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Understanding Noun Phrases

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One view of sentence comprehension is that word meanings are retrieved independently and then combined: another view is that the retrieved meanings for words are context dependent and thus different in different sentences. To examine retrieval of a noun's meaning in the context of an adjective, spoken sentences were probed with a picture. Subjects were instructed to respond positively if the picture illustrated a noun in the sentence (e.g., *house*), regardless of other information in the sentence (*burning house*) or in the picture. Even when the probe appeared immediately after an adjective–noun pair, an atypical picture incorporating the adjective was responded to more rapidly than a more typical picture. The results suggest that a noun's meaning is retrieved in conjunction with the adjective, not independently, when the phrase describes a familiar conception such as a burning house.

A central issue in the study of language comprehension is how the meanings of words are combined to reach an understanding of a sentence. One possibility is that the meaning of each word is retrieved independently of sentence context and then combined with that of the preceding words. A second possibility is that the preceding words influence the retrieval of a meaning for the word, such that the retrieved meaning is appropriate to the context. In this study we examine understanding of the noun in a noun phrase, asking to what extent the recovery of a meaning for the noun is influenced by a preceding adjective.

Independent retrieval of word meanings is an attractive possibility for noun phrases because it fits with the commonsense view that the extension of a noun phrase is the Boolean intersection of the extensions of the adjective(s) and the noun: For example, a red ball is a thing that is both a ball and red. Moreover, such an approach is well suited to explain the productivity of language comprehension. For instance, a new expression such as *an exhausted aardvark* can be understood by retrieving the meanings of the separate words and using rules to combine them (e.g., Johnson-Laird, 1977).

The empirical evidence for independent or context-free retrieval is largely based on studies of homonyms, where context-free retrieval would imply that all the meanings of a homonym are retrieved initially, regardless of prior context. There is some evidence in support of this prediction (e.g., Conrad, 1974; Foss & Jenkins, 1973; Warren & Warren, 1976; Swinney, Note 1; cf. Yates, 1978), although other investigations have not supported it (e.g., Mehler, Segui, & Carey, 1978; Schvaneveldt, Meyer, & Becker, 1976).

The second approach to the problem of word combination emphasizes the influence of context on the meanings of words. In the case of homonyms such as *jam*, the contexts of *strawberry jam* and *traffic jam* lead to the retrieval of two entirely different meanings of *jam*. Words that are not homonyms can also take on somewhat different meanings in different contexts. In Anderson and Ortony's example (1975), an apple container is apt to

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be different from a soft drink container. Although the independent meanings of *container* and *soft drink* could be used to construct an appropriate interpretation, it might be economical to retrieve the knowledge that soft drinks usually come in bottles or cans. That is, the context might influence the retrieval of a specific meaning for *container*.

Context-sensitive views of sentence comprehension have been put forward by Barclay, Bransford, Franks, McCarrell, and Nitsch (1974) and by Anderson and his colleagues (Anderson & Ortony, 1975; Anderson, Pichert, Goetz, Schallert, Stevens, & Trollip, 1976; Halff, Ortony, & Anderson, 1976). The experimental tests they have carried out typically measure memory for sentences. For example, Barclay et al. (1974) presented *piano* in two contexts, *The man lifted the piano* and *The man tuned the piano. Something heavy* was a better cue to recall *piano* in the former case, and *something with a nice sound* in the latter. The authors conclude that *piano*'s meaning or concept includes both its weight and its ability to make sounds, but that sentence context influenced which of those was activated. Such memory tests do strongly suggest that sentence understanding is accompanied by some conceptual selection or elaboration, but they do not rule out the possibility that the selective process *follows* the independent lookup of all word meanings.

To examine the influence of a preceding adjective on initial retrieval of the meaning of a noun, we presented an immediate probe of the noun. Subjects listened to sentences such as *It was already getting late when the man first saw the burning house ahead of him.* A picture probe appeared immediately after the critical noun, in this case *house*. The picture illustrated the noun alone, the whole noun phrase (e.g., a burning house), or did not illustrate any noun in the sentence (see Figure 1).

The subject's task was to decide whether or not the pictured object had been named in the sentence, *regardless* of the condition of the pictured object or the meaning of the whole sentence. Since the design was such that the prenominal adjective actually matched the picture probe on only 8% of a subject's trials, there was no incentive to combine the adjective and noun or indeed even to understand the sentence. Thus, the bias was toward context-free retrieval of noun meanings. Controls in which the adjective was omitted were included for comparison.

If the initially retrieved meaning of *house* is not influenced by a preceding adjective such as *burning*, then response to a typical picture should be the same whether or not the adjective is included in the sentence. The typical house should be matched to the noun *house* more rapidly and accurately than the less typical, modified picture of a burning house. If, however, the adjective *burning* constrains the understanding of *house*, the typical picture should be harder to match to *house* and the modified picture of a burning house should be easier to match, compared with the control sentence in which *burning* is omitted.

Even if the meaning of a noun is retrieved in a context-free manner, a combined meaning for the noun phrase should be computed subsequently. To test the hypothesis that there are two stages, half the probes were presented at the end of the sentence rather than immediately after the critical noun; a combined meaning for the noun phrase should be available by that time. If the two-stage hypothesis is correct, suitably modified pictures should benefit from a delay while typical pictures should lose.

A final variable was the location of the adjective. To assess the scope of the (possible) influence of the adjective, in one condition it was directly prenominal (part of the noun phrase) and in a second condition it was presented in an earlier part of the sentence.

Some comment about the use of pictures as probes of words in sentences is warranted. Several lines of evidence indicate that a picture of an object taps the same conceptual

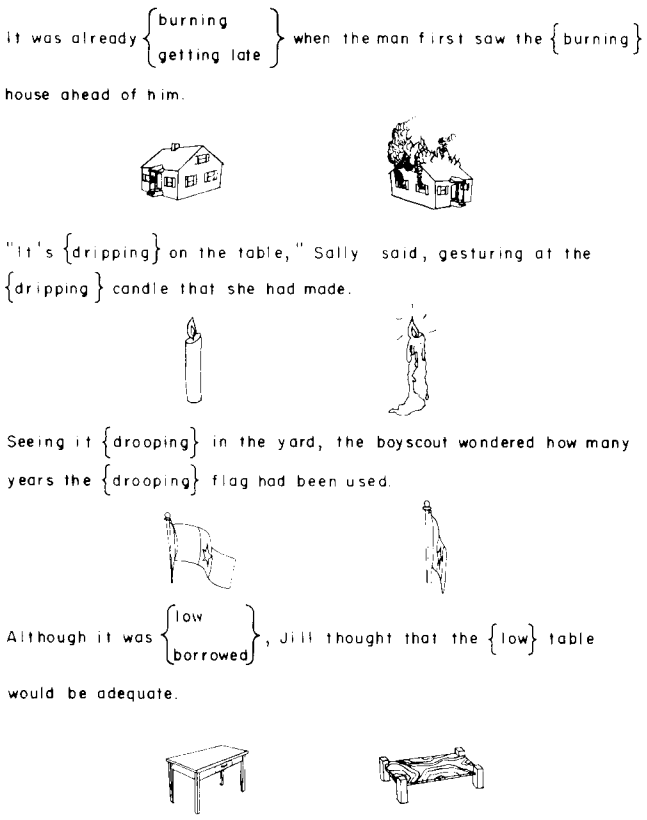

FIG. 1. Examples of sentences and typical versus modified picture probes. The three versions of each sentence (prenominal adjective, separated adjective, and no adjective) were obtained by appropriate combinations and deletions of the bracketed words.

representation as its written or spoken name. Moreover, a picture appears to activate the corresponding concept at least as fast as a word. For example, Potter and Faulconer (1975) found that a picture of an object such as a table was matched to a previously named superordinate category such as *furniture* about 50 milliseconds faster than the written word *chair* was. Since subjects take 260 milliseconds longer to name the pictures than to name the words, it is clear that the match was not mediated by the name of the picture (see also Potter, Valian, & Faulconer, 1977). Klein, Potter, and Fodor (Note 2) played subjects taped sentences followed by a written word or picture probe; the subjects' task was to decide whether the probe had been named in the sentence. Picture probes were 40 milliseconds faster than word probes. These experiments show that a pictured object maps onto the representation of a spoken word at least as rapidly as a written word does, validating the use of pictures as sentence probes.

METHOD

Subjects

The subjects were 48 college student volunteers, men and women, who were paid for their participation.

Materials

Forty-eight sentences of 9 to 19 words were written. Examples of the sentences and probes

are given in Figure 1 and all 48 sentences are included in the Appendix. All included at least one noun that could be pictured. From one to five words followed the critical noun. Three versions of each sentence were prepared. In one, there was no adjective; in the second, the target noun was preceded by an adjective that modified it in such a way that the modifier–head combination could be represented in a picture. In the third version, the modifying information appeared in an earlier part of the sentence, although it referred to the target noun. In this version the manner of presenting the modifying information was varied across sentences. In all but four cases, the modifier was in a separate clause (the first clause was about equally often subordinate, superordinate, and coordinate). In 38 of the sentences, the separated modifier was attached to a pronoun that referred to the target noun. A mean of 6.2 words separated the modifier and the noun.

The sentences were read aloud by a skilled speaker unacquainted with the purpose of the experiment. They took between 3 and 5 seconds each to read. The three versions of a sentence were counterbalanced over three master tapes so that each tape had 16 sentences of each type, in addition to 6 practice sentences. Two copies of each of the three tapes were made so that the timing of the probe could be counterbalanced across subjects. For each sentence, a signal was placed on the second channel of the tape so that the probe would appear immediately after the noun or immediately after the last word of the sentence (about 1 second later than the immediate probe). The signal, not heard by the subject, opened a shutter to display the probe and started clocks to measure the subjects' response time.

The probe pictures were line drawings of objects. One of the two positive probes for each target noun we judged to be a typical picture of the object, and the other picture was less typical because it incorporated the modifying information (see Figure 1). Twenty-four additional drawings of objects not named in any sentence were used as negative probes. The drawings were photographed and presented as slides.

Apparatus

The sentences were presented on a tape recorder via earphones. The probes were presented for 1 second using a shutter tachistoscope attached to a slide projector. The picture appeared on a screen about 2.7 m in front of the subject; it subtended about 4° of visual angle. The subject responded by pressing one of two buttons. Response time was measured to the nearest millisecond.

Design and Procedure

Sentence type, probe delay, picture type, and positive vs negative probe were all within-subject variables. The three versions of each sentence (prenominal adjective, separated adjective, no adjective), the two probe positions (immediately after the noun, or at the end of the sentence), the two versions of the positive picture probe (typical, modified), and positive versus negative probes were counterbalanced across subjects so that a given sentence was presented to two subjects in each of 12 positive conditions and four subjects in each of 6 negative conditions (for the negative-probe sentences, typicality of the probe was not varied). Correspondingly, each subject saw two sentences in each of the 12 positive conditions and four negatively probed sentences in each of 6 conditions.

The same random order of the basic sentences was used for all subjects. Each subject heard only one version of a given sentence and saw one of the two positive probes, or the negative probe. The subject was instructed to listen to the sentences and, when the picture appeared, to decide as rapidly as possible whether the object shown in the picture had been named in the sentence. It was emphasized that *the picture did not have to*

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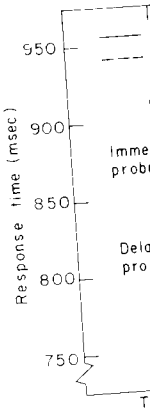

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match the meaning of the sentence but only had to match one word, the name of the object. Examples made that clear, and the low error rate showed that subjects understood. Six practice sentences were presented, during which the subject was encouraged to respond rapidly. The sentences were separated by 15 seconds on the tape; the word *Ready* preceded each sentence. There was one brief rest period halfway through the experiment.

At the end of the experiment, subjects were unexpectedly handed a sheet with the 48 probed nouns listed in random order, with a space for an adjective. They were asked to recall any adjectives or modifiers that they remembered from the sentences.

Results

The result of greatest theoretical interest concerns sentences with and without a prenominal adjective, when the probe was immediate. The mean response times for positive trials are shown in Figure 2. When there was no adjective, a typical picture probe was responded to 94 milliseconds faster than a modified probe. When there was a prenominal adjective, the modified probe was 25 milliseconds faster than the typical probe. The interaction was similar for delayed probes, although responses were 71 milliseconds faster, overall. Thus, contrary to the hypotheses that a noun's meaning is first retrieved independently and later combined with the adjective, delaying the probe did not increase the effect of the adjective. Unlike the prenominal adjectives, adjectives separated from the noun had little influence on the probe comparison in either the immediate or delayed conditions.

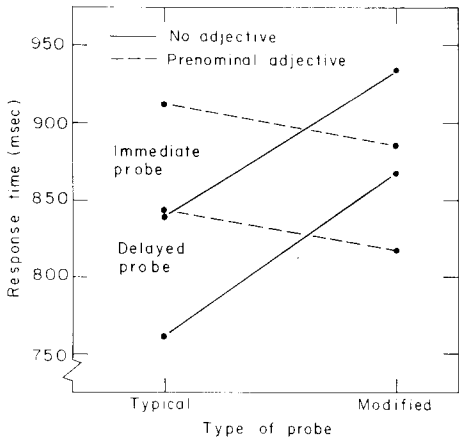

FIG. 2. Mean time to respond to positive-probe pictures for sentences with and without a prenominal adjective.

In the analysis of response time, times greater than two standard deviations above a subject's mean (less than .02 of the responses) were replaced by the mean plus two standard deviations. Only correct responses were analyzed; .034 of the responses to positive probes and .016 of the responses to negative probes were errors. The percentage of errors tended to be higher in the conditions with longer response times.

The first set of analyses compared the prenominal-adjective and no-adjective conditions, omitting the separated-adjective condition. Responses were faster when the probe was delayed, $minF'(1, 91) = 7.10$, $p < .01$. Neither probe type (typical versus modified) nor sentence type (with or without an adjective) had a significant overall effect on response time. The interaction between probe type and sentence type was significant, $F_1(1, 47) = 13.02$, $MS_e = 29{,}343$, $p < .01$, $F_2(1, 47) = 11.72$, $MS_e = 39{,}276$, $p < .01$; $minF'(1, 94) = 6.17$, $p < .025$ (there were no other significant interactions). Newman–Keuls tests showed that subjects responded more rapidly when the sentence had no adjective and was probed with a typical picture, than they did in the other three sentence-probe conditions. When the sentence had a prenominal adjective, subjects were faster when the probe picture was suitably modified than when it was typical of the noun.

Separated Adjectives

A second set of analyses contrasted separ-

ated-adjective and no-adjective sentences (Figure 3). Responses to typical pictures were faster than to modified pictures, $F_1(1, 47) = 19.11$, $MS_e = 29{,}479$, $p < .01$, $F_2(1, 47) = 12.22$, $MS_e = 59{,}531$, $p < .01$, $minF'(1, 90) = 7.45$, $p < .01$. Responses to delayed probes were faster than to immediate probes, $F_1(1, 47) = 24.14$, $MS_e = 30{,}916$, $F_2(1, 47) = 22.91$, $MS_e = 42{,}793$, $minF'(1, 94) = 11.76$, $p < .01$. No interactions were significant; thus, unlike prenominal adjectives, separated adjectives did not influence the probe comparison.

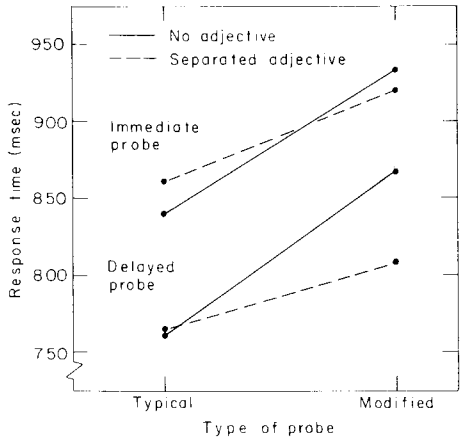

FIG. 3. Mean time to respond to positive-probe pictures for sentences with and without a separated adjective (or equivalent modifying information).

Negative Trials

The main theoretical question concerning negative responses was whether the presence of an adjective would affect response time. A significant effect of sentence type was obtained in the subjects analysis, $F_1(2, 94) = 3.50$, $MS_e = 5944$, $p < .05$, but not in the items analysis, $F_2(2, 94) = 1.37$, $MS_e = 19{,}591$. The means were 913 milliseconds for sentences without the critical adjective, 939 milliseconds for sentences with a prenominal adjective, and 937 milliseconds for sentences with a separated adjective. There is a weak suggestion, then, that the presence of an extra adjective anywhere in the sentence slowed probe comparison slightly. (When the negative probe was immediate, however, there was only a 2-millisecond difference between sentences with and those without a prenominal adjective.) As with positive responses, response to a delayed probe was 98 milliseconds faster than to an immediate probe, $minF'(1, 94) = 32.31$, $p < .01$. No interactions were significant.

Recall

Subjects were unexpectedly given a list of the nouns and asked to recall the adjectives. Overall, 38% of the adjectives were correctly recalled (less than 2% were correctly guessed when they had not been in the sentence). Analyses of variance, which will not be reported in detail, showed main effects significant at the .01 level for recall of prenominal (43%) versus separated (33%) adjectives; delayed (42%) versus immediate (34%) probes; positive (55%) versus negative (21%) probes; and, for positive trials, modified (63%) versus typical (47%) probes. No interactions were significant. The results are consonant with a depth-of-processing interpretation, with better recall of delayed probes and probes that matched the phrase. Although the probe comparison task could in principle have been carried out by treating the words as a list, it is clear that subjects did tend to process the sentence to the point of encoding the adjective–noun relationship, even when the adjective appeared much earlier in the sentence.

DISCUSSION

The results indicate that a prenominal adjective does influence retrieval of a noun's meaning. When subjects match a pictured object to a noun preceded by an adjective, they respond more quickly to a picture that is modified to reflect the combined adjective–noun meaning than to a more typical picture. That result was obtained even though adjectives and pictured modifications were irrelevant or misleading on most trials and had to

be ignored. Evidently interactive retrieval of the meanings of an adjective and noun in a noun phrase occurs automatically, when a sentence is presented.

The pattern of results did not change when the probe was delayed until the end of the sentence, so there was no suggestion that the listener started with an independent meaning for the noun and developed a combined meaning thereafter. Although responses to immediate probes were slower, overall, than responses to delayed probes, there was no interaction with the other variables (Figure 2). (Presumably response to immediate probes was slower because attention was divided between listening and responding.)

Little or no influence of the adjective was observed when the adjective and noun were separated. (There was a slight suggestion—see Figure 3—that the adjective had been joined with the noun by the time a delayed probe appeared.) Unlike prenominal adjectives, a separated adjective could not be related structurally to the noun until some information about the noun's meaning had been retrieved. For example, the sentence *It was already burning when the man first saw the* [*house ahead of him*] could have ended [*kid with the gasoline running from the house*]. *House* in the first version and *kid* in the second version appear at identical points in the sentence; it is not only their location in the surface structure but their meanings that make them good and poor candidates, respectively, for the referent of the thing that was burning. Therefore, independent retrieval of the noun would be expected. The absence of a significant influence of the earlier adjective on the probe comparison suggests, then, that context-dependent retrieval of meaning is not the result of global associations to previous words.[1]

The results appear to show that the meaning of a noun phrase is retrieved as a single unit. Before considering how such holistic retrieval might occur, we will consider a number of other possible explanations of the results. First, was the meaning of the noun retrieved independently but combined with that of the adjective so rapidly that the process was complete before comparison with even the immediate probe? If there is a stage at which representation of the noun's independent meaning is available, the results indicate that it is ordinarily extremely brief and leaves no trace. Otherwise, the independent representation (or its trace) should have been available more often when the probe appeared *immediately* after the spoken noun, than when the probe appeared at the end of the sentence.

One might explain the seemingly instantaneous completion of the combinatory process by adding a further assumption. Major syntactic constituents of a sentence appear to resist intrusion of extralinguistic events such as clicks, as though processing of the constituent has to be completed before other sensory events can be processed (Fodor, Bever, & Garrett, 1974; but cf. Clark & Clark, 1977). If completion of noun phrase processing is *obligatory* prior to picture matching, that would explain the failure to obtain an increase in the adjective effect with delay. This explanation would require, however, that a noun phrase with an adjective take longer to process than one without an adjective, since a combinatory stage would be added to the time required to comprehend the noun. Yet, prenominal adjectives only increased positive response latencies to immediate probes by 13 milliseconds and negative response latencies by 2 milliseconds, in neither case a significant change. (Using a different paradigm, Fodor and Garrett (1967)

[1]Swinney (Note 1) reports evidence that multiple meanings of an ambiguous noun are retrieved without influence from prior semantic context, although within a second the relevant meaning is selected. The context in Swinney's experiments was not provided within the noun phrase, and its effect seems to have been similar to that of a separated adjective. In any case, activation of the multiple meanings of an unsystematic homonym may be controlled by factors different from those that determine the interpretation of an unambiguous noun phrase.

likewise found no evidence for increased processing load when a prenominal adjective was added.) The process that combines the meanings of the adjective and noun appears to occur in conjunction with noun comprehension, not following it.

In a phoneme-monitoring task, Blank and Foss (1978) found that an adjective that was highly related to the noun (e.g., *bloodshot eye*) speeded response to a following phoneme by 20 milliseconds, compared with an unrelated adjective (*aching eye*). They concluded that context aided lexical lookup (i.e., recognition) of the noun. Did the adjectives in the present experiment merely speed noun recognition, without affecting retrieval of the noun's meaning once it had been recognized? No, because then adjectives should have speeded responses to both typical and modified probes—instead, responses to typical probes were slowed. Also, response to negative probes should have been speeded when there was an adjective, and they were not.

A similar possibility is that the adjective aided recognition of the object in the modified picture, but did not affect retrieval of the noun's meaning. By itself, that would not explain why a prenominal adjective produced a highly significant 73-millisecond increase in response time to a typical picture. Suppose, however, that the two words contributed *separately* to the probe match. For example, *burning* and *house* could be compared simultaneously but independently to the picture probe, giving a better match to the appropriately modified picture than *house* alone and thus producing a faster response. This matching explanation concurs with the context-dependent hypothesis in proposing that subjects irresistibly matched the whole noun phrase to the picture, not just the noun.

Unlike the context-dependent hypothesis, the matching explanation maintains that the meanings of the adjective and noun were separate at the time the comparison with the probe was made. Some of the adjectives were interpretable and perhaps imageable on their own (e.g., *burning*, *furry*, *bandaged*) and so could have been compared directly with the picture. Many, however, could not have been compared with the picture until they were combined with the noun's meaning. That is most obvious for relative adjectives (e.g., *long* skirt), but is also the case for many other adjectives (e.g., *caught* fish, *closed* hand). According to the matching explanation, the more interpretable adjectives would be more likely than the others to have contributed to the interaction between phrases and probes. A post hoc comparison of the 19 least interpretable and the 15 most interpretable adjectives offered no support for that hypothesis. As high a proportion of the uninterpretable adjectives (15/19) as of the interpretable adjectives (11/15) showed the direction of interaction predicted by the interaction hypothesis. Of the intermediate adjectives (e.g., *ransacked* desk) 11/14 showed the predicted interaction. The lack of difference between separately interpretable and uninterpretable adjectives strongly suggests that listeners had combined the meanings of the adjective and noun before the probe appeared.

We now consider two ways in which context-dependent or holistic retrieval of a noun phrase's meaning could take place. One possibility is that people have single lexical entries for a large number of phrases, just as they presumably have single entries for compounds like *hot dog*. There are, however, differences between such compounds and most of the noun phrases used in the present experiment. Compounds typically have a distinct stress pattern (Gleitman & Gleitman, 1970) and are lexically bound: One cannot refer to a frankfurter as a *hotter dog* or a *hot little dog*. Recognition of compounds may be feasible precisely because those variations are not permitted. In contrast, the phrases we used have many variations and paraphrases such as *burning suburban house* and *flaming dwelling*. It seems unlikely that each of these whole phrases has a separate *lexical* entry.

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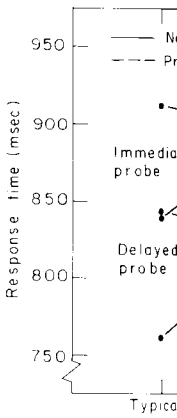

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The second possibility is that the adjective and noun activate separate lexical entries (that is, they are recognized independently) but there is interaction during retrieval of their meanings. This possibility assumes that a word's meaning is not represented in the lexical entry, but in a conceptual system addressed by the lexical entry. In the conceptual system (which can be regarded as a network of links between nodes) a word's meaning is not a fixed entity that is activated as a whole, but meaning is given by the pattern of activation produced on that occasion. Quillian (1966) proposed a model of sentence comprehension in which activation spreads from the content words until intersecting pathways are discovered; the intersecting pathways are then checked for their consistency with syntactic information in the sentence (cf. Anderson, 1976; Collins & Loftus, 1975; Woods, 1975).

With a model of this kind, priority is given to the pathway that first connects the concept nodes of the words in a noun phrase such as *the burning house*. Activation of *house* alone would spread activation to a large number of directly and indirectly linked nodes embodying a nonspecific and hence "typical" meaning of *house*. Activation of both *burning* and *house* short-circuits this process of spreading activation, confining it to the sequence of links and nodes connecting *burning* and *house* in a syntactically appropriate way. Alternatively, activation spreading between a noun and adjective may converge on a third node that represents the whole phrase—for example, a node for the idea of a burning house. Models of this type have been proposed by Nash-Webber (1975), Kieras (1977), and Anderson, Kline, and Lewis (1977). Presumably the same node could be activated by a similar expression such as *flaming dwelling*, or by an appropriate picture. Nonlexical nodes for complex ideas offer a natural vehicle for comprehension of indexical phrases (McCawley, 1970) and other referring expressions.

Such models might account for holistic understanding of many noun phrases, but the models ought to predict *independent* retrieval of the noun whenever a short pathway between the adjective and noun is not available. For novel phrases such as *furry umbrella*, an intersecting pathway may not be arrived at until one has retrieved the facts that part of an umbrella is fabric and that fur can be used as a fabric. By that time, a relatively complete retrieval of the independent concept of *umbrella* will have taken place.[2]

A post hoc test of this conjecture was carried out. Ten new subjects rated the 48 adjective–noun pairs (without the surrounding sentence) for the familiarity of the idea expressed by the noun phrase, *relative* to that of the noun. The mean ratings were used to sort the noun phrases into four levels of familiarity, with 12 phrases at each level (examples, ranging from novel to familiar, are *broken screwdriver*, *tangled puppet*, *closed hand*, and *roasted turkey*). The mean response times for the four groups of phrases are shown in Figure 4, broken down by condition (each curve corresponds to one point in Figure 2). For immediate probes, increasing familiarity was associated with a dramatic increase in the magnitude of the adjective's influence, in the expected direction (seen in the difference between the solid and broken curves in Figure 4). When the probe was delayed, however, the familiarity of the phrase was not systematically related to the size of the adjective effect. That is what one would expect if the combined meaning of even an unfamiliar noun phrase was available by the time a delayed probe appeared.

Although a post hoc analysis of this kind should be accepted with caution because of possible confoundings with other variables, the results support the conjecture that holis-

[2]Comprehending a novel meaning would require other mechanisms in addition to spreading activation. Presumably a computational routine is used to combine meanings of words whenever no prestored representation of the whole phrase is available (cf. Smith, 1978).

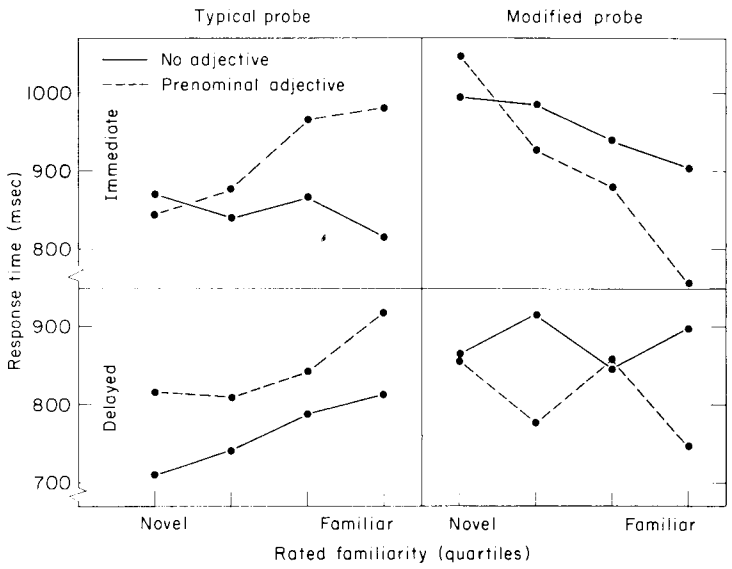

FIG. 4. Mean time to respond to positive-probe pictures as a function of the rated familiarity of the adjective–noun combination. Responses to the same nouns without the adjective are shown for comparison.

tic understanding of the sort observed in the present experiment occurs only when the concept expressed by a phrase is already familiar. A model of this type implies that the depth of retrieval of a noun's meaning will be negatively correlated with the availability of a link with an adjective in the same phrase. For example, more might be retrieved about kangaroos on hearing *the wading kangaroo* than on hearing *the hopping kangaroo*. That is, the model permits varying degrees of meaning retrieval, rather than a fixed semantic representation of a given word that is activated as a whole.

In conclusion a listener hearing a noun phrase such as *the burning house* retrieves a unitary meaning for the whole phrase, apparently without first retrieving a context-free meaning of *house* and then combining it with *burning*. Since unitary comprehension does not occur when the adjective is separated from the noun, interactive retrieval is probably under the control of syntactic as well as semantic structure. A post hoc analysis suggests that context-dependent interpretation of noun meaning may be limited to phrases that express ideas already represented in memory. A spreading-activation model of comprehension can account for retrieval of complex but familiar ideas in a holistic manner while allowing for computation of novel ideas following independent retrieval of individual word meanings.

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APPENDIX

Sentences used in the experiment: the bracketed words were added or deleted to obtain the three versions of each sentence. The critical adjective and noun are italicized.

[*juggling*]

1. Although [the activity] was not his forté, the [*juggling*] *clown* was successful.

[*upside down*]

2. It was [moving slowly], but at last the [*upside down*] *airplane* came in sight.
3. Seeing it [*drooping*] in the yard, the boyscout wondered how many years the [*drooping*] *flag* had been used.
4. "It's [*hanging*] over there," directed Mark, hoping Harry would find the [*hanging*] *saw* where he left it.

5. [*Tangled* and] forgotten in the attic, the [*tangled*] *puppet* was finally found.

[*burning*]

6. It was already [getting late] when the man first saw the [*burning*] *house* ahead of him.

[*swimming*]

7. He was already [*prepared*] when the boat arrived so the [*swimming*] *diver* decided to go.

8. It was [*electric* and] easy to use, so Jane produced the [*electric*] *coffeepot* whenever she had company.

[*it fell*]

9. On Joe's second try [he paused] and, eyeing the [fallen] *bowling pin*, he added the score.

10. It [The *box* style] turned out to be easy to manage, even though Jimmy had never tried a [*box*] *kite* before that day.

11. [*Empty*] after the move, the [*empty*] *bookcase* looked out of place.

12. A few minutes later [it *revolved* and] the chairman came through the [*revolving*] *door* for the meeting.

13. Helen put it aside [*half eaten*] because she was in a hurry even though the [*half-eaten*] *apple* appealed to her.

14. Though Sam had it with him [*in a harness*], he hoped that the [*harnessed*] *gun* wouldn't be necessary.

15. Charles carefully [*disassembled* and] cleaned the [*disassembled*] *trombone* he had found.

[an *antique*]

16. Although it was [on loan], Kathy used the [*antique*] *record player* all the time.

17. Although he was still [*dangling*] by himself, the [*dangling*] *monkey* was entertaining.

[*paper*]

18. Choosing her [favorite] one, the girl gave the [*paper*] *doll* to her friend.

[*contemporary*]

19. "It's [appropriate]," thought the newlywed, as she imagined the [*contemporary*] *chair* in the apartment.

[*stubby*]

20. It was [unfamiliar] so the first grader found the [*stubby*] *pencil* hard to hold.

21. "It's [*dripping*] on the table," Sally said, gesturing at the [*dripping*] *candle* that she had made.

22. [*Trumpeting* and] capturing everyone's attention, the [*trumpeting*] *elephant* was the main attraction.

[*caught*]

23. "I [want] it," said the child, as she pointed to the [*caught*] *fish* and smiled.

24. The [*Easter*] season encouraged brisk sales of [*Easter*] *hats* and other clothing.

[*wheelless*]

25. The boy found it [easily] when it was time to take the [*wheelless*] *bicycle* home.

26. It was left [*dirty*] on the counter but no one saw the [*dirty*] *pan* until suppertime.

[*Closing* it]

27. [Glancing around], the stranger held up his [*closed*] *hand* as a sign.

[*broke*]

28. "You [found] it," Andy said, noticing the [*broken*] *screwdriver* in the workshop.

29. [*Adjoining*] in typical New England style, the [*adjoining*] *barn* had many uses.

[the *furry* one]

30. Deciding that he liked [it], Phil bought the [*furry*] *coat* on credit.

[*hanging*]

31. It was [placed] in the center and most of the people thought the [*hanging*] *lamp* was a fine addition.

32. Carol examined it [*unstrung*] and decided that the [*unstrung*] *racquet* could be fine.

33. "It's [*bandaged* and] already taken care of," said the man looking at his [*bandaged*] *foot* without concern.

34. The waiter [*sliced* and] carried in the [*slice of*] *pie* that was the specialty.

35. "I don't have one [that *long*]," thought the customer, looking at the [*long*] *skirt* on display.

36. "He's [*hiding*] over there," indicated the keeper, pointing at the [*hiding*] *ostrich* in the field.

[*Bedraggled*]

37. [Impolite] as it was, Stan used the [*bedraggled*] *comb* frequently.

38. [*Closing* it] after he finished, the old man held the [*closed*] *accordion* and smiled sadly.

39. It had been [*ransacked* and] moved around while the Smiths were away, but the [*ransacked*] *desk* was still in the house.

[*turned* it *on*]

40. Connie [entered the room] and wondered what the [*turned-on*] *television* had to offer.

["It's *bloody*!"]

41. The woman screamed ["Help!"] as she stared at the [*bloody*] *dagger* in his hand.

[*half*]

42. Looking at the [last one] that was left, Edith wondered if the [*half*] *sandwich* would be eaten.

43. Attempting to complete the job, Dick [*loaded* and] moved the [*loaded*] *wheelbarrow* to the site.

[*low*]

44. Although it was [borrowed], Jill thought that the [*low*] *table* would be adequate.

[*stacked*]

45. "They are all [there]," said Linda, as her mother looked at the [*stacked*] *blocks* from the hall.

[*Melting*]

46. [Served] within 5 minutes, the [*melting*] *ice cream cone* was still welcome.

[*partly finished*]

47. It was [mid-summer] and Pa was proud of the [*partly finished*] *log cabin* he had designed.

[*large*]

48. It was [roasted], so Bob handled the [*roasted*] *turkey* with care.