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How Children Learn Words

The key is to see words in intelligible contexts. A dictionary is often misunderstood, but an interactive video display can mobilize the natural ability of a child to learn from context

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Listening to a child who is just learning to talk, one is most aware of the child's limited command of the language. What one tends to overlook is the sheer magnitude of the child's achievement. Simply learning the vocabulary is an enormous undertaking. The fact is that for many years after starting to talk a child learns new words at a rate of more than 10 per day! Yet little is known about how children do it. Certainly they do not do it by memorizing dictionary entries. Our findings and those of other workers suggest that formal efforts to build vocabulary by sending children to the dictionary are less effective than most parents and teachers believe. We are exploring the possibility that a computer program providing lexical information about new words encountered in the context of a story might be more effective.

When adults set out to learn a new language, they know what is in store. They realize they will have to learn a new pronunciation, a new grammar, a new vocabulary and a new style of using language. They know they will have to spend many hours every day for years before they can call themselves fluent in the new language. They also know, however, that they will be able to rely on teachers to explain, in their first language, everything they need to learn about the second language.

How different it is for infants. Having no language, they cannot be told what they need to learn. Yet by the age of three they will have mastered the basic structure of their native language and will be well on their way to communicative competence. Acquiring their first language is the most impressive intellectual feat many people will ever perform.

Students of how children learn language generally agree that the most remarkable aspect of this feat is the rapid acquisition of grammar. Nevertheless, the ability of children to conform to grammatical rules is only slightly more wonderful than their ability to learn new words.

How many words must one know in order to use English effectively? The answer depends on several variables, including the definition of "word." For the purpose of counting, a word can be defined as the kind of lexical unit a person has to learn; all the derivative and compound forms that are merely morphological variations on the conceptual theme would not be counted as separate words. For example, *write* is a word and its morphological variants (*writes, writ, wrote, written, writing, writer* and so on) are relatives in the same family. If such a family is counted as a single word and knowing a word is defined as being able to recognize which of four definitions is closest to the meaning, the reading vocabulary of the average high school graduate should consist of about 40,000 words. If all the proper names of people and places and all the idiomatic expressions are also counted as words, that estimate would have to be doubled.

This figure says something about the ability of children to learn words. If the average high school graduate is 17 years old, the 80,000 words must have been learned over a period of 16 years. Hence the average child learns at the rate of 5,000 words per year, or about 13 per day. Children with large vocabularies probably pick up new words at twice that rate. Clearly a learning process of great complexity goes on at a rapid rate in every normal child.

No one teaches children 13 or more words a day. Children must have a special talent for this kind of learning. Some valuable hints as to how they do it were uncovered a decade ago by Susan Carey and Elsa J. Bartlett, who were then at Rockefeller University. They worked with the names of colors. First they established that a group of three-year-olds did not know the color olive. Most of the children called it green and some of them called it brown.

Carey and Bartlett taught the children a nonsense name for olive—a name they would not have heard anywhere else. They took two cafeteria trays and painted one tray olive and the other blue. Each child was then told casually, "Hand me the chromium tray. Not the blue one, the chromium one." The child would pause and perhaps point to the olive tray. "This one?" "Yes, that one. Thank you."

A week later, with no further guidance, the children were again asked to name the colors. When olive was presented, they paused. They did not remember *chromium,* but now they knew that this color was not called green or brown. A single exposure was enough to begin a reorganization of their color lexicon.

This simple experiment demonstrated some important points about how children learn words. First, in order to learn a word a child must be able to associate its sound with its meaning. Mastering the mechanics of uttering and recognizing a word and mastering the concept that it expresses are separate learning processes. After their experience with the trays the children knew that olive has a special name—that it is not called green or brown—but they did not remember the particular spoken sound associated with that perceived color. Many repetitions may be necessary before the sound of a new word becomes familiar.

Second, a child's appreciation of the meaning of a word seems to grow in two stages, one rapid and the other much slower. Children are quick to notice new words and to assign them to broad semantic categories. After hearing *chromium* just once the three-year-olds assigned it to the semantic field of color names. Children are able to keep such fields separate even before they know what the individual words mean. Asked the color of something, they may respond with almost any color term at random, but they never answer *round* or *five* or *lunch*.

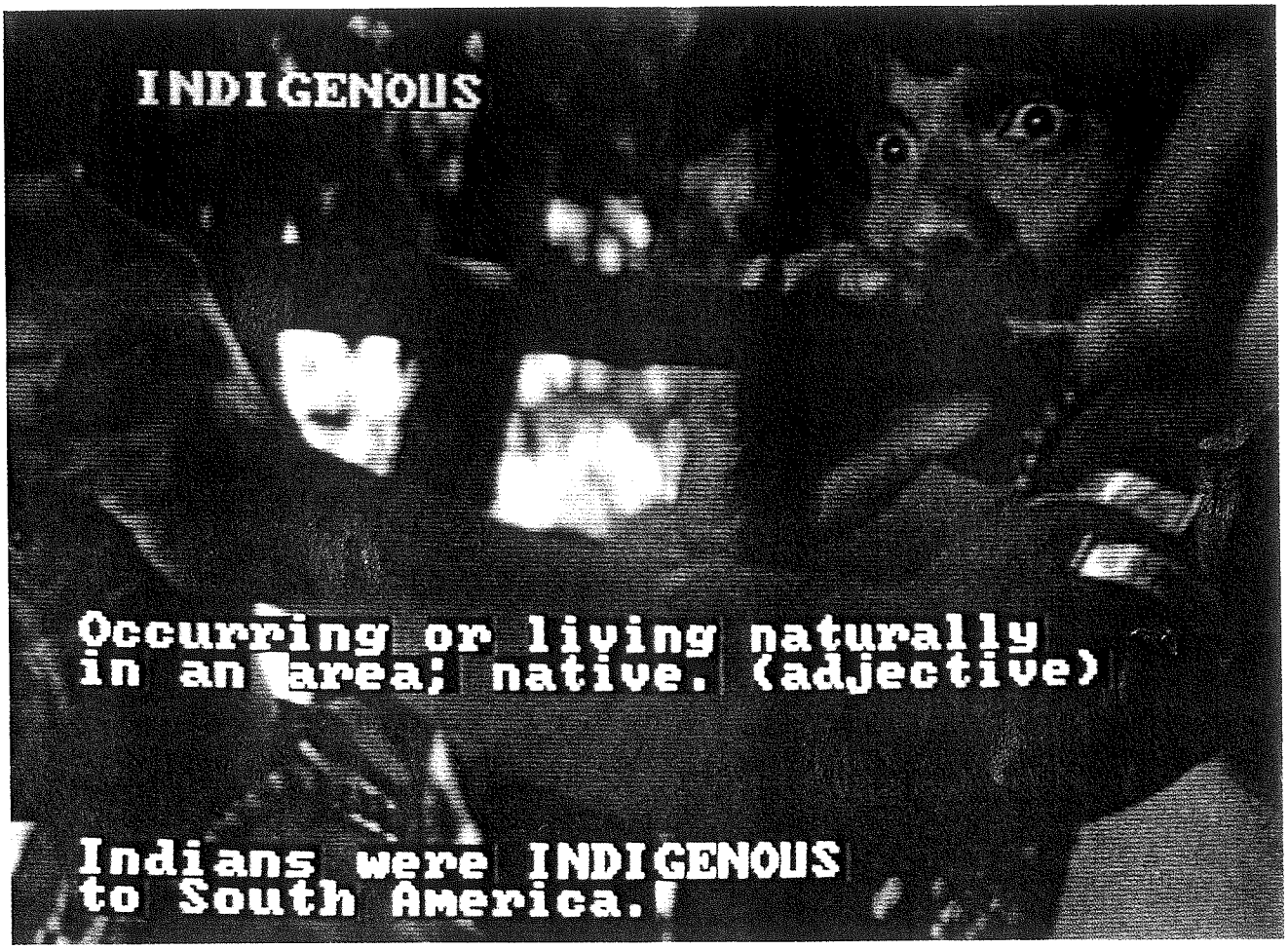
The slow stage entails working out the distinctions among words within a semantic category. A child who has correctly assigned *red, green, yellow* and *blue* to the semantic field of color terms still has to learn the differences between and relations among those words. This stage ordinarily takes much longer than the first and may never be completely finished; some adults, for example, correctly assign *delphinium* and *calceolaria* to the semantic field of flowering-plant names but have not learned what plants the words denote and cannot identify the flowers on sight. At any given time many words will be in this intermediate state in which they are known and categorized but still not distinguished from one another.

A related aspect of word learning by preschoolers that has attracted wide attention is called overextension. For example, a small child learning the word *apple* may apply it to a tomato. *Apple* is thought to mean, say, round, red and of a certain size; without further qualification those attributes define ripe tomatoes as well as ripe apples. Overextension can occur when the child's conception of a word's meaning is incomplete.

The opposite error also occurs, but it is revealed only by special questioning. For example, a child who thinks that being round, red and of a certain size defines *apple* might fail to use *apple* to refer to green or yellow apples. The only way to identify such an underextension is to show the child green or yellow apples and ask what they are called.

The ability of preschoolers to soak up words has attracted increasing attention in recent years. Much more is known about it than was known when Carey and Bartlett did their pioneering study with color names. The word-learning process becomes even more complex, however, during the school years.

In the early grades schoolchildren are expected to learn to read and write. At first they read and write familiar words they have already learned by means of conversation. In about the fourth grade they begin to see written words they have not



COMPUTERIZED TUTORING is being tested by the authors as an improvement over dictionaries in helping children to grasp the meaning of an unfamiliar word. The children read a text describing an episode from a motion picture they have just seen, in this case *Raiders of the Lost Ark*. The text contains specially marked words, such as *indigenous*, that the children are expected to learn. Interacting with a video display, the children can ask for information about the word in any or all of three forms: definitions, sentences and pictures. The aim is to present information about a word when the child is motivated to learn the word.

heard in conversation. At this point it is generally assumed that something special must be done to teach children these unfamiliar words.

This educational assumption runs into serious problems. Although children can recognize that they have not seen a word before, learning it well enough to use it correctly and to recognize it automatically is a slow process. Indeed, learning a new word entails so much conceptual clarification and phonological drill that there simply is not enough classroom time to teach more than 100 or 200 words a year in this way. Since learning runs so far ahead of teaching—some 5,000 words learned in a year compared with 200 taught—it is hard to avoid the question: How do schoolchildren learn so much more than they are taught?

Many words are acquired through reading. Children learn words at school in the same way as they do at home: by observing how the words are used in intelligible contexts. The difference is that the academic environment depends more on written contexts. Both public opinion and scientific evidence are converging on the view that the best way to facilitate vocabulary growth in schoolchildren is to have them read as much as possible.

Learning words by reading them in context is effective but not efficient. Some contexts are uninformative, others misleading. If the word in question expresses an unfamiliar concept, a single context of use will seldom support more than one hypothesis about the word's meaning. In order for reading to have any substantial effect on vocabulary a great deal of reading must be done.

How much? A child who spent 50 minutes of every school day reading at, say, 200 words per minute would read one million words in a 100-day school year. A million running words of English prose would typically contain no more than 50,000 distinct word types, representing roughly 10,000 word families. Schoolbooks would probably contain fewer different words. Even among 10,000 different words, it is unlikely that more than 1,000 would be totally new lexical items. Since multiple encounters are required in order to learn a new word, it is clear that reading one million words per year is not enough. In order to account for a growth rate of 5,000 words in a year it seems necessary to think about continued learning from conversational interactions supplemented by reading several million words per year. Indeed, children who read little outside the classroom generally do poorly on vocabulary tests.

The fact that children learn many more words than anyone has time to teach them also carries implications for the role of teachers in this learning process. Learning new words from purely literary contexts of use—from the contexts provided on the printed page—is harder than learn-

TRAY EXPERIMENT showed how quickly preschool children assign new words to semantic categories. A decade ago Susan Carey and Elsa J. Bartlett, who were then at Rockefeller University, established that a group of three-year-old children did not know the name for the color olive; they called it green or brown. The experimenters painted one tray blue and another one olive and asked each child to "hand me the *chromium* tray, not the blue one." A week later the children were asked to name the colors. They did not remember *chromium* but now knew the color was not called green or brown. A single exposure was enough to cause them to reorganize their semantic field of color terms. The photograph is of a reenactment of the original experiment.

ing them through interaction with a person. In conversation it is usually possible to ask the speaker what an unfamiliar word means. Moreover, in most conversations visual information supplements the linguistic information. Such help is missing from the printed page.

Given this additional difficulty, it seems reasonable to ask teachers to help children to be more efficient in learning new words from context. If they cannot teach all the words children need to know, perhaps teachers could help their students learn how to work out such things for themselves.

One way to figure out what an unfamiliar word means is to use a dictionary. In about the fourth grade, therefore, most schools begin to teach dictionary skills: spelling, alphabetizing, pronunciation, parts of speech and a little morphology and etymology. The idea, which is perfectly reasonable, is that children should learn how to find unfamiliar words in a dictionary and how to understand what they read there.

One trouble with this approach is that most healthy, right-minded children have a strong aversion to dictionaries. There may be good reason. We have looked at some of the tasks teachers assign in order to get students to use dictionaries. In our opinion these exercises do not merit the faith that teachers and parents have put in them.

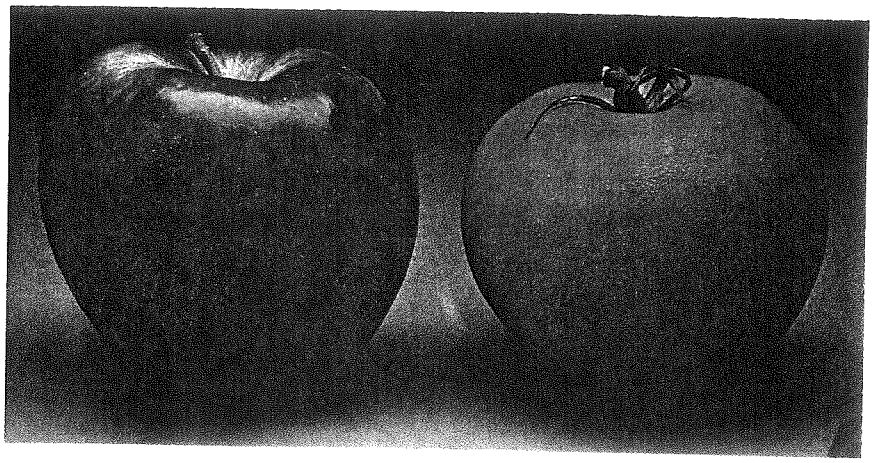
Two tasks are often assigned when children are being taught how to use a dictionary. One task entails disambiguation: the child is given a sentence that contains an ambiguous word—a word with two or more senses—and told to find it in the dictionary and to decide which sense the author of the sentence had in mind. The other task calls for production: the child is given a word and told to look it up in the dictionary and to write a sentence incorporating it. On the face of it both tasks look as though they should be instructive. It is therefore surprising to discover how ineffectual they are.

Learning from a dictionary requires considerable sophistication. Interrupting your reading to find an unfamiliar word in an alphabetical list, all the while keeping the original context in mind so that you can compare it with the alternative senses given in the dictionary, then selecting the sense that is most appropriate in the original context—that is a high-level cognitive task. It should not be surprising that children are not good at it. Even when most of the complications are removed, children are still not good at it. On a simplified disambiguation task, in which fourth-grade students were given just two senses and asked to choose the one that was intended in a particular sentence, the students did little better than chance.

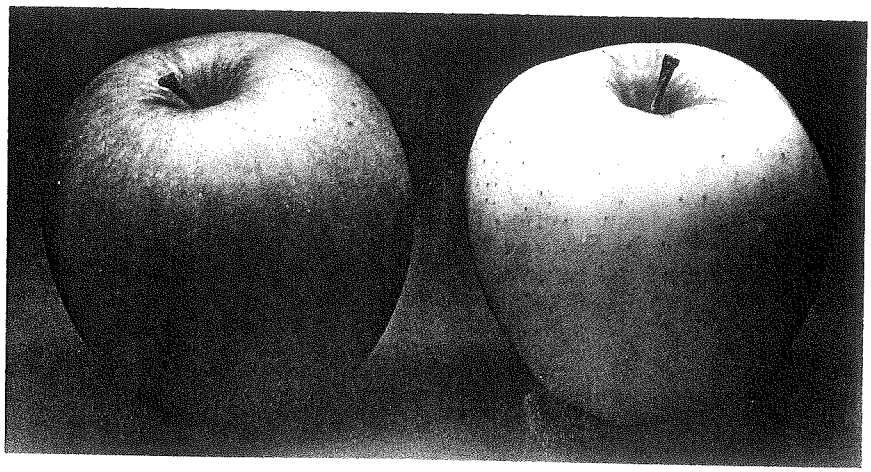
The second task, producing a sentence incorporating a new word, has the virtue of requiring the student to use the word and so, presumably, to think about its meaning. We have studied this production task extensively. After reading several thousand sentences that were written by children in the fifth and sixth grades we have concluded that it too is a waste of time.

Typical of the curious sentences we encountered was "Mrs. Morrow stimulated the soup." It illustrates the most frequent kind of error made by children in that age range. If they already know the word, their sentences are usually all right. If the word is unfamiliar, however, the results are often mystifying. In order to understand what the child did, you have to read carefully the same dictionary definitions the child read. The child who looked up *stimulate* found *stir up* among the definitions.

The example provides a key to what happens when children consult a dictionary. They find the unfamiliar word and then look for a familiar word or phrase among the definitions. Next they compose a sentence using the familiar word or phrase and substitute the new word for it. One of our favorite examples came from a fifth-grader who looked up the unfamiliar word *erode*, found the familiar



OVEREXTENSION in the use of words appears among preschool children when their understanding of a word is incomplete. A child whose understanding of *apple* does not extend beyond the fact that the object is round, red and of a certain size may call a tomato an apple, because without qualification those attributes also define a ripe tomato.



UNDEREXTENSION also appears, but it is revealed only by questioning. A child who thinks being round, red and of a certain size defines *apple* may not apply the word to green or yellow apples. One can find out only by asking what such apples are called.

phrases *eat out* and *eat away* in the definition and thought of the sentence "Our family eats out a lot." She then substituted *erode* for *eats out;* the resulting sentence was "Our family erodes a lot."

If children are so good at learning new words when they hear or see them used in context, why do they have trouble learning new words when they see them in a dictionary? We decided to look more closely at what goes on when an unfamiliar word is encountered in the context of a typical sentence. A preliminary study indicated that children can write better sentences when they are given a model sentence employing the word than when they are given a definition of the word. Since many of the sentences they wrote were patterned on the models, this result could not be interpreted to mean that the children learned more about the meaning of a word from illustrative sentences than they learned from definitions. Nevertheless, the observation was encouraging, and we pressed on.

The next step was simple: if one example is good, three should be better. When we made this comparison, however, we found that the number of examples made little difference. The acceptability ratings of sentences written after seeing one model sentence were the same as the ratings of sentences written on the basis of three examples.

That observation made us think again about what was going on. Apparently three unrelated sentences are hard for children to integrate, and so they simply focus on one of three examples and ignore the others. This behavior resembles what children do in reading dictionary definitions.

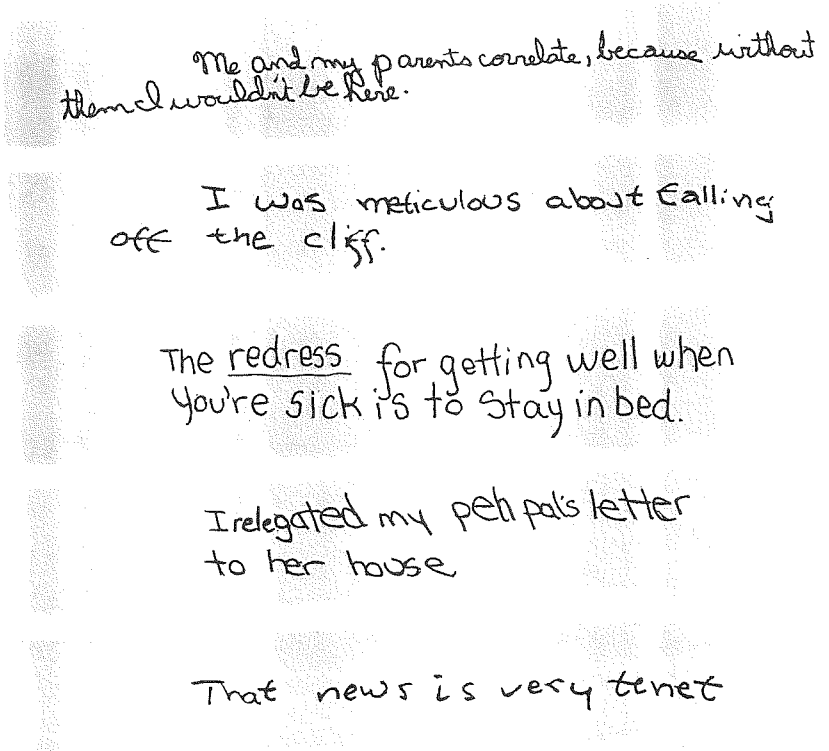
We were surprised by one result, although perhaps in retrospect we should have expected it. Mistakes resembling simple substitutions appeared even when model sentences were given instead of dictionary definitions. For example, given the model sentence "The king's brother tried to usurp the throne" to define the unfamiliar word *usurp,* the children wrote such sentences as "The blue chair was usurped from the room," "Don't try to usurp that tape from the store," "The thief tried to usurp the money from the safe" and so on. They had gathered from the model sentence that *usurp* means *take,* and so they composed sentences using *take* and then substituted *usurp* for it.

Children can appreciate at least part of the meaning of an unfamiliar word from its context, as in the case of *take* as one component of the meaning of *usurp.* Just as younger children may overextend *apple* because they know only part of its meaning, so this partial definition of *usurp* resulted in its being overextended. That is to say, if *usurp* is incompletely defined as *take,* it can be said of anything takable: chairs, tape, money or whatever. When it is seen from this perspective, the behavior of these children in the fifth and sixth grades is merely a later stage in the development of a word-learning process employed by preschool children.

The substitution strategy therefore seems to be quite general. In the context of a model sentence, however, something more than a simple substitution error appears. The children cannot search through an illustrative sentence for a familiar word as they could in a dictionary definition. First they must abstract a familiar concept from the context of the unfamiliar word. Only then can they apply the substitution rule.

Might there be a better way to foster the growth of vocabulary? What we and others have found out about the word-learning process will support some plausible suggestions. Put at the front of your mind the idea that a teacher's best friend in this endeavor is the student's motivation to discover meaning in linguistic messages. Then the problems with the traditional modes of instruction will begin to make sense. Drill on arbitrarily preselected lists of words seldom takes place at a time when the student feels a need to know those words; it fails to draw on the natural motivation for learning the associations between word and meaning. Learning through reading faces the opposite problem: not enough information about the word is available at the moment the student is motivated to learn its meaning.

What is needed is reading, which can make students curious about unfamiliar words, supplemented by immediate information about the meaning and use of those words. The important thing is to provide the information while the reader still wants it. Dictionaries are too slow. Recourse to a dictionary may help a mature and well-motivated student, but for the average child in the elementary grades it is likely to compound interruption with misunderstood information. A human tutor—someone immediately available to detect and resolve lexical misunder-



MYSTIFYING SENTENCES are often written by schoolchildren when their grasp of an unfamiliar word is incomplete. Here are examples in the handwriting of children in the fifth and sixth grades. The illustration on the opposite page reveals what was going on.

standings—would be much better than a dictionary.

Given the shortage of attentive tutors to sit at every young reader's elbow, it is natural to wonder how much of the tutoring task might be carried out by a suitably programmed computer. For example, suppose reading material was presented to the student by a computer that had been programmed to answer questions about the meanings of all the words in the material. No alphabetical search would be needed: the student would simply point to a word and information about it would appear. No sophisticated disambiguation would be necessary: the computer would know in advance which particular sense of a word was appropriate in the context. Indeed, no definition would be necessary: the phrase or sentence containing the word could be rephrased to show what the word meant in the context.

As a case in point, imagine what such a computer might do with *erode* and *usurp*. It might present a text containing the sentence "The president's popularity was eroded by his bad relations with Congress." If the student asked for information about *erode*, the computer might state: "Things can erode; when soil is eroded by rain or wind, it breaks up and so is slowly destroyed and removed. Someone's power or authority can erode too, being slowly destroyed or removed by unfavorable developments. That kind of erosion is meant in the sentence about the president."

Suppose that for *usurp* the computer presented a text containing the sentence "The king's brother failed in his effort to usurp the throne." Asked for information, the computer might say: "When you usurp a title, job or position from someone else, you seize it or take it away even though you have no right to it. In the sentence about the king's brother, *throne* means not just the piece of furniture the king sits on; it also stands as a symbol of the king's authority."

Providing such explanations almost instantly is well within the range of currently available computer technology. It is even possible to add a voice that pronounces the target word and explains it, or to show pictures indicating what the word denotes in the context.

We are exploring some of these possibilities with a setup in which children in the fifth and sixth grades interact with a video display. They are asked to read a text that describes an episode from a motion picture they have just seen. Included in the text are certain marked words the reader is expected to learn. When one of them comes up, the child can ask for information about its meaning in any or all of three forms: definitions, sentences and pictures.

For some children illustrative sentences are more informative than definitions or pictures. When such children are given a definition, they read it and quickly return to the story. When they are given a sentence that is relevant to the story and uses the word in the same context, they interpret it as a puzzle to be solved. They spend more time thinking about the meaning of the word and remember it better a week later.

We found that providing information when it is wanted can significantly improve the children's grasp of unfamiliar words, as is demonstrated by their ability to recognize the meanings and to write acceptable sentences incorporating the words. The results reinforce our belief that much can be done with computers to make learning words easier.

DEFINITION	EXCERPT	RESPONSE
correlate 1. be related one to the other: *The diameter and circumference of a circle correlate.* 2. put into relation: *Try to correlate your knowledge of history with your knowledge of geography.* v., correlated, correlating.	be related	Me and my parents correlate, because without them I wouldn't be here.
meticulous very careful or too particular about small details. *adj.*	very careful	I was meticulous about falling off the cliff.
redress 1. set right; repair; remedy: *King Arthur tried to redress wrongs in his kingdom.* 2. reparation; setting right: *Any man deserves redress if he has been injured unfairly. v., n.*	remedy	The redress for getting well when you're sick is to stay in bed.
relegate 1. send away, usually to a lower position or condition: *to relegate a dress to the rag bag.* 2. send into exile; banish. 3. hand over (a matter, task, etc.). *v.*	send away	I relegated my pen pal's letter to her house.
tenet opinion, belief, principle, or doctrine held as true. *n.*	true	That news is very tenet.

DICTIONARY DEFINITIONS read by the children who wrote the sentences in the illustration on the opposite page appear at the left here. When the word is unfamiliar, the child usually abstracts some familiar concept (*middle*) from the definition, composes a sentence embodying that concept and then substitutes the new word, such as *correlate*.