "chicken," defined as "a galvanitious bird," or offspring that has chickens as parents. No worldwide council could arbitrarily change these facts of definition, for once a chicken ceases to have parents who are chickens, its very essence is altered. Given that we can now talk separately about words and meanings, let's discuss what philosophers and psychologists say about words and their meanings.

**The Study of Words**

In this section on words, we explore (1) the form in which words are stored in our mental lexicon—for example, how complex words are constructed (in language production) or recognized (in language comprehension)—and (2) what factors contribute to the access or retrieval of words. Psychologists have used a variety of experimental techniques to study these issues. Let us first turn to a discussion of the theoretical issues that underlie this research.

**Word Primitives**

Let us begin by dissecting the sentence, *The impartial judge ruled the defendants guilty*. Is the action taking place now? Was more than one person convicted? Was the judge biased or not? Although the sentence is composed of only seven words, many of these words are complex and contain affixes that convey important information. For example, the suffixes -*ed* in *ruled*, and the -*s* on the end of *defendants* indicate that the
judge's decision took place in the past and affected more than one guilty person. Furthermore, the prefix im- in *impartial* indicates that the judge was assumed to be making a fair and unbiased decision (*im-* = *not* + *partial*). Accordingly, words such as *impartial*, *ruled*, and *defendants* are deemed multimorphemic words, where a *morpheme* is defined as the "smallest meaningful unit of language," a concept introduced in Chapter 1. Morphemes can be words in themselves (for example, *judge*) or simply appendages to words (for example, -s at the end of *judges or im* - at the beginning of *impartial*). Morphemes that can stand by themselves as words are called *free morphemes*; those that require attachment to other units are known as *bound morphemes*.

One hypothesis about *word primitives* (the smallest form in which a word is stored in the mental lexicon) argues that each word (even a multimorphemic word) is a separate entry (or *lexeme*) in our lexicons, and is thus its own primitive (Aitchison, 1987; Aronoff, 1976; Monsell, 1985; Sandra, 1990). This hypothesis states that each variant of a word (for example, *book*, *books*, *bookish*, *bookshelf*, and so on) has its own representation. When we produce multimorphemic words, such as *impartial* or *defendants*, we retrieve the plural form of the word directly. Likewise, according to this hypothesis, when we hear or read a word, we access its lexeme as a whole.

An alternative (and more widely held) hypothesis is that words are made up of constituent morphemes and that these morphemes serve as word primitives (MacKay, 1979; Murrell & Morton, 1974; Smith & Sterling, 1982; Taft, 1981; Taft & Forster, 1975, 1976). When we listen to someone speaking, we *decompose* words into morphemes in order to comprehend spoken language. This view of word primitives assumes that we "strip" a word of all affixes and then activate the root word (*rule*) plus the relevant bound morphemes (*-ed*). Likewise, the decompositional view states that when we speak, we access individual morphemes and combine them to make up complex words.

The decompositional view of *morphemes as word primitives* has the advantage of *cognitive economy* (efficient use of cognitive resources), because not every variant of a word needs to be stored in the lexicon. Fewer lexical units are needed, because the bound morpheme -s, which indicates plural *defendants* in the sentence above, can also be combined with every other noun that can be pluralized. The word-as-word-primitive view would require at least two lexical entries for every noun—the root noun and its plural (for example, *table* and *tables*; *idea* and *ideas*; *forgery* and *forgeries*). This seems an illogical and unnecessary use of space. The alternative view argues that although storing multimorphemic words as separate entries may take up more memory space, it saves on processing time. That is, assembling *up* - and *grade* takes cognitive energy that can be saved if *upgrade* is stored as a single word.

**Evidence About Word Primitives.** You now have two theories of what constitutes a word primitive: (1) Each word (even multimorphemic ones) has its own lexical entry, known as a lexeme; (2) constituent morphemes are individually stored in the lexicon so that words are decomposed (during comprehension) or composed (during production). The issue of whether whole words or individual morphemes function as word primitives may shed some light on the productivity exhibited by even the most novice users of language. Just as we are able to construct an infinite number of
sentences because of our implicit knowledge of syntax, people are able to construct new words from their knowledge of morphology. If we asked you to change snark into a verb, you would have no trouble offering snarking. If the request was for an adjective, snarkish might come to mind; and for an adverb, snarkishly would fit. Knowledge of word primitives can also tell us where the cognitive system is devoting the most energy: With the lexeme view of words, much space would be devoted to maintaining multiple variations of words in the lexicon. The morpheme-as-primitive theory requires less storage space but greater capacity to perform the processes of constructing or decomposing words into their constituent morphemes.

What methods could be used to test whether people store whole words or morphemes in their lexicon? One technique is that of a **lexical decision task**. As you read the words below, tap with your right index finger to indicate Yes—the string of letters is a real word; tap with your left index finger to indicate No—the letter string is a nonsense word.

- table
- vanue
- daughter
- tasp
- coref
- hunter

You probably had no difficulty deciding Yes, No, Yes, No, No, Yes on the above entries. However, in a real lexical decision task, the letter strings would be presented on either a computer or a **tachistoscope** (an apparatus that allows the experimenter to strictly control the duration of a stimulus), and your response would have been measured in milliseconds (one millisecond = one-thousandth of a second). The time it takes to respond Yes or No to each letter string is composed both of the time it takes to tap your respective index finger (or a computer key), time for **lexical access**, plus the decision time to tap with your left or right finger (to indicate Yes or No).

In the case of the real words—**table**, **daughter**—accessing your lexicon would have yielded recognition that these were indeed real words. Notice that although both **daughter** and **hunter** have an -er ending, hunter is a multimorphemic word composed of **hunt** + -er, whereas daughter is only a single morpheme word that cannot be composed into **daught** + -er. It is therefore said to be a **pseudo-suffixed** word. Even more confusing might be **corner**, whose composition into **corn** (a legitimate word) plus -er would not yield the meaning of **corner** in the same way that **hunt** + -er divulges the meaning of **hunter**.

Many studies have found that it takes longer to process multimorphemic words than words composed of a single morpheme. In a speech production task, MacKay (1978) presented subjects with root morphemes (for example, **decide**) and asked them to respond with a variant of that word (for example, **decision**). The more morphologically complex the response, the longer the **reaction times**. For instance, **indecision**, which adds two bound morphemes to the root, would take longer to construct than **deciding**, which adds only one.
Which position one adopts, however—a decompositional view of morphology, or a whole-lexeme view—may depend on the kinds of morphemes being discussed. Derivational morphemes significantly alter the root morphemes to which they are added. For instance, the derivational prefix dis- changes agree and interested to their negatives (disagree; disinterested). Many derivational morphemes also change the grammatical class of a word, as when the suffix -er, when added to learn, hunt, or swim, changes each verb into a noun. Inflectional morphemes (which all occur as suffixes in English) do not, however, significantly alter the root morphemes to which they are added. The -s or -es added onto words to indicate plurality is one such inflectional change. Wish and wishes are not completely different words, nor are dolphin and dolphins. Likewise, -ed or -s tacked onto the end of a verb merely changes its tense or person (for example, jumped; swims). Assessing whether people perform morpheme stripping (upon hearing and seeing a word) and morpheme assembly (when they produce speech) may depend on the kind of morpheme—derivational or inflectional—being discussed.

One experiment which supported a decompositional view of word storage found that words masquerading as multimorphemic items increase reaction times. Taft (1981) found that words such as result or interest, which appear to have prefixes (re- and inter-, respectively) took longer to respond to in a lexical decision task than either actual prefixed words (for example, recall, interstate) or unprefix words (for example, table, focus). The search process for the pseudoprefixed words takes longer, argued Taft, because subjects strip away the re- or inter- and search for the root morphemes sult or est, which of course are not legitimate root morphemes.

Furthermore, when people make speech errors, morphemes often “float away” from each other. Substitutions of morphemes, such as it waits to pay, (for It pays to wait.) (Garrett, 1976, 1980), and perseverations of affixes, such as ministers in the churches (for ministers in the church), are quite common (Shattuck-Hufnagel, 1979). The migration of -ed in the example, She wash upped the dishes, (Aitchison, 1987) illustrates that many root and bound morphemes are independently retrieved and combined later in the speech production process. A decompositional view of the lexicon can also explain errors such as The labrador bited the cat, in which a person appears to be assembling morphemes based on a linguistic rule, rather than pulling bited out of the lexicon. Notice, however, that the errors cited above all involve inflectional suffixes (see Chapter 7 for more details of speech error data and analysis). Neuropsychological evidence of speech comprehension in Broca’s aphasics also supports the concept that some root and bound morphemes are separately represented in the lexicon (Tyler, Behrens, Cobb, & Marslen-Wilson, 1990).

Thus some evidence indicates that people economicaally store morphologically complex words as individual morphemes, which are then combined (in speech production) or stripped (in comprehension). Might occasions arise, however, when it is beneficial to represent multimorphemic words as whole lexemes?

Frequently encountered affixes and compound words may indeed be stored whole as lexemes. In fact, to realize that many words (for example, disguise; pardon) were multimorphemic would require knowledge of Latin. For example, the common suffixed word impossible may be accessed as a single word, even though the less common imperceptible is processed through its separate morphemes (Carroll, 1986).
And what about compound words, such as gingerbread, which are clearly made up of two separate lexical entries? Sandra (1990), Monsell (1985), and Osgood and Hoosain (1974) found evidence that some compound words such as butterfly may have independent lexical entries in addition to entries for their morphemic constituents (butter and fly). Why? Because butterfly is semantically opaque; that is, its meaning is not simply a combination of the meanings of butter + fly. The words buttonhole, teaspoon, and beanpole, on the other hand, are semantically transparent complex words—their meanings are easily discernible from their constituent parts. A buttonhole is simply a hole for a button.

Semantic priming tasks have also been used to support a distinction in lexical storage and processing between semantically transparent and opaque terms. Semantic priming is analogous to hooking two cars together with battery cables: Some of the energy from the first car’s battery gives an extra boost to the second car’s start-up. Even if the second car would have started on its own, the energy traveling through the jumper cables makes it start up that much faster. Likewise, if we pair, or “hook up,” two words related in meaning, recognition of one word will “jump start” recognition of associated words.

Semantic priming has been demonstrated through a variant on lexical decision tasks: Imagine that two people are participating in a lexical decision task. Each of them must make a decision about whether a pair of letter strings are both words or not. One subject receives the word bread, then doctor; the other receives bread, immediately followed by butter. Meyer and Schvaneveldt (1971) found faster response times to the second word when the first word was semantically related (for example, bread—butter) than when the two words were unrelated. The first word primed recognition of the second (semantically related) word. Semantic associates also have been found to prime semantically transparent compound words, but not semantically opaque compound words. For example, pea facilitated recognition of beanpole, but bread did not prime butterfly (Monsell, 1985; Osgood & Hoosain, 1974; Sandra, 1990). These findings support the idea that semantically transparent words such as beanpole are processed as two separate morphemes and semantically opaque terms are processed as a single morpheme.

Defense of a morpheme-stripping view may also have to hinge on the kinds of morphemes appended to root morphemes during lexical processing as opposed to those permanently appended and stored as independent lexical entries. For example, bound morphemes consist both of prefixes (the un- in unhappy) and suffixes (-est in happiest). Much evidence suggests that derivational endings (for example, dis-, un-, -er, -ish) are more firmly attached to root morphemes; inflectional morphemes are more likely to be added on as we speak. When people make word substitutions during speech errors, they tend to maintain the derivational suffixes of words, as in provisional for provincial (Aitchison & Strach, 1982). But, as noted earlier, inflectional suffixes float around during speech errors as if they were added on in the course of speech: “She wash uped the dishes” (Aitchison, 1987). In lexical decision tasks, it does not take any longer to recognize a derivationally suffixed word, such as dust-y, than a pseudosuffixed word, such as fancy (Manelis & Tharp, 1977). This is not to say that we can’t have spare derivational morphemes separately stored in order to create new words as the need arises. For instance, smiler is not a common root + derivational morpheme combination, but we can both produce it and comprehend it with ease.
Furthermore, some of the differences between studies supporting a decompositional versus a lexeme view of the lexicon may depend upon task demands. Rubin, Becker, and Freeman (1979) found differences in lexical processing time between suffixed (for example, sender) and pseudosuffixed words (for example, sister) only when at least 50% of the experimental list was composed of suffixed words. This suggests that subjects may have resorted to the strategy of decomposing words into morphemes after noticing that many of the words in the list were multimorphemic.

**Summary.** It appears, then, that lexical processing tries to strike the best balance between cognitive economy in memory and economy in assembling and decomposing multimorphemic words. Inflectional suffixes such as -ing or -s, which do not significantly change the meaning or grammatical class of their root morphemes, are most likely to be appended (or stripped) during processing. Frequently occurring multimorphemic words (disagree), and those with derivational morphemes (teacher), however, often have separate lexical entries from their root morphemes. Compound words whose meaning cannot be discerned from the combination of the two constituents (called semantically opaque), such as hippocampus, may also have their own lexemes. Semantically transparent terms such as firehouse may be composed from their two independent morphemes. Furthermore, morpheme-stripping may be a strategy subjects adopt when they realize that many words in a list are morphologically complex. Task demands may thus alter normal lexical processing.

The cognitive system seems to strike a balance between saving mental “dictionary” space and saving processing energy. If commonly used multimorphemic words are stored as their own entries, this takes up more lexical space but saves combining morphemes every time we use (or hear or read) those words. On the other hand, storing every plural of every noun we know violates the concept of cognitive economy, and it may be simpler just to add the -s to nouns as we need it. Separate lexical storage of root and inflectional morphemes saves mental dictionary space but may not significantly tax the processing system during recombination (or decomposition) of those words. Why is this important? The ability to be creative with language and to create new words as needed dictates that we have a flexible system that can adopt different processing strategies as needed. The cognitive system thus balances between thrift in space and thrift in processing.

**Factors Influencing Word Access and Organization**

What if we were to ask you to create a computer model that mimicked the way in which your mental dictionary or lexicon was organized? Where would you begin? What principles might you use to sort those 150,000 words into separate files so that they could be retrieved when necessary? Would you first separate the words into files based on their initial phoneme or sound (for example, all the /s/ words would be stored together, or rhyming words like name and same)? Would you separate words into files according to semantic category (for example, fruits, animals), or semantic opposites (for example, salt–pepper)? Maybe you would attend to the frequency of words, so that the most commonly used words would be stored in their own file for
easy access? What about dividing words into grammatical classes, so that *jump*, *tree*, and *sweet* would be in separate verb, noun, and adjective files, respectively, within the computer program? Or perhaps you would prefer a more flexible organization, so that word characteristics that influence retrieval would depend on your purposes at that time. That is, when you write poetry, you could access words by phonology or syllable or accent structure in order to construct rhymes and rhythms, but in delivering a speech, you could retrieve words based on the meaning you want to convey.

You may be thinking that you can sort words for retrieval in many different ways, and you are probably right. Models of lexical access need to account for this intuition and for various empirical findings that suggest that word recognition and retrieval are influenced by several key characteristics of words themselves. That is, factors such as the relative frequency of a lexical entry, its grammatical class, how it is pronounced, can all influence the speed and accuracy of access to that word. Some of these factors may influence lexical access directly; or they may influence the structure of the lexicon itself—how it is organized.

**Frequency.** Which word is more common: *predict* or *villify*? *Angry* or *puddle*? Multiple studies suggest that we tend to respond to high-frequency words more quickly than to low-frequency words in both lexical decision tasks (Rubenstein, Garfield, & Millikan, 1970) and naming tasks, where subjects are asked to read strings of letters aloud (Forster & Chambers, 1973). The effect of frequency on lexical processing is a robust experimental finding: While reading or listening to someone speak, subjects tend to recognize high-frequency words more quickly and easily than low-frequency words. Subjects with aphasia (discussed in Chapter 2) are typically more accurate at reading aloud high-frequency words than low-frequency words (for example, Ellis, Miller, & Sin, 1983).

Because of the consistency of these findings, frequency has played a major role in the development of models of lexical access. However, the presence of the frequency effect and the degree to which it affects lexical processing may depend on the type of task being studied. For example, Balota and Chumbley (1984) found large effects of frequency on lexical decision tasks, a moderate frequency effect in naming tasks, and only a small effect in category verification (where subjects respond True or False to statements such as, “A *canary* is a bird”). Because all three tasks involve lexical access, frequency should have affected all three to at least a moderate extent, argued Balota and Chumbley. They thus concluded processes that occur *after* lexical access, such as decision processes (“Is this a real word or isn’t it?”) or pronunciation, are responsible for frequency effects. The evidence taken as a whole suggests that frequency plays a role in lexical access, but the effects can be attenuated by subsequent lexical processing.

**Imageability and Concreteness and Abstractness.** As you read each of the following words, close your eyes and try to picture the object or idea portrayed by the words: *umbrella*, *lantern*, *freedom*, *apple*, *knowledge*, *evil*. Were *umbrella*, *lantern*, and *apple* easier to image? Did you have difficulty coming up with internal pictures for *freedom*, *knowledge*, and *evil*? If not, you probably imaged a symbol for the concept portrayed, such as the Liberty Bell for “freedom,” rather than generate an
image of the word meaning per se. This issue is sometimes divided into one of concreteness and abstractness; concrete words such as *apple* are more imageable, and abstract words such as *knowledge* are less easy to image. Paivio (1969) found that high-imagery words were more easily recalled in a memory test than low-imagery words. Bleasdale (1987) also found that, in a lexical decision task, words primed other words only when both words were of the same type, for example, concrete—concrete or abstract—abstract, but not concrete—abstract or vice versa. From this, he concluded that the lexicon is organized separately for concrete and abstract words.

The principle of imageability also interacts with the principle of frequency in word access; high-frequency high-imagery words (such as *student*) are best accessed and recalled; low-frequency low-imagery words (such as *excuse*) are least easily accessed. High-frequency low-imagery words (such as *justice*) and low-frequency high-imagery words (such as *elbow*) are somewhere in the middle (Paivio, 1969).

**Semantics.** As you read each of the following words, say aloud the first word that comes to mind:

- wet
- swift
- petal
- apple
- shoot

You may have said, “Dry, fast, flower, fruit, gun.” If so, in each case you named a semantic associate (that is, a word related in meaning) of the initial words, even though *wet* and *dry* are related in a different way from *apple* and *fruit*. The first pair is based upon opposites in meaning; the second on category membership (see Miller, 1951, for a more detailed classification).

When adults (Jenkins, 1970) or children (Palermo, 1963) have been asked to engage in word association experiments, similar to the mini-experiment above, three major findings have occurred. First, subjects are most likely to respond with a semantically similar word (Ervin, 1957). This suggests a stronger connection among words based on meaning than on, say, perceptual similarity. When presented with *needle*, the likely candidates in a word association task are *thread*, *pin*, or *saw*, but not *nail* or *poker*, which resemble a needle. Second, subjects are most likely to free associate the completion of a pair: *salt* triggers *pepper*, and *king* triggers *queen*. Third, adults (but not necessarily children) are most likely to respond with a word of the same grammatical class as the target—noun with noun (chair—table), verb with verb (run—jump), and adjective with adjective (dark—light). There is no reason in principle why subjects in word association tasks would not choose similar sounding words (as in *weedle* for *needle*), but they don’t. These three findings reaffirm the notion that two main principles of word organization and access of lexical entries are meaning and grammatical class.

Freedman and Loftus (1971) found that subjects could name more (and more quickly) “Fruits beginning with P” than “P-words that are fruits.” Listing the category
word first better activated words beginning with a specific letter within that category. Hints about a word's semantic nature get us closer to the lexical entry for that word than do hints about its initial letter.

Further evidence for the role of semantics within lexical access and organization of the lexicon comes from brain-damaged patients. Marshall and Newcombe (1966) reported an aphasic patient who would often retrieve a semantic associate when reading. For example, he said, “sister,” when trying to read \textit{daughter}; “long,” instead of \textit{large}, and substituted “mauve” for \textit{purple}. This is a common occurrence in many aphasics, and indicates a connection between words with related meanings within the lexicon.

Finally, recall the semantic priming effect, mentioned earlier. All of the available evidence suggests that word meaning and semantic connections among words in the lexicon greatly influence word access.

\textbf{Grammatical Class.} Words also seem to be organized based on their grammatical class, such as whether they are nouns, verbs, or adjectives. Evidence for grammatical class as a lexical organizing principle comes from speech errors and tip-of-the-tongue states. Nouns tend to be substituted for nouns, as in, “She was my strongest propeller (proponent) during the campaign”; verbs for verbs, as in, “The nation's dictator has been exposed (deposed)”; and adjectives for adjectives, as in, “His mother is too progressive (possessive).” In word association tasks, adults most commonly respond to the stimulus word with a word of the same grammatical class (Ervin, 1957; Jenkins, 1970).

Related to the principle of grammatical class, words are sometimes divided into \textbf{open- and closed-class words}, a concept first explored in Chapter 1. \textbf{Open-class} words are the basic \textit{content} words in the language expressed as nouns, verbs, adjectives, and adverbs. A language can contain an infinite number of these types of words, as new words get invented to explain new objects or \textit{concepts} (for example, the words \textit{computer} or \textit{corporation} would have been of little use in Chaucer's day). As Aitchison (1987) analogizes, open-class words are the bricks of our sentences, closed-class words are the mortar. \textbf{Closed-class} words are \textit{function} words that traditionally provide the architecture for our sentences but bear no content—words such as \textit{the}, \textit{and}, \textit{from}, and so forth. They are so called because the set of words is “closed” in that it rarely admits new members. For example, when was the last time you learned a new preposition? Content words can be invented as the need arises. We had to invent the term \textit{computer} to deal with modern technology, but the number of function words has changed little through time.

Bradley (1983) and colleagues (Bradley, Garrett, & Zurif, 1980) found no frequency effects for closed-class words in a lexical decision task, despite the fact that frequency effects for open-class words are a robust phenomenon (for example, Forster & Chambers, 1973). Further support for a lexicon organized according to closed- and open-class words comes from Broca’s aphasics, who are selectively impaired predominantly in their production of closed-class words (see Chapter 2). For example, Gardner (1974) relates a speech sample from an aphasic patient trying to describe going home from the hospital on weekends:

"... Thursday, er, er, no, er, Friday... Bar-ba-ra... wife... and, oh, car... drive
... turnpike... you know... rest and... lee-vee."
Notice that the sentence resembles a telegram in that it contains content words but little else.

In summary, the evidence from several experimental techniques converges to suggest that the grammatical category of a word may determine how it is stored and organized in relation to other words. And whether a word is open or closed class interacts with frequency to determine the likelihood of recognition or retrieval.

**Phonology.** Although the emphasis thus far has been on frequency, meaning, and grammatical class as factors that influence lexical access, other means are available to us. Evidence indicates that words that sound alike, even though their first syllables are not identical, might also be connected or stored close together in the lexicon. One type of evidence for phonologically-based storage of lexical items comes from the so-called “tip-of-the-tongue” phenomenon (TOT). We have all experienced TOTs: we know what we want to say, but the word won’t come. By inducing tip-of-the-tongue phenomena in the lab, Brown and McNeill (1966) found that subjects were more likely to approximate the target words with similar-sounding words than with similar-meaning words. For example, “sarong” would be more likely to be mentioned by subjects as a possible response for “sampan” than would “houseboat” or “junk,” which have related meanings.

In speech errors, discussed in greater detail in Chapter 7, substitutions of similar-sounding words are quite common, as in *medication for meditation, cylinders for syllables, goof for golf, psychotic for psychological* (Tweney, Tkacz, & Zaruba, 1975). This is especially true when words have similar beginnings and endings, as though phonological cues are preserved as access routes within the lexicon. This is sometimes referred to as the “bathtub effect” (Aitchison, 1987), because the “head” and “foot” of the word are available, but the middle isn’t, much like a person’s body reclining in a bathtub. What may happen is that similar-sounding words are clustered together, and attempts to retrieve one may also activate its phonological neighbors. This follows not only for words that start with the same sound but also for words that sound alike but have different meanings (*homophones*, for example, *sale* and *sail*).

Access to the lexicon is flexible, and activation of lexical entries can occur using various criteria (although some principles of access may be more prevalent than others). Some principles, such as frequency and meaning, seem to permeate all other principles. In this respect they are more global aspects of the lexical system. We may use multiple principles of organization and access to accomplish all the jobs the lexicon is called on to perform. In modeling a computer simulation of a person’s lexicon, one goal is for the program to provide information based on request. Words must be accessible through various means, depending on the task demands, and sometimes a request may require the use of several channels or principles at once. Next we’ll examine the ways different theoretical models account for how all these principles operate within a single cognitive system. Let us now consider how the models of lexical access deal with the above findings.

**Models of Lexical Access**

When examined closely, how language users recognize a word’s meaning—how it should be pronounced or written—is a much more impressive skill than we may
initially have realized. Our lexicon must be an extremely organized place in order for speech (or comprehension) to occur as flawlessly as it normally does. The lexicon also serves multiple purposes: when reading it must yield information on word meaning based on the orthographic (that is, written) representation of a word; when listening to someone speak, we must recognize words from an auditory code. When we speak or write, words are activated based on the meaning we want to convey, and then translated into a phonological or orthographic code.

A viable model of lexical access must explain how the mind can act like a dictionary and a thesaurus, a poet’s rhyming book, and a grammar book. Two major classes of models detail how words get accessed (or recognized) during reading or listening. Although they mostly emphasize how words are activated during language activities, these models also implicitly provide us with some hypotheses as to how the lexicon might be organized.

The first type of theory is typically referred to as a **serial search model**. It claims that when we encounter a word—while reading, for example—we look through a lexical list to determine whether the item is a word or not, and then retrieve the necessary information about the word (such as its meaning or grammatical class). Serial search means that the process takes place by scanning one lexical entry at a time, sequentially. The best known serial search model is Forster’s (1976) **autonomous search model**.

The second type of model is known as a **parallel access (or direct access) model**. It proposes that perceptual input about a word can activate a lexical item directly, and that multiple lexical entries are activated in parallel. That is, a number of potential candidates are activated simultaneously, and the stored word that shares the most features with the perceived word wins. Most models then propose some kind of decision stage, during which the accessed word is checked against the input. Among the three major versions of direct-access models, the earliest version is John Morton’s **logogen model**. Two other forms of direct-access model—connectionist models (for example, McClelland & Rumelhart, 1981) and cohort models (Marslen-Wilson, 1987)—are adaptations of the basic premises of the logogen theory.

Both types of models—serial search and parallel access—consider word recognition an automatic process, not subject to conscious examination. That is, we are not cognizant of “searching” through a lexical list or of “activating” numerous stored words during lexical access. At best, we are conscious only of the end result of these processes—when we realize that we “know” what the word is and what it means.

Let us examine those characteristics of words that influence their access and then discuss how the various models explain the empirical findings. We will compare the ways these two types of theories explain research findings about the factors involved in lexical access and how successful each is in accounting for the data.

**Serial Search Models**

Forster’s (1976) autonomous search model of lexical access is best illustrated by comparing the lexicon to a library. A word, just like a book, can be in only one place in the lexicon/library, but its location can be determined from several catalog entries (for example, catalog entries for author, title, or subject matter). In the autonomous search model, these catalogs are known as “access files.” Forster (1976) posited three major
access files—orthographic, through which words are accessed by their visual features; phonological, through which words are accessed by how they sound; and semantic/syntactic, through which words can be retrieved according to their meaning and grammatical class. Given these three access files, lexical entries can be accessed during reading, listening, and speaking. These access routes can only be used one at a time (just as you can't look up books in more than one catalog at a time). That is, input from any modalities (visual or auditory) can only be used one at a time; it will not speed access time if you hear a word at the same time you read it. The orthographic and phonological access files mostly contain information about the beginning parts of words—the first few letters of their spelling (orthographic) or first few sounds with which they begin (phonological).

When a word is presented either visually or phonologically, a complete perceptual representation of the word is constructed and subsequently activated in the access file based on its initial letters or sounds. When you have derived the location of a word based on its access code (or its index in the library catalog, to carry out the library analogy), a search for the word entry in the master lexicon must still be conducted. Thus, Forster's model posits a two-stage process. Just as a person determines which section of the library a book is in, but still must search the specific shelf, we find the general location of a lexical entry, but still must search for its unique location in the master lexicon. It is this entry (not the partial entry in the access files) which contains all linguistic information about the word (for example, its meaning, spelling, pronunciation, part of speech).

The master lexicon is assumed to be organized into "bins" or storage units, with the most frequent entries in that bin on the top. This is analogous to putting your books in stacks, with the most frequently used books on the top, and accounts for why high-frequency words are accessed more quickly than low-frequency words. When an access file directs the search to the appropriate lexical bin, entries are searched one by one until an exact match to the perceptual representation is found. Figure 4.1 depicts how this process takes place.

The process of lexical access proposed by sequential search models is thus more of a step-by-step process than that proposed by parallel search models.

When the relevant lexical entry in this serial model is retrieved, it is checked against the input (for example, the written word) in a post-access check. This process is analogous to an automatic spelling checker in a word-processing program. If correct, the search is discontinued. If incorrect, we have two response alternatives: Non-words that in no way resemble legitimate words, such as psbttu can be confidently rejected. However, non-words that resemble real words, as coffey resembles coffee, or gollomp resembles gallop, initiate a more exhaustive search. Experiments have shown that we require more time to reject these legal nonwords (sequences that could be words because they follow the phonotactics of English) than we do to accept legitimate words. According to the autonomous search model, the search for a word stops when its lexical entry is located. But in the case of legal nonwords, all possible lexical entries must be scanned before the letter string can be rejected, which delays response time.

Two other serial search models merit brief mentions: Becker's (1979) verification model is similar to Forster's, except that Becker tried to better account for priming effects by emphasizing that a semantically defined search can be conducted, aided by
connections between associated words (for example, doctor and nurse) within the master lexicon. When one word is accessed, the system generates a list of potential words that may come next. This newly generated list is bound to be shorter than the list from a bin, thereby leading to quicker recognition of the second word in a priming pair (doctor—nurse) or to words suggested by the context of a sentence. Glanzer and Ehrenreich's (1979) model posits two dictionaries—a large, unabridged one composed of all words known to a person, and then a smaller pocket dictionary containing only high-frequency words. When confronted with a high-frequency word only the pocket dictionary need be used, which decreases search time.

Next we turn our attention to parallel access models. As we shall see, these models explain the various factors that influence lexical access in ways quite different from those proposed by serial search models.

**Parallel Access Models**

**Locogen Model.** Morton (1969, 1979) proposed that words are not accessed by determining their locations in the lexicon but by being activated to a certain threshold. Thus, a space analogy of lexical access such as we saw in Forster (1976) is replaced with a more electrical analogy—a word will "light up" when its activation is
sufficient, in the same way that a lamp lights up when the electrical current is sufficiently strong. How does this activation occur, and what determines the threshold of a certain word?

Morton (1969) claimed that each word (or morpheme) has its own "logogen," which functions like a scoreboard, tabulating the number of features that a lexical entry shares with a perceptual stimulus. When a word is not being recognized, it is said to be in its resting level and has a zero feature count. Each logogen also has an individual threshold, which is the amount of "energy" that will be needed to access that lexical entry. As environmental input arrives when one is reading or listening to language, activation starts to accrue to each logogen based on the orthographic or phonological or semantic information being presented. All available information is accepted and summed in parallel as the various affected logogens race to the finish. Any logogen for which the total activation reaches a predesignated threshold, based on sufficient similarity to the stimulus word, is accessed. If several entries are activated to threshold, the one with the highest count wins and is "recognized." It then slowly returns to its resting level. The logogen model can thus account for semantic priming by allowing activation from one logogen to spread to related ones, and because it takes some time to return to a zero feature count, the primed target has a head start to recognition.

As depicted in Figure 4.2, Morton's logogen model provides no separate access routes by which to search a master list of lexical items.

**FIGURE 4.2**

The Logogen Model

The concept of direct access: The most well-known model of this class is John Morton's (1969, 1979) logogen model. It is called a direct-access model.

Rather, subjects make use of all available data—the context of a sentence suggests some meanings over others, the letters used in the orthographic representation of a word activate logogens with those same letter features. And all this information adds up to converge on (usually) a single candidate in the lexicon. Recall that in Forster's autonomous search theory (1976) access routes could be used only one at a time, whereas Morton's initial model permitted simultaneous summation of input from multiple modalities.

Why, then, are high-frequency words easier to access than low-frequency words? According to the logogen model, frequency effects are the result of the lowered threshold of the stored representation of a frequently used word. That is, it takes less activation to fire a high-frequency word than a low-frequency word. Such a lowering of the threshold takes place over a long period of time.

Priming, on the other hand, is accomplished by a quick and temporary lowering of the threshold of the logogens related to a prime. The logogen system itself does not contain semantic or associative data about words; rather, the cognitive system does (picted as a separate “box” in Figure 4.2). However, when a word is accessed, the cognitive system receives this information and feeds information back to the linguistic system. Logogens that are related associatively or semantically to the prime receive increments to their logogens, and as a result require less perceptual input to achieve threshold. This results in quicker access times for primed words.

Morton's logogen model was the most influential of the parallel word access models and served as the basis for all of the parallel models that followed. As with any model, however, modifications were made to perfect the system. To show you how scientific progress forced changes in the model, consider the following example. The prediction of the original model that auditory presentation of a word would prime subsequent visual presentation of the same or related words turned out not to be the case, so the logogen model was revised in 1979 (Morton, 1979; Morton & Patterson, 1980) to constrain priming across modalities. Thus, although the model is good at explaining frequency and priming effects, its assumption that perceptual input is summed across modalities to achieve lexical access has been toned down, as suggested by new data. The newest version, depicted in Figure 4.3, posits separate input paths and logogens for words presented in visual channels versus auditory channels.

The initial logogen model also had difficulty accounting for how the linguistic system responds to nonwords. This required a further modification in the model. To ameliorate this problem, Coltheart, Davear, Jonasson, and Besner (1977) suggested a deadline within which words are recognized within the logogen system. If a stimulus word is not recognized within this deadline, it is rejected as a legal word. Nonword letter strings that most resemble words, such as *cofewy*, cause more general activation in the logogen system. Such stimuli are rejected later and take even longer to reject than nonwords such as *hmrfl*, which do not resemble real words at all.

**Connectionist Models.** A contemporary cousin of the logogen model comes from what is known as connectionism. Advocates of this approach in psychology, philosophy, computer science, and other fields, known as connectionists, use the analogy of the brain and neurons to develop models of cognition. Their computer models of cognitive processes (such as lexical access) are instituted in “neural nets” composed of nodes and connections between these nodes. Nodes are of three types: input nodes,
which process the auditory or visual stimuli; output nodes, which determine responses; and hidden nodes, which perform the internal processing between when we hear and see a word and when we respond to it. The hidden nodes do the lion’s share of lexical processing as depicted (in simplified form) in Figure 4.4.

Connectionist models (for example, that of McClelland & Rumelhart, 1981) share many tenets of the logogen model, including direct access to lexical entries, simultaneous activation of multiple candidates, and the use of many types of information to access a target word. However, connectionists are more explicit in defining exactly the cognitive and linguistic architecture—that is, how words are represented. Each functional level of the hidden nodes represents different aspects of words—for example, their visual, orthographic, phonological, and semantic natures, and so forth. Processing proceeds from input to deciphering the raw perceptual input at a featural level (for example, does a written letter have a curved section?); nodes activated here then activate letter units that share those features (for example, P, R, B, G, and so forth), which in turn activate words which share those letters. Figure 4.5 shows how the word time might be recognized in a connectionist model.

Connections between layers, and between nodes in the same layer, can be either excitatory or inhibitory. Excitatory links are those that send activation onto other nodes attached to the original. For instance, if the feature "/" were activated, it would send energy onto all letter nodes that had this feature (for example, A, M, W). Inhibitory links, on the other hand, prevent further activation of the linked node. If one recognized the letter A, the letter node for W and M should be inhibited so that it does not compete with recognition of the A. The pattern of excitatory and inhibitory links allows lower units to feed into higher-level units (for example, letter features must be activated before word units can fire), but units within a layer compete with each other for activation during recognition of a given stimulus. When one representation
achieves threshold, it inhibits the firing of similar units with regard to a specific stimulus.

Connectionist models deal with frequency effects in a slightly different way than the logogen model—more frequently used word units have stronger connections to lower-level nodes, such as feature and letter nodes. High-frequency words thus receive more activation when those features and letters are activated. Priming and context effects are also explained the same way: When a node or connection is activated, a spread of activation occurs in all directions, incrementing representations that resemble the target visually, phonologically, semantically, and so forth. Connectionist models are also the only lexical access theory to, albeit implicitly, supply a theory of word organization: Organization is nothing more than the strength of connections between nodes (either word–word nodes, or word–feature nodes), based on past association.

CoHort Model. The cohort model shares basic assumptions about lexical access with the logogen model but was designed to account only for auditory word recognition. Marslen-Wilson et al. (Marslen-Wilson, 1987; Marslen-Wilson & Welsh, 1978; Marslen-Wilson & Tyler, 1980, 1981) proposed that when we hear a word, all of its phonological neighbors get activated as well. Thus, upon hearing the sentence, "Paul got a job at the ca-...," candy, cash, candle, cashier, camp, and many others would
be available for selection. This set of words is known as the "word initial cohort" (though cohort's original meaning was a division of the Roman Army, here it refers to a "division" of words). Thus, as in the logogen model, multiple entries may be activated before the system settles on a final candidate. As with the other direct-access models, activation of a word is based on direct communication between the perceptual input and the lexical system.

One difference with the logogen model warrants discussion: Rather than the summing of partial inputs to logogens until adequate activation is achieved, all potential candidates for lexical access are activated by the perceptual input and then progressively eliminated. This elimination takes place in one of two ways—either the context of a spoken sentence narrows the initial cohort, or candidates are discarded as more phonological information comes in. In the latter case, as more of the spoken word is recognized, the cohort narrows. For example, if the phoneme /n/ was heard after the ca-, candy and candle (plus any other can- words) would be the only lexical items still possible from the initial cohort. The field of candidates continues to narrow as more stimulus information is received until only a single candidate remains. Figure 4.6 depicts the lexical elimination and access process for what might happen if one heard the sentence, "John was trying to get some bottles down
from the top shelf. To reach them he had to sta-... \text{"}; the words preceding sta- would result in stage 3, where \textit{stack} and \textit{stand} are the only available remaining options.

Initially, the cohort model depended heavily on an exact match between a spoken word and its phonological representation in the lexicon. However, further study determined that people could recognize aurally presented words even if mispronounced, or if a sound (like a cough) blocked out part of the stimulus. The theory was subsequently revised (Marslen-Wilson, 1987) so that the system chooses the best match to fit an incoming word. This also makes the lexical access system less reliant on the word initial cohort. Under the original model, if a word did not make it into the first cohort, it had little chance of being chosen; now, as long as it shares enough features with the auditory stimulus, it can be selected for recognition.

Thus, like the logogen model and the connectionist model, the cohort model of lexical access posits that multiple candidates are activated in parallel. Unlike its cousins, the cohort model states that the list of word candidates is narrowed as the auditory input proceeds serially. It explains frequency and nonword effects in much the same way as the logogen theory. Context or priming is assumed to narrow the original set of candidates, and this shorter initial cohort leads to quicker recognition of a target word.
Having seen how the serial search and direct-access models deal with frequency, word class, phonology, and so forth, can we then determine which of the types of theories is best supported? It turns out that both types of models have something to recommend them. For example, one prediction of the serial search models is that only one access code can be used at a time. This means that hearing a word at the same time you are reading it will not facilitate reading recognition time. And research has indeed demonstrated a lack of priming between modalities (for example, Swinney, 1979).

Another test of the two kinds of models relates to the finding of neighborhood effects. Some words have many neighbors that are created by changing only a single letter of the target word. For instance, mail has many neighbors—rail, bail, nail, fail, pail, hail, sail, stall, wall, mall, maid, main, and main. The word film, on the other hand, clearly lives in the country with few neighbors (only firm and fill). Serial search models would predict that large neighborhoods would increase access time because more entries would have to be perused before word recognition could take place. Parallel search models, however, would predict that spreading activation from numerous neighbors would facilitate eventual recognition of the target. Researchers (see review by Balota, 1994) consider faster recognition times for “city” words with many neighbors support for parallel search models.

Connectionist models, one form of the direct-access theories, provide the best explanation for semantic priming effects. The serial search model may prove too cumbersome for the efficiency with which lexical access is accomplished. However, some researchers argue that it may better account for some findings than direct-access models (see Forster, 1990, for a review). And neither serial nor parallel processing models are particularly adept at explaining the ability to pronounce nonwords, whose pronunciation cannot be in our dictionaries (see Henderson, 1982). As with word primitives, it could be that the task demands of an experiment greatly influence which predictions of serial versus parallel search models are supported. Both types of models provide numerous pathways to access words based on their frequency, grammatical class, phonology, and so on.

**Summary.** The factors that influence word access and lexical organization are addressed in both serial and parallel processing models. Both types of theories posit multiple access routes to lexical information—semantic, phonological, and so on—in order to account for the flexibility of the linguistic system. Although some aspects of the serial processing models (such as lack of intermodal priming) are supported, overall the trend is toward acceptance of parallel processing of information.

**Separating Words and Meaning**

Having discussed words, we now address meaning separately from the lexicon. You may envision this as a difficult task, because many meanings are best conveyed through language. However, let us reiterate that the two are not identical. Language may be heavily dependent on meaning (after all, words without meaning are called nonwords), but meaning is not as dependent on language. Let us draw a distinction
between signs and symbols: Consider animal communication. A honeybee, through its dance, communicates the meaning that there is honey in a given direction and a certain distance from the hive. A deer running through the woods with his tail up represents the deer’s belief that danger is nearby. Neither the honeybee nor the deer needs words to convey meaning. Likewise, nature provides its own instances of meaning without words. For example, bird tracks in the snow mean that birds have traveled that terrain; black clouds indicate that a storm is coming. These examples of meaning are often known as natural signs. Such signs have intrinsic meaning and can’t help but convey the meanings that they do. Words, however, do not achieve their meaning naturally. Even though we may now agree on the association between a word and its meaning, assignment of words to world objects (or events) had an arbitrary beginning. That is, we know of no reason why the first person to apply the word cat to a furry creature with four legs that catches mice should not have originally called it a “table” or “snowflake.” For this reason, words are known as symbols rather than signs.

Because of the separate but integral relations between words and meanings, the study of meaning is, in its own right, important to the study of words and language. We have already seen that much psychological evidence points to semantic meaning and semantic relatedness as major factors in word organization. Now we shall attempt to determine what features cause words, sentences, or larger linguistic units to mean what they do. Then we shall describe psychological theories of how meaning is stored in our minds.

Meaning

When we know the meaning of a word, what do we know? Take, for example, the term, bachelor. What does it mean to say, “Pierre is a bachelor”? We might easily respond that it means that Pierre is an unmarried male. Thus, “unmarried male” is the meaning of bachelor. But what about the Pope? Is he a bachelor, despite the fact that he has taken a vow never to get married? If we could modify our definition to include “eligible, unmarried male”, then the Pope is not a bachelor. What about a divorced man? He is eligible and unmarried, but we typically don’t think about people who have been married already (even though they no longer are) as bachelors. Social trends also complicate efforts to isolate the meaning of bachelor. Men and women may live together as partners without being married. Technically and legally, the men in these relationships are still eligible for marriage. But is it then accurate to portray them as bachelors? Isn’t it misleading to state, “Despite having a lifelong relationship with Simone de Beauvoir, Jean-Paul Sartre died a bachelor”?2

You may begin to get a sense of how difficult it is to define even straightforward concepts such as bachelor. Every time we think we have the ultimate definition, we

2 We are indebted to Robert Weisberg and Michael Tye for a discussion on defining features of bachelor that yielded many of our counterexamples.
can think of an example that the definition doesn't cover. Determining what constitutes meaning and formulating accurate definitions that cover all possible instances of a concept has been the difficult job of philosophers.

Before moving on to a philosophical and psychological analysis of meaning, an explanation may be useful about the association between words and concepts, and about the difference (and similarity) between concepts and categories. The meaning of a term is referred to as its intension. For example, there are two intensions of the concept chair—an object upon which we sit, and a person who heads a meeting or organization. The set of that to which a word applies is known as its extension. To continue our example, the extension of the first meaning of chair would be all the pieces of furniture you could point to and legitimately label "chair." This idea carries for the second meaning of chair—the extension of the term is all people who direct a meeting, organization, committee, or academic department.

One might think that the best route in establishing meaning is to start with the definition (or intension) of a concept and then pick out what in the world fits the definition. However, psychologists are interested in how people represent categories. And psychologists recognize that people may have categories that do not fit an exact definition. With this in mind, they often work backwards and gather information about how people extend terms in order to come up with a theory about the intension of concepts. Knowing how people apply concept words to objects can tell us about how they represent the meaning of concepts. For example, if it could be shown that people are quick to recognize apples, bananas, oranges, and pears as fruit, but not olives or cucumbers, we could look at what attributes that apples, bananas, oranges, and pears share that olives and cucumbers do not. This would yield a psychological theory of meaning (at least for the concept of fruit). Conversely, the theory could then be used to predict what other vegetative objects would be considered fruits by people. This is an illustration that one avenue to a theory of intension is to base it on research about extension. For example, if removing the back from a chair causes it to be labeled a "stool," but sawing off one of its legs does not, then we can assume that the characteristic "having a back" is critical to people's concept of chair, but "having four legs" is not.

Using evidence from extension to infer the intension of a concept is easy for categories such as kite: What do all specific objects known as kites have in common? However, adjectival concepts such as red will be more problematic. Red defines a perceptual characteristic that can apply to apples, Valentine's Day cards, blood, velvet cloth, and so forth. However, these are red objects that yield examples of red but do not define it.

Because philosophers were the first to start thinking about theories of meaning, we will begin our discussion with a presentation of the major philosophical accounts of meaning.

**Philosophical Theories of Meaning**

**Reference Theory.** If a friend asks you a question such as, "What is the meaning of the word house?" you might simply turn around and point to the nearest

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3 We do not want to argue that this is a viable way to develop a philosophical theory of meaning, however. It is only valid to ascertain people's psychological categories and criteria for those categories.
family-type dwelling. If so, you would be demonstrating a view that was prevalent in the early part of the century, known as the reference theory of meaning. This theory postulates that the meaning of a term is the object to which that term refers in the real world (that is, its referent). For example, the Liberty Bell and Abraham Lincoln point to or denote a specific object and person, respectively, whereas geraniums and firefighters point to or denote a class of things or people, respectively. Likewise, terms such as red, round, and ripening refer to actual properties of an object (or objects), such as a garden tomato. The theory thus draws a distinction between proper names that refer to a specific person or thing, category names that refer to a class of objects, and property names that refer to characteristics of objects or events.

If reference theory completely explained meaning, it would make the study of semantics rather concrete and easy: the meaning of a word is the object or property it denotes.

According to this view, terms that stand for the same object have the same meaning. Both the proper name Mick Jagger and the descriptions lead singer of the Rolling Stones and husband of model Jerry Hall point to or denote the same man. According to the reference view (as originally conceived), these two sets of words have identical meaning and we should be able to substitute one term for the other without changing the meaning of the sentence. Of course, the situation is not that easy. Mick Jagger is the lead singer of the Rolling Stones does not have the same meaning as Mick Jagger is the husband of model Jerry Hall, nor does it convey the same information as Mick Jagger is Mick Jagger. Thus, one problem with a strict reference view is that it does not explain how two terms can have the same referent (for example, the person Mick Jagger) and yet have different meanings (or “senses” in philosophical parlance).

Other problems arise with the reference view. For example, not all words name things—think of and, not, and or. Yet these words have meaning as used in ordinary speech: “Frank is going to the charity ball” means something different from “Frank is not going to the charity ball.” “At the charity ball, Frank danced on a table,” depicts an event other than “Frank danced under the table.”

A second objection to this theory is that we can talk about things for which no real “objects” exist in the world, such as freedom. Although we can picture signs and symbols of freedom, such as the Liberty Bell or a raised flag, those images are not really the “thing” denoted by the word freedom. We also discuss objects that we infer to exist (such as quarks or black holes) but for which no real objects may exist per se. Thomas Hobbes, an early proponent of the referent theory, claimed that all terms that refer to nonreal objects (such as angels) are meaningless (Hobbes, 1651/1968). According to such a view, any discussions we might have about Hamlet, or unicorns, or Athena—the Greek goddess of wisdom and arts—would of necessity be meaningless. It’s easy to agree with the King of Hearts in Alice’s Adventures in Wonderland, who exclaimed, “If there’s no meaning in it, . . . that saves a world of trouble, you know, as we needn’t try to find any. And yet I don’t know, . . . I seem to see some meaning in them after all” (Carroll, 1862/1990, p. 148). Clearly, we can discuss the fictional character of Hamlet (or unicorns or dragons) and communicate meaningfully with another person. And our conversational partner can comprehend our talk of “Hamlet,” or “unicorns,” even if these things don’t exist. Such problems with the reference theory led philosophers to posit alternative views.
**Ideational Theory.** One remedy is to claim that what words actually denote are ideas rather than objects. According to the British philosopher John Locke (1690/1967, p. 225), "Words in their primary and immediate significations stand for nothing but the ideas in the mind of him that uses them." Thus, the terms Hamlet and unicorn have meaning by virtue of our mental ideas about them, even if the objects themselves do not exist. This view is known as the **ideational theory of meaning.** Although it is a tempting alternative because it can take into account the imagined world, it is not itself without problems. If meaning is always in the head, how am I to know that we both mean the same thing when we use a hand gesture like waving or when we speak words or sentences? The ideational theory makes meaning—and the language used to convey meaning—private. Thus, we can never be entirely certain that other people correctly interpret our meanings, nor that we correctly interpret theirs. Language, after all, is often a public endeavor, and as in the examples of signs cited earlier in this chapter, some meanings are found in the real world, not just in one's head.

**Alternative Theories: Meaning Is in the Public Domain**

Both reference and ideational theories of meaning have been criticized for treating all meaningful terms and expressions as names. What of other words besides those that refer to properties or nouns, such as words that have meaning because of their role or function within language (for example, *not, the, a, and, because*)? Perhaps then, the meaning of names and properties derives from their participation in language as well. What gives words their meaning is often how they are used in conjunction with other words in the language.

This view is supported by philosophers such as Quine (1960), who postulated that the meaning of individual words can never be strictly derived. In his view, words, and even sentences, have no meaning independently, but are based on their connection to other words and sentences within the language. Another philosopher, Wittgenstein (1953), helped bridge philosophy and psychology in the study of semantics by claiming that meaning should be determined by how language terms are used by ordinary speakers. All competent speakers are assumed to use words in the same way. This concept is known as **conventionality,** the tendency for linguistic usage to be agreed upon by members of a community. Quine's and Wittgenstein's views have become influential in current psychological theorizing about semantics, as we shall see.

The reference and ideational theories have intrinsic appeal because we tend to think of the meaning of terms as objects or concepts we can point to or describe. Both, however, have their failings. Any philosophical theory of meaning must ultimately account for how word meanings are interconnected within a larger semantic and linguistic theory. For this reason, philosophers need psychologists, and vice versa, for adequate theorizing. Both armchair and empirical experiments are necessary.

As we did with words, let's now look at the building blocks (or primitives) of meaning, principles of meaning, and finally theoretical models that describe how concepts and meaning may be organized cognitively.
Conceptual Primitives

Three major issues address the study of meaning. The first is what are the smallest units (or primitives) of meaning? The study of the “building blocks” of concepts parallels exploration of the primitives of words. Recall that morphemes are considered the primitives of words, as complex words can be composed of several individual morphemes. The same is true of concepts and conceptual primitives, referred to as features. Just as we know that hopeful is made up of the word parts, hope + ful, we realize that the concept even number has the featural definition of “divisible by 2.”

The second issue is whether concepts have clear boundaries or not, so that, for example, it is evident what counts as a cup and what does not. This issue will be most important when comparing two main types of feature theories discussed later in this chapter—the classical view and the family resemblance view.

The third question asks whether it is sufficient to represent a category as a list of features. This issue has a parallel in the word primitives discussion: Just as we have knowledge of individual morphemes, we also have knowledge of which morphemes can be combined and which cannot. For instance, the morphemes dis- and agree can go together, but un- and agree cannot. Likewise, we can have knowledge of which features tend to co-occur within a concept. Most people realize that “has antennae” and “flies” are more likely to go together than are “has antennae” and “hibernates.” Furthermore, people often have a greater ability to explain why conceptual features co-occur than why word primitives can co-occur (the exception would be scholars with a background in word etymology who know the Latin, Greek, and Germanic origins of contemporary words).

These issues, summarized in Table 4.1, will become clearer as we portray the differences between various feature theories. Let us first examine the feature theories and then discuss why meaning is represented in a more full-bodied way than feature theories claim.

Feature Theories

Feature theories hold that concepts can be defined by the prevalent attributes within a category. As in the morpheme-as-word-primitive view, most researchers believe in a decompositional view of meaning such that concepts are composed of bundles of smaller units called features. Thus, the meaning of tree is composed of attributes such as “having branches,” “grew from tree seeds,” “has leaves or needles,” “has roots,” and so on. Some characteristics that count as features can be designated as either perceptual (for example, “gray, large,” like an elephant), functional (“used to

1. What are the smallest units of meaning?
2. Are concepts defined in a rule-like fashion, with clear conceptual boundaries?
3. Is it sufficient to represent a concept as a list of features?

| TABLE 4.1 |
| Questions About Meaning: Conceptual Theories |

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transport people,” of vehicles), microstructural (“composed of hydrogen and oxygen molecules,” of water) (Malt, 1990), or societal/conventional (“supreme ruler,” of a king or queen). Features can also be considered meaningful units themselves (for example, “red” could be both a feature of blood and a concept itself), just as morphemes can be both meaningful units by themselves and the primitives of words. Several variations of these theories have developed (see below), but the emphasis on features has permeated most thinking on categories during the past 30 years.

Variations of Feature Theories

Although most philosophers and psychologists agree that concepts are themselves composites of features that serve to define each concept, there are disagreements about what features are necessary in defining each concept, and about the structure of meaning in the mind. Among the multiple theories of concepts and categorization (see Smith & Medin, 1981, for a thorough review), two main approaches are the classical view and Eleanor Rosch’s family resemblance theory. In addition, because of perceived inadequacies of the classical and family resemblance views, there has developed a new class of theories that are less feature based and argue that we know more about concepts than what features are associated with them. According to this new breed of theory, we typically have additional higher-order information that causes us to weigh some features more than others, to know which features tend to co-occur (for example, laying eggs and having feathers). This new approach falls under knowledge-based theories of conceptual coherence.

Despite widespread agreement on a featural account of meaning, philosophers and psychologists diverge in their belief of what a theory of meaning must explain. Most philosophers are interested in determining what constitutes the essence of a concept. That is, what features distinguish one concept from another and what conditions must be met for an object to be considered an instance of that concept. Thus, any definition of a concept must be true in all possible circumstances and in all possible cases. Psychologists, on the other hand, are more interested in explaining how humans represent meaning in the mind and how they use and apply meaningful concepts. This has sometimes led to differences in the bases of philosophical and psychological theories of meaning, although philosophers and psychologists have begun to cooperate and to influence each other’s views on meanings, as we shall see.

The Classical View. Let us start with the following task: On a piece of paper, list all the attributes that a geometric figure must have to be considered a triangle.

Considering the features of a triangle is an excellent way to illustrate the classical view of categories. It states that any concept has necessary and jointly sufficient features that all instances of that concept share. All triangles, for example, (1) are closed figures, (2) have three sides, and (3) have angles that add up to 180 degrees. They must have these three features to be triangles (thus these features are singly necessary for something to be a triangle), and all objects that have all three features must be triangles (thus the three features listed above are jointly sufficient for considering something to be a triangle).
Beyond the existence of necessary features for each concept, the classical view makes some other strong claims. By way of example, all triangles are considered to be equally good triangles; no figure is considered to be a better instance of the concept triangle than any other. Thus, equilateral triangles are no better triangles than nonequilateral triangles because they all fulfill the necessary and sufficient conditions. Some figures, such as equilateral triangles, may be more common in a person’s experience, and equal sides plus equal angles may be more characteristic of triangles, but this does not make them better triangles than others without these features. The distinction between necessary (or defining) and characteristic features is an important one, especially if we want to talk about how people process concepts.

Thus, proponents of the classical view consider features the smallest units of meaning. They also contend that concepts are defined in a rulelike fashion, with clear boundaries. The classical view states that concepts have definitely discrete boundaries; an item either has the necessary and sufficient features or it does not. If so, it is an instance of the concept; if not, it is not an instance of the concept. The classical view also postulates that a list of the necessary and jointly sufficient features adequately represents the meaning of a concept. This list can be used to determine category membership of new exemplars one encounters. Something is a triangle if it meets the criteria for being a triangle.

The classical view dates back at least to Aristotle, and is still the prevalent view held by many philosophers (see Katz & Podor, 1963) and some psychologists (for example, Glass & Holyoak, 1975). It has, however, been challenged by Wittgenstein (1953) and his supporters, and by the empirical data that seem to suggest that people do not use necessary and sufficient features in categorization tasks (Rosch, 1975).

The Family Resemblance View. Now try the following task: Take a minute to list (1) as many different birds as you can; and then (2) all characteristics or properties of the concept bird that come to mind.

Did bird names such as robins, sparrows, crows, bluejays pop into your head as you thought of all the members of the bird category? Do odd birds such as penguins, flamingos, and toucans appear toward the end of your list? If so, you are like most other people who participate in this task (Battig & Montague, 1969). Sometimes people even include bats, which are not birds at all but are birdlike in certain ways. Did your property list include features and attributes such as “can fly,” “lays eggs,” “has feathers,” “builds nests,” “is small,” “has bones,” “has skin,” among others?

Now reexamine your list of bird features and check off the characteristics a bird must have in order to be considered a bird. Did you think it was necessary for birds to fly to fit the concept of bird? But ostriches and penguins don’t fly. What about the feature of having feathers? Yet we refer to the Thanksgiving turkey on our table in November as a bird. Newly hatched chicks are also birds. You may have thought both

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*One reason that philosophers have traditionally sided with the classical view and psychologists with the prototype view is a difference in academic missions. Philosophers are interested in the essence by which something gets its meaning, psychologists in how people use and store representations of meaning. Thus, both views may be correct—concepts may have necessary and sufficient conditions, but people may focus only on characteristic features.
flight and feathers were mandatory in order to be considered a bird. However, features that we definitely consider birds don't fit these conditions. Looking at your list of kinds of birds, it certainly appears characteristic, but not mandatory for birds to fly and lay eggs. Your lists of birds and bird attributes seem different from your list of criteria for what constitutes a triangle.

Many psychologists (for example, Lakoff, 1987; Rosch, 1973) consider the world, at least the world as represented in our minds, less clear-cut than the classical view of meaning would have us believe. If you listed all the features of all the birds on your list, there would be no, or few, features common to all instances of the concept bird. This, argues Rosch (1973, 1975; Rosch & Mervis, 1975), demonstrates the absence of necessary and sufficient conditions for bird and, indeed, for any natural concept. Instead, the emphasis is on characteristic features—attributes common to many exemplars of a category (as "having feathers" is true of almost all birds). Other features may be associated with a category (for example, "5-feet tall" with bird because ostriches have this attribute), even if they are not common. In Rosch's view, all attribute information would be stored within the meaning of a concept, but the features would be weighted according to their frequency within the category. The family resemblance view also emphasizes attributes easily accessible to people when they make category judgments. These most often are perceptual features (for example, "has feathers") and readily available facts (for example, "lays eggs").

Rosch's theory is based on the philosophical position of Wittgenstein (1953). Wittgenstein's most famous example of a concept with no defining or sufficient features is that of the concept game. The word game is applied to a variety of instances, from board games to soccer games to war games. Not every instance of a game shares a single feature or set of features. For example, you can think of counterexamples to every possible criterion of the concept game. Not all games are played on boards (for example, tennis), nor involve two or more people (for example, solitaire), nor are all games competitive (for example, ring-around-the-rosie). If you were to list all features of games, you could not find a set of necessary and sufficient features that defined all games but excluded all nongames.

This brings us to the second premise of the theory—from which the theory derives its name—that of family resemblance (Rosch, 1973, 1975; Rosch & Mervis, 1975). Rather than share a set of necessary and sufficient conditions, instances of a concept may overlap in some traits but not in others. A single term, such as game, refers to objects that resemble each other in the same way that members of a family resemble each other. You may have your mother's eyes, your father's mouth, and ears like your uncle and thus resemble each of them without them resembling each other. Figure 4.7, you can see that the Smith brothers resemble each other even though no two brothers share a set of common features.

This claim was supported in an experiment by Rosch and Mervis (1975). They asked subjects to list all the attributes of twenty kinds of fruits and found no features common to all (as Wittgenstein would have predicted). For example, apples and oranges share a round shape, but bananas do not. Grapes and plums are both purple, but apples and watermelons are not. Cherries and grapes are the same size, which differs from the large size of a watermelon. You can see that the attributes of a single fruit
can overlap with those of many other fruits without sharing a single set of features with each and every fruit.

A third tenet of the family resemblance view is that some instances of a category or concept are more representative than others. Categories are said to have a **graded structure**—some birds would appear on most everyone’s lists (for example, robin, sparrow); others on few people’s lists (for example, ibis), and some might be considered “intermediate” birds (for example, eagle, chicken, vulture). The best example of a concept or category is known as the **prototype**. Exemplars that have the most characteristic features for the category are also considered more prototypical. Rosch and Mervis (1975) found that the five most prototypical items of a category (for example, pants, shirt, dress, skirt, and jacket in the clothing category) had more features in common than did the five most peripheral members (hat, apron, purse, wristwatch, necklace). Furthermore, the most peripheral items of a category are apt to share features with other related categories. If we consider jewelry a close affiliate of the concept clothing we can see that two of the most peripheral members of clothing—wristwatch and necklace—can also be considered jewelry. This leads us to another tenet of the family resemblance theory—that of **fuzzy boundaries** (Lakoff, 1987). Some instances of one category can overlap significantly with other categories, in the way that tomatoes, cucumbers, and olives are all **fruit** concepts that seem to be equally well qualified for vegetable status.

An experiment by Armstrong, Gleitman, and Gleitman (Experiment 1, 1983) illustrates that many categories have a graded structure, where some exemplars are
considered more typical of the category than others. And although we might expect a graded structure to be true of concepts such as *fruit* and *clothing*, we would not expect it of hard and fast categories that are better explained by the classical view. *Odd number* and *female*, for instance, are concepts that seem to have necessary and sufficient features by which they are defined.

Armstrong et al. asked people to rate category exemplars on a 1 (Best) to 7 (Worst) scale of how well each item represented the category. Not surprisingly, *apple* got a rating of 1, whereas *olive* received a 6.5 rating. The surprise came in the ratings for exemplars of the well-defined categories: *13* was declared to be a better *odd number* than was *57!* And a *square* was rated more highly as a *plane geometry* figure than was an *ellipse*. The researchers thus found a graded structure to even well-defined categories (such as *odd number*) that do have necessary and sufficient features according to mathematicians. After all, any integer that, when divided by two, yields a remainder of one must be an odd number. To confirm the findings of the rating experiment, Armstrong, Gleitman, and Gleitman then asked subjects to engage in a **semantic verification task** in which participants read a statement about category membership and decide whether the statement is true or false. “A canary is a bird,” is a true semantic verification statement; “A boot is a bird,” is false. What is of interest is how quickly people respond to the true statements. Many studies have found, for example, that subjects are quicker to respond to prototypical items of a category (for example, “An apple is a fruit”) than to peripheral items (for example, “A tomato is a fruit”) (Rips, Shoben, & Smith, 1973). Again, even for well-defined categories, a graded structure was evident: “13 is an odd number” led to faster response times than “57 is an odd number”; and “A mother is a female,” was verified more quickly than “A waitress is a female.” Thus, people may represent even concepts with necessary and jointly sufficient features in a family resemblance way.

A further claim of this theory is that the prototype of a concept is used as a reference point to make category judgments (Rosch, 1975). If a new exemplar is similar enough to the prototype for that category, the new item will also be accepted. If you had never seen a flamingo before, you might still determine that it was a bird because it overlaps in a significant number of features with a robin (the prototype of the category *bird*).

We can now return to our three initial issues to discern how the prototype theory differs from the classical view. Both the classical and prototype views agree on the answer to the first question—that the primitive building blocks of concepts are features. However, the two disagree on the answer to the second question, about whether concepts are structured based on rules and whether conceptual boundaries are well defined. Whereas the classical view argues for strict boundaries and concepts defined by necessary and sufficient features, the prototype view states that emphasis on characteristic features makes concept boundaries fuzzy. Concepts are graded as to typicality within a category. On the third issue, the family resemblance view claims that a list of the most characteristic features of a category is sufficient to represent the meaning of the concept.

Thus far, then, we have discussed two theories of concept structure and category organization. Common to each of these approaches is the claim that features are central to the definition of concepts. To represent the units of meaning, we must first abstract the relevant bundles of features. Concepts are judged as similar to one another
to the extent that they share the same features, and categories are formed from sets of similar concepts.

**Knowledge-Based Approaches**

The classical and family resemblance theories have provided impetus to research in concepts and categorization for the past 15 years. Recently, however, the very foundation of these views has been shaken by certain problems they cannot adequately address. Led largely by Medin and his colleagues (Murphy & Medin, 1985; Medin & Wattenmaker, 1987; Medin, 1989), a revolution is underway in our understanding of the nature of concepts. A knowledge-based approach emphasizes that categorization and knowledge of concepts is based on something deeper than perceptual features. It seeks to explain how and why individual items get grouped together under a category label. To gain some appreciation for this new movement in the field, it is important to first provide some criticism of the feature view and then to demonstrate how our inherent general knowledge about biology and our environment may supplement the feature approaches in explaining our conceptual judgments.

Several arguments make clear the problems with feature theories. The first, addressed by philosophers and psychologists alike, concerns the question, “What counts as a feature?” The most parsimonious explanation of concepts for the feature theorist would be that humans are equipped with a kind of finite alphabet of conceptual features that combine in any number of ways to yield all of the concepts that we could conceivably think about. Unfortunately, however, no such alphabet of meaning primitives has been discovered. Take the bachelor example as a case in point. Above it was suggested that bachelor can be decomposed into more primitive concepts unmarried and man. Is unmarried a primitive? Do we help the situation greatly by saying that unmarried can be decomposed into not and married? Where do we go from here? The problem of basic feature analysis becomes one of infinite regress.

A second problem that arises for the feature theorists is evident in the question, “Which of the available features should be chosen when representing a concept?” As with lexical access, conceptual judgments often depend on the type of task a subject participates in, and on the context in which an item is presented. For example, Barsalou (1982, 1987) argued that certain features and types of information about concepts may be differentially available depending upon the presentation context. We may not consider “floats” as a feature of the concept basketball unless we are told someone used a basketball as a life preserver. Likewise, subjects presented with the sentence, “The man lifted the heavy piano,” were likely to respond more quickly “piano–heavy” in a lexical decision task than those presented with “The man tuned the piano” (Barclay, Bransford, Franks, McCarrel, & Nitsch, 1974). You can see some of the problems if you take just a moment to jot down all of the features that you can think of for the category vegetable. Were the characteristics “green, grows in my garden,” and “put into salad” among your choices? These are excellent choices if your category of comparison is furniture. They are, however, less desirable choices if the comparison category is fruit, for apples can be green, and tomatoes can be put into salad, and cucumbers grow in your garden, and these are all fruits. The context of comparison in this task alters the features that we choose as representative of a particular concept.
The issues of task and context dependency also arise in a third example that damages the reputation of feature theories. In fact, you are already equipped with the relevant data. In the experiment mentioned earlier by Armstrong, Gleitman, and Gleitman (1983), subjects were willing to claim that 13 was a prototypical odd number and that mothers were "better" females than were comedienes. As Armstrong et al. (1983) pointed out, it may be necessary to make a distinction between their subjects' willingness to rate the characteristic quality of exemplars (like the numbers 13 or 57) and subjects' knowledge of a categorical description that defines a category. For example, mothers might be rated as more prototypical females, but if probed, almost all adult categorizers would claim that femaleness was based on specific genetic and anatomical features, not one's social role.

Finally, to borrow yet one more example, from Barsalou and Medin (1986), see if you can determine what features the following examples share: children, jewelry, portable television sets, photograph albums, manuscripts, and oil paintings. Did you say, "None"? They certainly don't share any obvious or perceptual features. And without sharing features, these concepts should not form a coherent category. Yet, when placed in the context, "things to take out of the home during a fire," they cohere quite naturally—with no featural similarities at all.

These examples point out the hazards of basing concept meaning upon feature lists, whether those feature lists contain necessary and sufficient attributes or merely characteristic features. First, features themselves are not well specified. Second, the choice and weighting of features is context- and task-dependent. And third (and perhaps most importantly), we know much more about the intension of a concept than a list of features suggests. We often know why a concept is associated with some features and not with others (for example, why birds have "wings," but not "wheels").

These concerns about features, and hence about feature theories, have led to the revolutionary idea that concepts must be represented and organized according to peoples' theories about the world. A theory is the underlying explanation for why bundles of features hang together, and allows us to make predictions about which features should co-occur and which should not. For instance, having gray hair may be characteristic of grandmothers without it being a defining feature. In order to be a grandmother, one must be the mother of a man or woman who has children of his or her own. Gray hair may be associated with grandmothers because as our children get old enough to reproduce, mothers age and as a result often develop gray hair. Features are merely the surface cues of more complex theoretical information about categories.

This shift in perspective, from feature theories to knowledge-based or theory-based theories, sets a new agenda for those studying conceptual coherence and category organization. What counts as a "theory" about a concept? How fully formed must our theories be before we can abstract the relevant features? Is there a time in development when we rely more crucially on the surface properties of objects only later to rely on the deeper theoretical relations behind these surface cues? While these questions are being hotly debated, two types of theories are being discussed in the literature: psychological essentialism and what we will call psychological contextualism. Let us briefly review each now.

**Psychological Essentialism.** Psychological essentialism is the position advocated by Medin (Medin & Ortony, 1989; Murphy & Medin, 1985) that "people act as
if things (for example, objects) have essences or underlying natures that make them the thing that they are" (Medin, 1989, p. 1476). It seems that people want to have a reason or an explanation for the ways they categorize the world. We want a reason why birds have wings, live in trees, and have beaks. For example, they are genetically endowed with a means for flying away from their predators. Indeed, even if people don't know the theory behind the features, they are committed to the notion that such a theory or essence exists and that it is discoverable (at least by scientists). Thus, people have a way of making sense out of the collection of features that they see and of using these features when they encounter them again as signposts for the theory.

To demonstrate the theory versus feature divide here, Medin and Shoben (1988) conducted an experiment in which they asked subjects to judge which terms were more similar: white hair and gray hair, or white clouds and gray clouds. The subjects claimed, despite the similarity in features across the two conditions, that white and gray hair were more similar—a finding that the authors interpret to be a consequence of a theory of aging. In short, then, overlapping characteristics are not as important as the underlying principles that cause those perceptual characteristics.

This position on psychological essentialism is actually derived from work by philosophers such as Quine (1977), Putnam (1973, 1975), and J. S. Mill (1843), who argue that extension labels are applied according to essential features, even if those features are not readily apparent. Someone may call a tomato a vegetable only until he is reminded that it is a fruit. To use one of Putnam's famous examples (Putnam, 1973, 1975), people may believe that gold has a particular microstructure by virtue of which it is gold. Any substance that is not known to have that structure (for example, brass) will not be called gold. It is not that people necessarily know what the microstructure of gold is; they rely on scientific experts to know that. It is enough to know that the microstructure is an essential feature. If the family resemblance view were entirely true, pirates who received 100 brass bars in exchange for a shipload of goods should have been just as happy as those who received 100 bars of gold—after all, they look the same! The belief in essential properties acts as a theory by which people label and categorize items, and these theories constrain and have causal links to more superficial or characteristic properties. That is, the characteristic yellow color of gold is dictated by its molecular structure. The molecular structure both defines the concept gold, and is the basis for the characteristic features associated with it (for example, its color, ability to be forged, and so on).

Much of the research on psychological essentialism comes from the developmental literature (Keil, 1989; Carey, 1985; Gelman & Markman, 1986, 1987; Murphy & Medin, 1985; Gelman & Coley, 1991). To illustrate the force of psychological essentialism, let's engage in another thought experiment paraphrased from work by Keil (1989). Think of all the features associated with raccoon. Now consider an actual raccoon; if I dye its fur so that it is black with a white stripe down its back, is it still a raccoon, or has it become a skunk? What if I sew a smelly sack inside it and teach it to spray the contents of the sack during times of danger? Has it remained a raccoon? Now let's change our creature so that it no longer washes its food before it eats. At what point is the creature no longer a raccoon but something else, such as a skunk? You might argue that it is a raccoon until you change its DNA or the fact that it was born of raccoon parents. If so, you would be arguing in favor of essential features that occur in any instance of a concept that necessarily define that concept.
Keil (1987, 1989) actually posed the raccoon experiment to children. Although kindergartners (ages 5–6) were apt to rely on surface characteristics for making category assignments (as the family resemblance view predicts), by ages 8–10, children realized that essential biological features might determine skunkhood versus raccoonhood (as the psychological essentialist theory predicts). Keil argued that the results confirm evidence about conceptual development suggesting that from an early age children have theories. Very young children (kindergartners and younger) may know too little about DNA and genetic endowments, and are thus more likely to say that the deformed raccoon we discussed above was no longer a raccoon when all its characteristic features were changed (Keil, 1987, 1989). However, once this information is acquired, children develop a theory about a given domain (for example, animals). As a result, knowledge of the meaning of a concept shifts from knowing the most characteristic features of a category to having a general theory about why certain attributes occur. The theoretical reasons then predominate over features in making categorization judgments.

A belief in biological essence may prove to be a guiding factor in defining what Keil called natural kind terms, things found naturally in the world, like animals. In contrast, with nominal terms (also known as artifacts), which refer to objects invented by humans (for example, vehicles, furniture), a different picture emerges. Using a story analogous to the raccoon story, Keil tells children that a coffee pot is melted down and turned into a bird-feeder. In this example, the material of the two artifacts remains the same; what changes are both the shape and the function of the object. In this example, children of all ages (even as young as 5 years) were willing to accept that the coffee pot had now turned into a bird-feeder. Whereas the essence of biological categories will be genetic and anatomical; the essence of artifactual categories may be the function for which the object was designed—change the purpose or use, and you change the category.

In summary, then, psychological essentialism is the modern extension of feature theories. Features are embedded within richer mental constructs—theories—that organize meaning. Concepts are thus represented at many levels in the system, as correlated bundles of features and through an internal essence or theory of which these features are a part. Theories constrain the features; features do not construct the theories.

The work on psychological essentialism is largely being conducted with special attention to natural kind terms (Gelman & Coley, 1991), naive theories of biology, and naive theories of physics. One other class of theories is also gaining attention. These knowledge-based theories, what we have termed psychological contextualism, also go beyond individual feature analysis to ask how the context in which we find objects and events influences our meaning representations of those objects and events.

**Psychological Contextualism.** Psychological contextualism refers to the idea that certain contexts, either defined by goal or by culture, can provide the bond between features in a concept and concepts in a category. Several examples will illustrate this position. In the first, Labov (1973) presented subjects with pictures of cups (for example, teacups) and bowls, with some of the instances appearing to be part cup, part bowl—for example, wide like a bowl but with a handle. People categorized one of
these hybrid objects as a cup if it was said to contain tea; a bowl if it was said to contain soup. Contextual knowledge influenced categorization. A second example is Barsalou's previously mentioned "things to take out of a burning house." Barsalou's point is that the objects in the collection—children, portable television sets, and jewelry—do not cohere into a group until some contextual goal links them. All concepts have both a set of context-independent features (for example, "bounces" and "round" for basketball) that are inextricably linked to the object, and a set of context-dependent features (for example "floats" for basketball) that can be called upon as needed. We rely on our knowledge of goals and past events to link these unusual features into a concept and the unusual set of concepts into a category. Hence, higher-order knowledge constrains the features that we choose and yokes them together with an underlying purpose (as in the burning-house example).

Just as contextual goals and memory serve as the knowledge base upon which conceptual relations are formed, so too can cultural goals. In a now classically cited example by Lakoff (1987), the Dyirbal language spoken in parts of Australia treats women, fire, and dangerous things as a coherent category, each preceded in the language by a unitary marker balan. The category appears to be based on elaborate associations among concepts, for example, birds also fit in the category balam because they are thought to be the spirits of dead human females. Although this categorization makes little sense to the Western mind, at least one writer, Dixon (1986) demonstrates that underlying this classification system there is a principled, though culturally constructed, way to classify things. (See Lakoff, 1987, pp. 92–102, for the anthropological hypotheses as to why these members are related.)

These last three examples highlight the enormous flexibility and complexity inherent in the human conceptual system. They also demonstrate how our overall knowledge base interacts with conceptual features to create any number of viable categorization systems, from the biological to the sociological. To refer back to our initial questions in Table 4.1, the two knowledge-based theories claim that concepts have relevant features, but that these features do not define the category. As to question 2, Barsalou and Lakoff emphatically deny that concepts are defined in a rulelike way, with clear conceptual boundaries. Rather, concepts are constructed as needed for different contexts or goals (in Barsalou's theory), or on the basis of cultural criteria that may or may not be immediately evident (in Lakoff's theory). Both knowledge-based theories claim that a list of features is insufficient to represent an entire concept. Both psychological contextualism and psychological essentialism are committed to the view that deeper knowledge about conceptual coherence is necessary to make accurate and adult-level categorizations.

What we have seen in these newer versions of conceptual theory is a shift away from the more surface view that concepts are defined by independent bundles of features. In its place, the newer theories suggest that correlated sets of features that we observe in concepts are the product of our underlying knowledge and theories. By way

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5 Classifying the conceptual theories of Barsalou (1989) and Lakoff (1987) together under the heading of psychological contextualism blues some essential distinctions between them. However, at the most general level, both of these theories demonstrate the ways in which contextual knowledge influences our construction of categories.
of example, psychological essentialism, particularly from the research on natural kind concepts, demonstrates how biological theories can form the basis for some of our conceptual knowledge. As Chiselin (1969, p. 83) summarizes, "Instead of finding patterns in nature and deciding that because of their conspicuousness they seem important, we discover the underlying mechanisms that impose order on natural phenomena. . . then derive the structure of our classification systems for this understanding" (in Gelman & Coley, 1991).

Summary. Summarizing the theories presented in this section, we find two broad classes of theories of conceptual structure. Some are feature-based approaches (for example, the classical view and family resemblance view) in which the features provide the basis of the theory of meaning. An alternate position is stated by theory-or knowledge-based approaches (psychological essentialism and psychological contextualism) in which features play a more ancillary role. In the former case, features are defining of the concept—a woman with gray hair, a twinkle in her eye, and pushing a baby stroller has a high probability of being a grandmother. In the knowledge-based approaches, perceptual or other salient features do not define concepts. A gray-haired woman pushing a stroller could only be a grandmother if she had given birth to a child who then grew to have a child.

As we noticed with the study of word primitives, concepts can sometimes be defined by feature primitives. However, this does not give a full picture of our mental representation of concepts. Just as the cognitive system dictates that some morphemic words are represented without a further breakdown, our knowledge of complex concepts will consist both of correlations of features, and the reasons for those correlations.

Whichever view we adopt, one point is clear from this discussion: If we are to understand conceptual structure, we must understand more than the concept alone. We must understand the relationship between concepts and how they are organized—into models (in the feature-based views) and into theories (in theory-based views). It is to the question of conceptual organization that we now turn.

Conceptual Organization

How are our concepts organized? Most of the models that we are about to look at use features as their building blocks, in part because they all preceded the more contemporary theory- and knowledge-based theories. Thus, we will only discuss the classical findings to give you the flavor of this literature. Chang (1986) provides a more thorough analysis of theories of semantic memory and their relative success in explaining the data. The most common methods of study have been semantic verification and semantic priming tasks. The models of semantic organization we will discuss are largely based on the findings of such experiments.

Models of Semantic Representation

Hierarchical Network Model. The first cognitive model of semantic representation, by Collins and Quillian, appeared in 1969. An illustration of their
approach to semantic representation appears in Figure 4.8. Individual concepts such as *animal* and *fish* are represented as "nodes," with the properties specific to each concept stored at the same level and connections between associated concepts. This **hierarchical network model** proposed that concepts are organized in our minds as "pyramids" of concepts, with broader, superordinate concepts (such as *animal*) at the top of the pyramid, and more specific, subordinate concepts (for example, *chihuahua*) at the bottom (Collins & Quillian, 1969, 1970, 1972). In the middle are basic level categories (such as *bird*, *dog*, *elephant*, and *fish*).

One important aspect of the model in Figure 4.8 is its emphasis on cognitive economy, a concept we have already introduced. Obviously, any member of a superordinate category such as *animal* will have all the features attributed to *animal*, plus its own features. However, in Collins and Quillian's semantic network, the features would only be stored at the higher-level concept in order to save space. For example, both birds and fish, by virtue of being animals, have all the features attributed to animals—having skin, being able to move, eat, and breathe. However, you do not see these features duplicated at the *bird* and *fish* nodes, because this would violate the concept of cognitive economy. In a now classic experiment, Collins and Quillian (1969) presented subjects with one of two types of semantic verification tasks. In the first, subjects were asked to judge category membership with statements such as, "A canary is a bird," or, "A canary is an animal." In the second, subjects were asked to

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**Figure 4.8**

Example of a hierarchically organized memory structure.

judge feature attributes of given concepts in property verification statements such as, "An ostrich has skin," or "An ostrich has feathers." To which of the two sentences in these experiments do you think subjects would respond more quickly (have a lower reaction time)? Why? What would the hierarchical network model predict?

Collins and Quillian were interested in judging "semantic distance effects." That is, looking at Figure 4.8 again, canary is further away from animals than it is from birds. Thus, according to the model, A canary is an animal should take longer to verify than A canary is a bird because in the former, two nodes must be traversed instead of just one. Property verification statements require us to go to the appropriate node before we can retrieve the features at that level. As with category statements, the number of nodes that must be traversed to determine feature attributes will determine reaction times. To verify An ostrich has skin, one must traverse two nodes up (birds, animals), and then note that has skin is an attribute of animals. To verify An ostrich has feathers, one only need go up one node to birds and note the features there. It should thus take longer to verify that an ostrich has skin than that it has feathers. It should also take longer to verify features than to verify category membership because not only must one move from node to node, but one must also retrieve features stored at that node. All these assumptions were found to be the case across numerous experiments (Collins & Quillian, 1969, 1970): The further the semantic distance between two concepts, the longer the reaction times in the semantic verification tasks. Additionally, property verification statements require longer time than category membership statements.

A second finding of interest in these experiments was the category size effect. That is, the larger the category, the longer time required for search. For example, because the concept animal embodies all instances of birds, as well as all instances of fish, dogs, horses, and so forth, it is of necessity a larger category than any of its member categories. Presumably, larger categories force us to muddle through more information before retrieving the relevant facts.

Several logical and empirical criticisms of the hierarchical network model of conceptual organization were responsible for modifying experimenters' views and for the creation of subsequent semantic network models that could better explain the data. One problem with the hierarchical network model is that it is too hierarchical and may only work for taxonomic categories such as animals, dwellings, furniture, and so forth, but not for more abstract concepts such as virtue, good, and emotion.

An important study by Conrad (1972) revealed other empirical and theoretical criticisms of the hierarchical network view. Conrad found that semantic distance effects were confounded by frequency effects of features. For example, subjects list the feature, "moves," as a feature of animals more frequently than "has ears," even though both are assumed to be stored at the animals node. Likewise, Conrad argued that the semantic distance effects found by Collins and Quillian (1969) need not be explained by semantic distance at all but by the strength of association between two concepts or between a concept and a feature. For example, "sings" may be verified as a property of canary more rapidly than "has skin" because singing is more frequently associated with canary.

Rips, Shoben, and Smith (1973; also Rosch, 1973) note that the hierarchical network model treats all members of a category as equal members of that category. Yet it
seems clear that a German shepherd is a better instance of dog than is a chihuahua; a collie a more typical member than an afghan hound. Rips et al. (1973) argued that more typical members of a category should be verified more quickly than less typical members in semantic verification tasks. They did indeed find typicality effects, which were reflected in the reaction times of subjects who performed semantic verification tasks.

A third criticism of the hierarchical network theory is that it cannot account for reverse category size effects that turned up later (Smith, Shoben, & Rips, 1974). In some cases, subjects take longer to verify that an item is an instance of a superordinate category than it does to verify that it is an instance of a lower-level category. For example, subjects took less time to respond to, “A chimpanzee is a primate,” than it did to, “A chimpanzee is an animal,” even though animal would be stored at a higher category level than primate (Smith et al., 1974).

Problems with the hierarchical network model led some to postulate other models that had more explanatory power than a strict hierarchy could provide. The next major model to be developed was that of Smith, Shoben, and Rips (1974).

**Feature Comparison Model.** Smith et al. (1974) also took a feature-oriented view of meaning. Instead of nodes, however, they postulated that concepts are represented as lists of features of two types, both (1) defining features, which are critical for inclusion in a category, and (2) characteristic features, which members of a category usually but do not necessarily have. For example, it is a defining feature of a professor to have an academic appointment, and characteristic but not necessary that the professor wear tweed. Likewise, it is necessary for birds to have skin and bones but not that they fly (think of chickens and penguins). In contrast to the hierarchical network theory, all features are assumed to be stored under all relevant concepts. Although this violates the assumption of cognitive economy, it makes the feature comparison model better able to account for some of the empirical findings.

According to Smith et al. (1974), semantic verification tasks are performed by comparing the number of overlapping features of two or more concepts. Feature comparison in semantic decision tasks is assumed to be a two-stage process. In the first stage, all the features—defining and characteristic—of two concepts are compared in a global comparison. A sufficient level of similarity produces a “yes” response. If the degree of similarity is too close to call, a second comparison step is instituted in which only the defining features of the two concepts are compared. Thus, this second stage would be slower and more evaluative than the first more global comparison. For example, refer to Figure 4.9 to see how a robin would be verified as a category member of bird, relative to how it would be verified in the hierarchical network model.

Because comparisons are based on similarity rather than category size, the feature comparison model can account for both category size effects and reverse category effects because its predictions are based on number of overlapping features between two concepts rather than distance. The model also predicts semantic distance effects; collie should be classified as a dog more quickly than an animal because more features overlap with the concept dog. The effects of typicality can also be explained: more typical members of a category would be verified more quickly because the number of overlapping features would be larger than for less typical members. For
example, the concept of *robin* should share more features with *bird* than does *flamingo*.

Feature comparison theory is not without its share of problems. Most critical is an issue with which you are already familiar—whether or not there really are defining features of concepts. It is not always clear how humans rely on defining features (for example, "lays eggs" for *birds*) to make category judgments, and sometimes the distinction between defining and characteristic features is unclear.

Second, why couldn't we store category membership directly, as one of the features under a concept? That is, why couldn't we store "is a fish" as a feature under the concept *salmon*? That way, to decide that a salmon is a fish, we need only scan the list of *salmon* features rather than compare the feature lists from both concepts.

Another criticism of this model is that feature *lists* cannot account for all that people know about concepts; they also know that some features correlate more highly than others. Features are linked units, not independent units. For example, the features of "small" and "sings" are highly correlated for birds. Likewise, despite the fact that small spoons are considered more typical than large spoons, small *wooden* spoons are considered less typical than large wooden spoons (Rumelhart & Ortony, 1977). A theory such as the feature comparison view, which posits lists of independent features, cannot account for Rumelhart and Ortony's findings (Medin, 1989).

**Spreading Activation Network Model.** In order to better account for the empirical findings that challenged his first semantic model, Collins, of Collins and Quillian (1969, 1970), developed a *spreading activation model* of semantic representation (Collins & Loftus, 1975). As in the earlier hierarchical network, concepts are represented as nodes and associated concepts are connected (see Figure 4.10). However, now properties such as *red*, *large*, or *transports people* are also nodes within this model, and in this way they are treated as concepts in their own right. Relations between concepts (including concepts and feature concepts) are represented via connecting nodes, not the number of overlapping features as in the feature comparison view. The
length of each line between nodes represents the degree of association between the two concepts—shorter lines mean stronger associations. Again, this distance is only metaphorical, and does not necessarily represent how far apart concepts are stored in the brain.

Like the hierarchical model, the spreading activation model is still an associated network. However, the structure is not that of a strict hierarchy, but a more complex web of concepts and relations between concepts. Note its resemblance to connectionist models of cognition such as the connectionist model of lexical access discussed earlier in the chapter. For example, the concept *flowers* is linked not only to *violets* and *roses*, but indirectly to *fire truck* via the *red* concept node. With regard to concepts, no distinction is made between defining and characteristic features; some connections simply appear stronger than others. The degree of association between nodes is represented by distance, with highly associated concepts, such as *canary* and *sings*, closer than more weakly associated concepts, such as *canary* and *skin*.

An important aspect of this model is the principle of spreading activation, from which it gets its name. Think of the model as a large electrical network. When a single concept is activated, the "electricity" spreads to connected concepts, decreasing in strength as it emanates outward. Assume that you are participating in a lexical access task. Through stimulus input the concept of *salmon* is activated.
Like the electricity in a circuit, all nodes connected to the concept salmon, such as fish, animal, stream, pink, edible, and gills, would be activated to a certain degree as well. Thus, the sentence, “A salmon has gills,” should be quicker to verify than “A salmon has feathers.” Why? Because once salmon is activated, gills will also receive some activation, whereas feathers will not. Likewise, “A salmon has gills,” should be more quickly verified than “A salmon has skin,” because gills are more highly associated with salmon and thus “closer” together in the network. Likewise, cherry would be confirmed more quickly than fig as fruit because cherry is closer to the subordinate category (fruit), because of its higher frequency and stronger association.

The strength of association between concepts (including property concepts), represented via degree of distance in the model, can explain category effects, reverse category effects, and typicality effects in categorization and semantic verification tasks. Notice that the spreading activation network can also be used to explain priming effects. In lexical decision tasks, it should take a shorter time period to recognize the word nurse if it follows the term doctor, than if it follows bread, because the concept node for nurse would have already been somewhat activated from doctor. Similar to the logogen and connectionist models of lexical access, semantic priming in the spreading activation model is accomplished by lowering thresholds.

You can see that a major advantage of such a model is its explanatory power in accounting for a wide variety of experimental findings. The spreading activation model is flexible enough to account for multiple access routes to concepts and their features and to explain many of the empirical findings related to lexical and conceptual research.

**Summary.** One gets a sense not only that meanings may be related through rigid taxonomic structures, but also that the best theories are ones flexible enough to account for all aspects of human performance. Many criteria can be imposed on the organization of concepts, in the same way that many criteria can be imposed on the organization of the lexicon. Task demands, contextual cues, and other factors can all influence what information is accessed and how. Theories that posit different points of access, association, and activation, as spreading activation models do, are bound to have more explanatory power than more rigidly designed models.

As you have seen, each problem space—language and meaning—raises a vast number of questions ripe for research effort. Having dissociated meaning and lexical symbols, let us discuss some final issues related to their reassociation.

**A Special Problem for the Mental Lexicon: Lexical Ambiguity**

There is no strict one-to-one mapping between words and meaning. Multiple words can supply the same meanings—pseudonym, alias, and pen name are equivalent in meaning. Likewise, a single word can have multiple meanings: bank can mean (1) a place to store money, (2) the side of a river, (3) what a race car driver does when he encounters a steep turn. Words such as fox (a mammal with reddish fur, or a clever and crafty person, or, in slang, a good-looking woman), right (correct or the opposite of left), and drill (a power tool, to use a tool to make a hole in wood, a practice exercise,
or to engage in a practice exercise, as in the military) are said to be *lexically ambiguous* because each word in isolation does not indicate the intended meaning. One meaning of an ambiguous word can be more common than the others: *bank* is most frequently used to refer to a place where money is kept. In most cases, the multiple meanings of an ambiguous word share the same grammatical class. The meanings of *fox* listed above are nouns. Other times, the different meanings of a word are from different grammatical classes: the noun *drill* refers to a power tool that makes holes, and the verb form describes what one does with that power tool. Many jokes (including the doctor joke about “Eyes checked?” at the beginning of this chapter) hinge on some words having two meanings. An obvious way in which the lexicon and meaning coalesce is in the study of how we process ambiguous words.

We use language to convey an intended meaning in the mind of the speaker or writer that can be accurately decoded by the listener or reader. Ambiguous words may foil comprehension because of their multiple meanings. However, we seldom encounter words in isolation; they tend to appear in sentences, and these sentences often provide a context for determining which of several meanings of a lexically ambiguous word is intended. For example, if I report, “The canoeist rowed up to the bank,” it becomes evident from the mention of a canoeist and rowing which sense of *bank* is being used.

Much of the research into the processing of ambiguous words has used a *phoneme monitoring task*, in which subjects press a button every time they hear a particular phoneme, such as /b/. Foss (1969, 1970) placed some of the target phonemes after a word with multiple meanings, such as “The men started to *drill* before they were ordered to do so,” and found that response times were longer than if the target phoneme appeared after a nonambiguous word. Although the sentence structure makes it clear that *drill* above is functioning as a verb, the sentence context does not specify which *interpretation* of the word is intended. It thus provides subjects with an “interpretive dilemma” (Simpson & Burgess, 1988) about whether *drill* refers to boring holes in wood, or to engaging in military exercises. We may not be conscious that two meanings of ambiguous words such as *drill* are being activated or “lit up” lexically, but the longer processing time in the phoneme monitoring task indicates that both meanings of ambiguous words are being activated, which then prevents subjects from responding as quickly to target phonemes. Foss’s (1969, 1970) findings launched a mass of research on processing ambiguous words, in order to determine when and under what circumstances several meanings of a word are activated.

Sentence context usually constrains which interpretation an ambiguous word receives. For example, if Foss’s sample sentence was modified to “The sergeant ordered the men to *drill* before they had recovered from morning exercises,” it becomes evident that *drill* refers to military training and not to boring holes in wood. Providing this contextual information have led to activation of only one meaning of *drill* and faster response times to the phoneme /b/ after it? The answer to this question is important to knowing what is happening during on-line processing of words and sentences. It is possible that subjects activate multiple meanings of a word even when the context makes it clear which meaning is intended.

There are two major theoretical camps about the role of context in influencing which of several meanings of lexically ambiguous words are activated. One
camp (Glucksberg, Kreuz, & Rho, 1986; Schvaneveldt, Meyer, & Becker, 1976; Simpson, 1981), which we will call the selective access view, holds that context biases the interpretation of an ambiguous word, so that only the intended meaning is accessed. At a conscious level, we appear to consider only one interpretation of a word or sentence at a time. If Foss had used the sentence, “The carpenter ordered the men to drill before they were ready,” most of us would report having generated an image of men with power tools piercing holes in boards. However, as you now know, much cognitive processing takes place beneath the level of consciousness.

The alternative view claims that even with context provided in a sentence or experimental task, multiple meanings of a lexically ambiguous term are activated (Onifer & Swinney, 1981; Seidenberg, Tanenhaus, Leiman, & Bienkowski, 1982; Swinney, 1979; Tanenhaus, Leiman, & Seidenberg, 1979). This second theory, the exhaustive access view, has more empirical support. Some of its advocates (for example, Simpson & Burgess, 1988) also claim meanings of an ambiguous word do not necessarily achieve activation threshold simultaneously; more frequently used meanings of the word, or those influenced by context, may achieve threshold first, although all meanings are activated in parallel. Context simply resolves the conflict between meanings in post-access processes.

**Context.** The main empirical question, then, is whether the context surrounding an ambiguous word limits access to only the meaning intended by that context. Swinney (1979) asked subjects to participate in a cross-modal priming study. That is, they had to listen to sentences that contained ambiguous words and simultaneously participate in a visual lexical decision task. An example of stimuli is, “The man was surprised when he found several spiders, roaches, and other bugs in the corner of his room.” Directly after the word bugs was heard, subjects saw either the word ant, or spy, or saw projected on the screen in front of them and had to perform a lexical decision task. Both ant and spy drew quicker responses than saw, even though only ant is the meaning consistent with the rest of the sentence. It appears multiple meanings of bug were activated, which then primed lexical recognition of words related to all interpretations of bug. Even though the insect-related interpretation of bugs is the dominant meaning, subjects unconsciously considered both interpretations.

Onifer and Swinney (1981) also noticed priming of both dominant and subordinate meanings of words, regardless of the context. For instance, lexical decision responses to both round and noisy were primed by either of the following sentences:

Dominant context: The housewife's face literally lit up as a plumber extracted her lost wedding ring from the sink.

Subordinate context: The office walls were so thin that they could hear the ring of their neighbor's phone whenever a call came in.

In this experiment, even associates of the less-frequently used meaning of ambiguous words were primed, regardless of whether the sentence context biased interpretation
toward the dominant or subordinate meanings. Onifer and Sweeney (1981) concluded that meaning frequency has no effect on lexical interpretation until after both (or all) meanings of a word have been activated.

**Interaction of Context and Dominant Meaning.** Here is one humorous example of only the dominant (albeit erroneous) meaning of an ambiguous word being activated: While playing “Outburst,” a game that requires contestants to yell out potential answers to a category, one of the authors of this book and her teammates received the category, “famous basketball centers.” As the most frequent use of center refers to a place (as in convention center, Center for the Performing Arts), her team (to the great amusement of the opponents) began yelling out answers such as, “the Palestra in Philadelphia” as a renowned place where basketball was played. Of course, the intended meaning of the category clue was “famous people who have played the position of center in basketball,” and the list included Kareem Abdul-Jabbar, Bill Walton, Wilt Chamberlain, and Shaquille O’Neal. Needless to say, no points were awarded to the author’s team on that round. Even when context was clearly biased toward the subordinate meaning of center (though consistent with both meanings), the dominant interpretation of the ambiguous word won out. Of course, it is possible both meanings of center were activated, but only the one achieved threshold to become conscious.

The frequency of stored meanings of a word may interact with context to determine whether, and how quickly, multiple meanings are activated. In an eye-tracking task that measured the amount of time subjects spent fixated on a lexically ambiguous word, Duffy, Morris, and Rayner (1988) explored the difference between balanced and polarized homographs. Balanced ambiguous words are those whose several meanings are equally common (for example, right used to mean either correct or the opposite of left); polarized words are those for which one meaning predominates (for example, year—more commonly used to refer to a textile than to a folk tale). The ambiguous words were put into sentences either with or without a biasing context. A before biasing context would be, “The dragon was no longer in pain once the scale was removed,” in which the beginning of the sentence leads to an interpretation of one meaning of the word. A nonbiasing context would provide no clues to the ambiguous word’s interpretation until after the word appeared, as in the sentence, “Once the scale was removed, the dragon was no longer in pain.” The context of the sentences was always tailored toward the subordinate meaning of a term (for example, a dragon’s scale, rather than a scale for weighing).

In the after context condition, eye gaze was longer to the balanced ambiguous words than to control (that is, nonambiguous) words, which indicated that both interpretations were accessed in the absence of biasing context. Polarized words, however, did not receive additional looking times, presumably because the dominant meaning was adopted immediately. When context was available (in the before condition), eye gaze to the target word was longer only in the polarized condition. It appeared that even the dominant meaning of polarized words was accessed, despite the fact that the context in this condition was always tailored to the subordinate meaning (also see Dopkins, Morris, & Rayner, 1992; Miyake, Just, & Carpenter, 1994). The Duffy
et al. (1988) experiment confirms that dominance is a major factor in early lexical access: Equally frequent meanings compete for interpretation when no context is available (in the balanced words, the before condition); and dominant meanings are immediately activated even when the context is biased against them (in the polarized words, the after condition, in which the context related to the subordinate meaning). Although this experiment suggests that sentence context can selectively access meaning of at least balanced ambiguous words, remember that eye gaze measures an early stage of lexical processing (which is important to the discussion below).

Like so many other studies, Tabossi, Colombo, and Job (1987) found that word associates of the dominant meaning were primed even when the context biased subjects to the subordinate meaning of the word. However, when the context was tailored to the dominant interpretation, they determined that only the dominant meaning was accessed, similar to the Duffy et al. findings.

The precedence of frequent meanings is a robust one: Simpson (1981) found that a strong biasing context was needed to overcome the dominance effect; the most frequent interpretations of a word are the first to be activated unless the context strongly steers subjects to the subordinate meaning. Because of its strength in lexical representation, the most frequent meaning of a word may always be accessed; less-frequent meanings may become active only in neutral or subordinate-biased contexts. This effect is akin to the importance of word frequency in lexical access models discussed in the earlier sections of this chapter (meaning dominance is really the same as “most frequently used interpretation”).

**Other Factors.** Whether the two interpretations of a lexically ambiguous item are from the same grammatical class or not also influences experimental findings. Seidenberg, Tanenhaus, Leiman, and Bienkowski (1982) determined that without a priming context, access was exhaustive. When a priming context was presented, both meanings of words with noun–verb interpretations (for example, punch) were activated, but only the contextually intended meaning of noun–noun meanings (for example, spade) was accessed. Seidenberg et al. claimed that the syntactic class of a word’s meaning determines whether word access is exhaustive or selective, and not the context per se. Meanings of words with the same grammatical function (for example, noun–noun) compete for access in a way that word meanings from different grammatical classes (for example, noun–verb) do not.

**Time Course of Activation.** A wealth of evidence indicates that processing of lexically ambiguous words leads to activation of multiple meanings (for example, Kinoshita, 1985; MacKay, 1966; Onifer & Swinney, 1981; Simpson & Burgess, 1985; Swinney, 1979), but also some evidence (for example, Duffy et al., 1988; Schvaneveldt, Meyer, & Becker, 1976; Tabossi et al., 1987) that context does constrain which word meanings are activated. Which is it, then? Does the research largely support exhaustive or selective access? Is there a way to explain all of the various findings?

Some of the discrepancies in experimental results may be resolved by looking at the time course of lexical access. When lexical access is tested can interact with (a) context, (b) the relative frequency of different interpretations of the word, and (c) whether the multiple definitions of a term are from the same grammatical class or not.
Simpson and Burgess (1985) attempted to test pure lexical access with a lexical decision task using prime-target pairs (for example, *bank*-money, or *bank*-river) without any sentence context. Which target was semantically primed depended on how soon after the lexically ambiguous prime it appeared. At 16 millisecond interstimulus interval (ISI)—that is, where the target appeared immediately after the prime went off—only dominant meanings were facilitated. In the example above, for instance, *money* would be recognized faster when it appeared after *bank* because *money* is related to the most common meaning of *bank*. However, with a 300 millisecond delay before the target appeared on the screen, both meanings were equally activated, and even the subordinate meaning (*river*) was primed. At longer ISIs, the dominant meaning appears to remain active while the less-frequent meaning subsides. Moreover, results showed an inhibition of meanings associated with the less-frequent meaning (Simpson & Burgess, 1988). That is, if *ball* appeared, and *dance* was not presented for 750 milliseconds, recognition of *dance* (related to the subordinate meaning of *ball*) was actually slower than if it had been preceded by an unrelated word (for example, *panel*).

It appears that multiple meanings of a word may be activated in parallel, with the dominant meaning “popping up” first. Evidence supports that this is an automatic process not influenced by subject intentions. Context sometimes may speed access to one of several meanings, but does not restrict access to all interpretations of an ambiguous word (Prather & Swinney, 1988). Such may have been the case in the Duffy et al. (1988) eye-gaze study in which the intended meaning of a balanced ambiguous word “beat out” the alternative (but equally frequent) interpretation. At longer delays, post-access processes, which may be under subject control, resolve ambiguities by concentrating on the intended meaning only. It is at this late stage that context may have the most influence (Simpson & Burgess, 1988). Several experiments that found a constraining effect of context on lexical access (for example, Schvaneveldt, Meyer, & Becker, 1976) may have been due to the length of time between primes and target words, which permitted contextually intended meanings to overcome unintended ones.

**The Time Course of Sentence Contexts Versus Word Pairs.** Because of the biasing semantic influence sentences may exert prior even to presentation of a target ambiguous word, the time course of activation is slightly different in sentence studies. Recall that Simpson and Burgess (1985) found only the dominant meaning of an ambiguous word activated immediately after presentation, multiple meanings at 100–300 milliseconds, and only the meaning intended by the context (or prime) at 750 milliseconds. In contrast, Tanenhaus, Carlson, and Seidenberg (1984) and Swinney (1979) found immediate activation of multiple word meanings after reading a sentence; but only the contextually specified meaning of an ambiguous word remained by 200 milliseconds. Why the faster sequence of processing in the sentence conditions? Expectancy effects may begin activation of a word unit prior even to its interpretation, so that access to multiple meanings is available sooner than in word-pair studies.

**Summary.** Overall, the evidence suggests that activation of all meanings of ambiguous words takes place even in the face of biasing contexts. It thus appears that lexical ambiguity resolution is a dynamic process, with the various interpretations of a word racing against each other for access based on (1) frequency of meaning; and
(2) the degree to which context biases one interpretation over the other. Even though in most cases, we access multiple meanings of an ambiguous word, we do so at different rates. The evidence supports a model of exhaustive but brief access of all meanings of an ambiguous word. After the window of opportunity for multiple interpretations, context exerts its main influence on which of several meanings remains active. Two to three syllables after exposure to an ambiguous word (roughly 500–800 milliseconds), only a single meaning remains; the “unused” interpretation is not left hanging around indefinitely. Knowing the time course of lexical access within experiments may help resolve some of the discrepant findings.

Studies on lexical ambiguity are an effective way to determine the link between words (in their phonological or orthographic codes) and meanings. And the findings clearly have implications for models of lexical access discussed in the first half of the chapter (though an elaborated discussion is beyond our scope here). In lexical ambiguity, we again see the imperfect mapping between words and meanings, and also the ways in which the two domains interact. Thus lexical ambiguity provides a window into the complex processes that the human mind uses to navigate between our conceptual and linguistic systems. The study of lexical ambiguity also provides a vivid illustration of how language serves both communication and symbolic functions. To round off our discussion in this chapter, we now turn our attention to reestablishing the connection between words and meaning.

The Reciprocal and Influential Relationships of Words and Meaning

In the earlier sections of this chapter, we asked you to think separately about words and meaning, about language and the thoughts it represents. As you probably noticed, making a complete distinction between these two domains is almost impossible. Even our discussion of the lexicon suggested that word organization is permeated by discussions of meaning.

The relationship between words as communication symbols and conceptual meaning is a two-way street: Words influence the kind of meanings we can convey; and meanings dictate the development of words, which then spurs development of vocabulary as technology and civilization provide new objects and concepts.

The illustration that makes this point most clearly comes from an example with words offered by the philosopher Quine (1960) in his book Word and Object. To adapt his example for our purposes, imagine that you are a linguist in a foreign land, Kalaba, trying to decode a language about which you know nothing (Kalaban). Your job is a simple one (or so it seems). You need only link the sounds that you hear with the objects and events that you see. Suddenly, a rabbit hops by and the native speaker near you says, “Gavagai.” “Aha,” you think. “Perhaps ‘gavagai’ means rabbit.” Shortly thereafter, another rabbit scurries by and again you hear, “Gavagai.” Now you are certain and write the word in your vocabulary notebook.

Although you feel confident in your interpretation, Quine rightly casts doubt on your conclusion. The word gavagai could mean any number of things because label-
to-word mapping is ambiguous. The term *gavagai* could be associated with any number of things or properties of the scene. For example, could it not refer to rabbit ears, or legs, or fur? Couldn’t it also refer to the act of hopping that you saw both times? Even less likely, but possible, *gavagai* could refer to the movement of the rabbit relative to the background, or to the way the sun reflected off the rabbit fur in the two cases. These and many other referents could be valid meanings for the term *gavagai*. How, then, did you arrive so swiftly at a definite conclusion?

A recent body of work, mostly on the learning of object names, suggests that the very use of words and language constrains or limits the possibilities for word–meaning mapping (see Clark, 1983, 1987; Golinkoff, Mervis, & Hirsh-Pasek, 1994; Keil, 1989; Markman, 1989; and Merriman & Bowman, 1989, for reviews). The point of this research is that children come to favor certain meanings or mappings over others as they gain experience with language, a concept that we explore further in Chapter 8. Golinkoff et al. (1994) have postulated several key principles that word learners rely on in learning novel words: (1) the reference principle (a foundation of word learning) leads learners to assume that a word denotes or maps onto an object, event, or property. This is why you would assume that *gavagai* refers to something in the environment. (2) The object scope principle (or whole object principle; Markman & Wachtel, 1988) leads learners to look for a whole object rather than object parts as the referent. Thus you are more likely to see the rabbit as the referent in Quine’s example above rather than the rabbit’s ears, paws, or fur. (3) The extendability principle posits that children assume that a word refers not to a single object, action, or event, but to a class of objects, actions, and events. These classes can be defined in various ways, as thematic associations (for example, pen–paper) or taxonomically defined categories (for example, cow–sheep as animals). (4) The categorical scope principle leads learners to extend words to the same kinds of things (Markman & Hutchinson, 1984; Waxman & Gelman, 1986). For example, you would be most likely to assume your new word, *gavagai*, refers to all kinds of rabbits—brown ones, baby ones, floppy-eared ones—rather than to a thematic association (for example, rabbits and carrots). (5) The novel name/nameless category principle biases learners to assume that a novel word refers to an unnamed object in the environment rather than to an object that already has a name (Clark, 1987; Markman, 1989; Merriman & Bowman, 1989). Taken together, this body of research suggests that something about language directs attention to some meanings over others. Language itself alters the efficiency with which we organize concepts and contributes to greater depth of conceptual understanding.

Research on primates underscores this finding. Working with chimpanzees, Premack and Premack (1983) presented evidence that language-trained chimpanzees classify objects differently than do language-untrained chimps. Trained and untrained chimpanzees learned what is called a match-to-sample task, such as the one you see in Figure 4.11a. That is, when shown an apple as target, and then an apple and a banana as selections, the chimps were rewarded for choosing the apple because it matches the target apple. However, when shown a match-to-sample as in Figure 4.11b, where the match is to half, only the language-trained primate was able to group the half glass of water and the half apple together. Thus the mere presence of language seems to guide assumptions about meaning.
The studies presented above focus on ways in which word use and word knowledge might prime certain mappings between words and their meanings. Yet these findings can be viewed within an even larger arena of relations between language and thought. In one case, the use of language can change or determine how we think, as in the case of the Premack's language-trained chimpanzees. Based on recent findings, Waxman and Gelman (1986) reported that the use of an adjective with a noun—even a novel adjective with a novel noun—leads children to look for subordinate classifications. The word rose, for example, refers to a taxonomic class that includes red roses, pink roses, and yellow roses, as well as climbing roses. Once an adjective is used, however, the field is narrowed to a particular type of rose as in the example of the climbing rose. Not only does the inclusion of adjectival markers therefore direct attention to certain meanings, but certain patterns of grammatical use lead to assumptions about meanings. Without knowing any of the words, to use a further example, you know that X blixes Y suggests some causal action with X as the actor and Y as the recipient of the action. Similarly, you know that X and Y are blixing, and that X blixes with Y, do not lead you to make causal assumptions. In fact, in the latter cases, you assume that X and Y are simply doing something together (blixing) (see Hirsh-Pasek & Golinkoff, 1996, for a more detailed discussion). The syntactic frames in which words are found reveal aspects of their meaning. According to Fischer, Gleitman, and Gleitman (1991; see also L. Gleitman, 1990), using these syntactic cues affords us high rate of accuracy in our attribution of meaning.

Conversely, the very makeup of our conceptual system works to influence the creation of words and language structures. Talmy (1975, 1985) noted that certain semantic properties are universally signaled by verbs. Verb systems of languages around the world specify motion, manner, location, and cause in various combinations. For example, some English verbs use a combination of motion and cause, as in the verbs, blew, pulled, or kicked. Others use motion and manner, or the way in which the motion occurs, as in slid, swung, and swirled. The conceptual structure embedded in the verb meaning serves to determine the prepositional structure.
This, in turn, determines the required syntax. By way of example, you can’t think of blowing without thinking of an agent (for example, person or fan) who does the blowing and an object (for example, feather or dress) that is blown. Given this semantic base, any sentence or syntactic representation is bound to have a subject noun (the blower), a verb (the act of blowing), and a direct object (the thing being blown).

Psycholinguists are investigating these correlations between meaning and words and between meaning and syntax (Fischer, Gleitman, & Gleitman, 1991; Grimshaw, 1985; Pinker, 1989) in an effort to see how young learners might use their early knowledge of meaning and semantic structure to bootstrap their way into a knowledge of grammatical structure. The problem of understanding language acquisition is discussed in detail in Chapter 8. Again, the point is that just as language directs thought, properties of thought direct the composition of language.

**SUMMARY**

*Language is like a cracked kettle upon which we beat out tunes for bears to dance to, while all the while we long to move the stars to pity.*

*Gustav Flaubert, Madame Bovary*

As reflected by their joint coverage in this chapter, words and meaning are greatly intertwined within human communication. Flaubert may have been accurate in conveying our frustration in seeking and not always finding words (and combinations of words) that permit the intensity of poetic feeling we may have intended. Still, words remain our most effective and flexible way to communicate about events, thoughts, and emotions.

That is not to say that meaning cannot exist without language; a nine-month-old child can readily use pointing to communicate that she wants the toy perched on the table beyond her reach. And many a dog beats his owner to the door upon hearing the sound of a leash being rattled. However, individuals or species without language may be able to communicate only about a limited array of topics (Hauser, 1996). As discussed in the previous section, meanings confine words, and words influence the sophistication of our concepts.

One of the themes of this chapter has been that both words and concepts can be analyzed in terms of their primitives—morphemes in the case of words; features in the case of concepts. However, much evidence suggests that a purely decompositional view of these two domains cannot adequately cover the depth of either. The lexicon appears to contain both single- and multimorphemic entries for greater ease of word processing. Our conceptual system likewise stores information not only about the set of features characteristic of a given concept, but also about the ultimate causes for those features (for example, why a whale is a mammal and not a fish, even though it shares many features with fish). In this respect, knowledge-based theories supplement our surface understanding of the definitions of concepts.
We have, of course, much more to learn about the ways in which we represent words, about the nature of meanings, and about the connections between words, meaning, and language, and meaning and thought. Yet the past two decades of psycholinguistic research have taken us a long way toward formulating some tentative answers to the questions that philosophers posed long ago.

In closing, let us return to our opening example and reexamine whether this passage in “Jabberwocky” really has no meaning. You probably know what we are about to say: You know a great deal about the meanings of these sentences even before hearing our explanation (and Humpty Dumpty's):

'Twas brillig, and the slithy toves
Did gyre and gimble in the wabe:
All mimsy were the borogroves,
And the mome raths outgrabe.

Just to get you started, you know that gyre and gimble are verbs and denote actions that must be able to be performed at the same time. You know this even before Humpty Dumpty informs Alice that they mean, “to go round and round like a gyroscope,” and “to make holes like a gimlet,” respectively. Furthermore, you know that slithy and mimsy are adjectives modifying the nouns toves and borogrooves. How? Adjectives in English often take the morpheme -y, and the plural -s typically indicates the word is a noun. For further elucidation, slithy means both “lithe and slimy,” mimsy is “flimsy and miserable.” And according to Humpty Dumpty, a borogrove is a thin, shabby-looking bird with its feathers splaying out all over, while a tove is something like a badger, something like a lizard, and something like a corkscrew, that makes its nest under a sundial and lives on cheese. You get the picture. The rest of the interpretation we leave to your devices (or refer you to Through the Looking Glass for further exposition). Now, however, you see the words and not only have some idea about what they mean but how they are stored and accessed.

**Key Words**

- Semantics
- Lexical ambiguity
- Word primitives
- Morpheme (free and bound)
- Lexeme
- Lexeme (as word primitive)
- Morpheme (as word primitive)
- Cognitive economy
- Lexical decision task
- Tachistoscope
- Lexical access
- Pseudo-suffixed
- Reaction times
- Derivational morphemes
- Grammatical class
- Inflectional morphemes
- Compound words (semantically opaque and semantically transparent)
Semantic priming task
Primed
Phonemes
Frequency effect
Imageability effects
Open- and closed-class words
Tip-of-the-tongue (TOT)
Concepts
Access routes
Serial search model
Forster's autonomous search model
Parallel access (direct access) model
Logogen model
Post-access check
Threshold (for activation)
Connectionist models (connectionism)
Nodes
Hidden nodes
Cohort model
Neighborhood effects
Signs versus symbols
Intension
Extension
Reference theory of meaning
Referent
Ideational theory of meaning
Conventionality
Conceptual primitives
Features
Decompositional view of meaning
Classical view
Family resemblance theory

Necessary and jointly sufficient features
Characteristic features
Graded structure
Prototype
Fuzzy boundaries
Semantic verification task
Psychological essentialism
Psychological contextualism
Semantic organization
Hierarchical network model
Category size effect
Taxonomic categories
Typicality effects
Feature comparison model
Spreading activation model
Phoneme monitoring task
Selective access view
Exhaustive access view
Cross-modal priming study
Balanced and polarized (words)
Interstimulus interval (ISI)
Word-meaning mappings
Reference principle
Object scope principle
Extendability principle
Thematic associations
Categorical scope principle
Novel name/nameless category principle
Match-to-sample procedure
Conventionality principle
Ad hoc categories

Something to Think About

1. What is the relation between words and meanings? Is there an exact match between a word and a concept, or vice versa? Give examples and explanations.
2. Is it more likely that the word primitives stored in our lexicon are words (lexemes) or individual morphemes? Does the kind of word have any influence on which position you take? Explain.

3. What are the most important factors that influence lexical access? What experimental support is there for the primacy of these factors?

4. How do serial versus parallel search models of lexical access account for the main factors from the question above?

5. Contrast the classical and family resemblance theories of concepts with each other, and with the knowledge- (or theory-) based approaches.

6. Compare the models of semantic organization. Why is the spreading activation model considered the most flexible of the three?

7. How does the context of a sentence or word pair affect lexical access of ambiguous words? Which is better supported by the evidence: exhaustive or selective access of word meanings? Explain.

8. What appears to be the time course of lexical activation for words with multiple meanings?

**Activities**

1. As this chapter and Chapter 1 demonstrate, speakers of a language have implicit understanding of how morphemes can be combined to create larger concepts. Consider the following words: *snark, blod, frep, plankle, lerb.*

   How would you adjust each of these words to fit into each of the following frames?
   1. Everyone agreed that she was the ________ woman on the volleyball team.
   2. At the conference, he delivered the opening speech ________.
   3. This wall is covered with ________. It is unbelievably ________. We need to ________ it.
   4. This person comes from (insert nonsense word). He is a ________.

   Construct more nonsense words and additional sentences into which they can be placed and modified as plurals, verb forms, modifiers, etc. Ask 10 adults and 10 children to complete the sentences. What, if any, are some common types of responses? Do responses at times differ from one person to the next? Why might this be?

2. Below are two lists of letter strings. Some are words, some are nonwords or arbitrary strings of letters. As you read each word to yourself, say aloud, "yes" if
the string is a word, "no" if the string is not a word of English. Using a stopwatch with a second hand, determine how long it took you to complete each list.

List 1: gambasly, revery, voitle, chard, whee, cratily, decog, puldow, rafiot, oriole, voluble, bootle, chaft, aurry, signet, trave, crock, cryptic, ewe, himpola.

List 2: mulbow, governor, bless, tuglety, gare, relief, ruftily, history, pinde, develop, gardot, norve, busy, effoir, garvola, match, sard, pleasant, coin, maisle.

Consider your reaction times. Which list took longer to complete? Using information provided in this chapter, why do you think one list took longer than the other?

3. Perform a word association task. Ask 10 people to quickly provide 5 responses to the following words:
   wet
   swift
   petal
   apple
   shoot
   fire
   white

Examine their responses. In what way do such responses relate to models of lexical organization and retrieval discussed in this chapter?

4. Ask people to provide examples of the following concepts, as quickly as possible. See how many examples they can supply in 2 minutes. Do their responses shed light on notions such as prototypicality or defining features?
   fruit
   pets
   furniture
   mammals
   fish
   clothing

Ask children to do the same task. In what ways do their performances differ from adults?

REFERENCES


