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Representation of a Sentence and Its Pragmatic Implications: Verbal, Imagistic, or Abstract?

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To test the hypothesis that the meaning of a sentence is represented in an abstract format rather than one mediated by words or images, 96 spoken sentences were immediately followed by a word or drawing probe. Subjects decided whether or not the probe was related to the meaning of the sentence. Response times to the drawing and word probes did not differ significantly overall. There was no interaction between probe modality and either the imageability of the sentence or the semantic relatedness of the sentence and probe. Unexpected free recall of the probes was better for drawings than for words; subjects accurately recalled the modality of probes. Although modality-specific representations must be computed (since they are retained), it is concluded that the meaning of a sentence or a probe is not represented in a modality-specific format but in an abstract conceptual format. This abstract representation, used in computing the pragmatic implications of the sentence, is directly accessible from either verbal or pictorial stimuli.

How the meaning of a sentence is represented, immediately after one has heard it, is poorly understood. One way in which the form of that representation can be determined is to compare the relative efficacy of different kinds of probes of sentence meaning, when the listener is required to assess the pragmatic relation between the sentence and the probe item. One might expect that if the representation of a sentence such as

(1) The jungle shrilled with the cries of exotic birds.

is connected with the verbal system, then a following word probe such as "monkey" would be more easily judged as pragmatically relevant to the sense of the sentence than would a drawing of a monkey. On the other hand, if the representation of the meaning of (1) is primarily imagistic, then the drawing might be judged to be relevant more readily than the word probe. If, however, neither a word nor a drawing has preferential access to the representation of sentence meaning, then the representation is presumably more abstract than either a verbal or imagistic representation.

One would consider a representation to be verbal if words are elements or constituents of the representation, or if access to the primitive elements of meaning requires the activation of words. By "word" we mean a mental representation that is the common denominator of all written and spoken tokens of a given word

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type. The mental word or name code is necessarily invoked in the recognition and production of spoken and written words. That characterization of a word-representation we take as given; the question to be addressed is whether such words have a privileged (or mandatory) function in the mental representation of the meaning and pragmatic implications of a sentence. That words might have a privileged status in the accessing and processing of information is plausible, given the centrality of language in the acquisition and communication of knowledge.

A sentence representation may be considered imagistic if the words and syntax of a sentence are used to obtain a perception-like representation of the state of affairs described by the sentence. Such a representation is most credible for sentences about concrete objects and events.[1] Unlike a verbal representation, in an imagistic representation words are not elements or constituents of meanings; rather, imaged objects, scenes, and actions are the constituents. Hence the meaning of a scene is apprehended directly, whereas the meaning of a sentence is obtained indirectly by translation to an imaginal code. Images are typically more specific than the words that they illustrate; that is, they specify more attributes and therefore may differ markedly between individuals, and within an individual on different occasions. Unlike words, images can specify continuous rather than discrete values on such dimensions as color, size, shape, location in space, and rate of movement. (Not all perceptual properties have to be represented in a given image according to this view; whether some properties such as spatial position are obligatory is open to investigation.) In sum, in an imagistic representation meaning is not "tied to specific words but to the world of objects and events to which the words refer" (Paivio, 1971, p. 460). Since the real world is what we are ultimately concerned with, and since children and nonhuman animals can think without knowing language, an imagistic representation of concrete knowledge is at least plausible.

In an abstract conceptual representation of sentence meaning, in contrast, words and images would be replaced by a single underlying code. In this view, the meaning of a given sentence is represented by abstract conceptual elements and their relations. Much the same set of elements would be activated when perceiving the event described by that sentence. No translation from words to images or (for scenes) from images to words is required; each form of input is translated directly into a single conceptual format. An abstract conceptual representation is plausible not only on the logical and philosophical grounds put forward by Pylyshyn (1973, 1976) and others, but also because we seem able to mix verbal and perceptual information without difficulty.[2]

Heretofore, the principal evidence concerning the form in which a sentence is represented

[1] There is another hypothesis about mental representation in which logical relations are represented in imagistic schemes such as Venn diagrams or other perceptual metaphors. Although the format is spatial, the relations that are expressed are abstract. The present discussion of images is confined to representations which are some respects perceptually similar to the referent.

[2] A unitary conceptual code is incorporated in computer-based models of human memory such as those of Collins and Quillian (1969), Rumelhart, Lindsay, and Norman (1972), Schank (1972), Anderson and Bower (1973), and Anderson (1976). In making claims about the form of representation of meaning, however, these theories have two weaknesses. First, by functional criteria their conceptual representations are indistinguishable from verbal representations because in practice their constituents correspond to words and other linguistic units, and most of the supporting experiments use verbal materials. The ability of the models to represent perceptual knowledge (apart from the highly constrained block worlds of Winograd, 1972, and others) remains an unfulfilled promise. Second, the theories give an inadequate account of the extensive evidence for perception-like mental representations that are distinct from verbal or conceptual knowledge (e.g., Paivio, 1971, 1975; Shepard & Judd, 1976; Shepard & Metzler, 1971; Kosslyn & Pomerantz, 1977).

has come from memory for sentences and other material. Because meaning-preserving paraphrases are typical in memory, the claim has been made that the representation is conceptually abstract rather than verbal (e.g., Bransford & Franks, 1972). Alternatively, the same result is taken as support for an imagery theory of representation (Paivio, 1975). Performance in such studies may not reflect the representation responsible for initial comprehension of the sentence, however, because the sentence may have been recoded subsequently or reconstructed at the time of the test from partial verbal or imagistic traces.

A different way to distinguish among the three types of representation that have been characterized is to consider the relative time to encode or process different forms of stimuli. The assumption is made that stimuli that correspond directly to constituents of a given representation are encoded more rapidly into that format, other things being equal, than stimuli that must be recoded or translated first. For example, in a dual coding theory such as Paivio's (1971, 1975), words have direct access to the verbal code (and the abstract knowledge it alone is thought capable of representing) but indirect and much slower access to an associated imaginal code (with its pictorial, spatial information). Conversely, perceived objects and events have direct access to an imagistic representation and indirect access to an associated verbal code. The well-known difference in time to name drawings and words reflects the difference in accessibility of the verbal code. If the representation of meaning takes a more abstract conceptual form, however, the verbal or pictorial format of a stimulus would not be expected to have a systematic effect on the time to comprehend its meaning.

By measuring the time to compare two stimuli that are verbal, pictorial, or mixed, investigators have inferred that the format in which the comparison is made can be either verbal or pictorial (Tversky, 1969, 1975), pictorial (Seymour, 1974), or abstract (Chase & Clark, 1972; Potter & Faulconer, 1975). Those experiments used highly practiced materials or single words and drawings, so their relevance to the representation of sentences heard for the first time is open to question. The present experiment probed comprehension of a sentence by asking the listener to judge whether an item, presented within a second after he had heard a sentence, was or was not related to the meaning of the sentence. In the process of comprehending (1), part of one's knowledge about jungles such as what animals and plants are found there is presumably activated, and so the probe *monkey* can be judged relevant and the probe *igloo* irrelevant. In discourse the knowledge activated during comprehension not only plays a role in encoding new information by preparing the listener generally for what might be said next, but also allows him to interpret such specific linguistic devices as pronouns and the definite article, even when their referents are implied rather than stated (Chafe, 1972; Stenning, Note 1). The presentation of a meaning probe immediately after a sentence, in the present experiment, was expected to maximize the likelihood that the listener would have a verbal or linguistic representation of the sentence's meaning.

To determine whether the format in which sentence meaning is represented is verbal, image-like, or abstract, two forms of probe were contrasted: the probe was either the written name of an object or a line drawing of the object. Predictions are based on previous evidence from naming and imaging tasks that an item presented as a drawing or word takes time to translate into the other form. Hence, if the representation of the sentence is verbal, the word "monkey" should be a better probe than a drawing of a monkey. If it is imagistic, the drawing should be better than the word. If, as we hypothesize, the representation is abstract (neutral between language and perception), then a drawing and a word should be approximately equal as probes.

Method

Subjects

The subjects were 32 college students, both men and women, who were paid for participating.

Materials

The probe stimuli were 96 line drawings (maximum dimension 3.75 cm) and written names (Letraset Berling 14-point lower case) of objects, including animals, food, clothing, furniture, vehicles, tools, and the like. The same items were also used by Potter and Faulconer (1975), who established that the duration thresholds of the words and drawings, when preceded and followed by a mask, were equal (44 msec for drawings, 46 msec for words).

The sentences that preceded the probes were designed to be clearly relevant to the probe item, without making the probe easy to guess in advance. The sentences were between 4 and 11 words in length; the mean was 8 words. The relationship between the sentence and the probe varied widely. As in (2), many of the probes bore a case relationship (Fillmore, 1968) to the sentence.

(2) Pioneers had to clear the land. *Ax*

In others such as (3), the relation was associative, and in still others such as (4), the probe was neither strictly case-related nor associated with any single word in the sentence.

(3) Adam and Eve were the first humans. *Apple*

(4) The dogsled raced across the hard-packed snow. *Bear*

Apparatus

The probes were presented in a mirror tachistoscope (Gerbrands T-2B-1). Response time (RT) was measured with a voice key and a Standard clock timer.

Design and Procedure

The subjects were divided into two groups of 16 each, an experimental group and a guessing control. Experimental subjects were run individually; control subjects were run in groups of three or four. In the experimental condition, each subject had practice trials and then 6 blocks of 16 trials. Blocks of drawings and words alternated. The modality of the probe was blocked so that the subject could adopt whatever strategy he or she might find optimal for dealing with that probe; in that way, the instrinsic advantage of one or the other probe would not be concealed by a strategy designed to compensate for the more difficult probe. Within each block, a random half of the trials were positive. Each subject saw a given probe only once (i.e., in one mode only). The mode of the probe and its relation to the sentence (positive or negative) were counterbalanced across subjects. Four different orders of probe stimuli were used. To produce the negative trials the sentences that matched those probes were reassigned randomly to other negative probes. The new assignments were inspected to eliminate fortuitous matches, but no other steps were taken to maximize mismatches on the negative trials.

The experimental group was instructed to say "Yes" as fast as possible if the probe item was "related in some way to the meaning of the sentence," and to say "No" otherwise. The experimenter spoke the sentence and pressed a button at the end of the last word. After an 800 msec delay, the probe item appeared for 250 msec. A visual mask consisting of haphazard black lines with a small red fixation cross in the center was in view except when the probe item was presented. The subject was instructed to fixate the red cross at the beginning of each sentence. At the end of the experiment, which took about 30 minutes, the subject was unexpectedly asked to recall the probe items in any order. After 5 minutes of recall, the subject was asked, again unexpectedly, to report the mode in which he had seen each of the items recalled.

The guessing control group was instructed to listen to each sentence and guess what the probe item would be. The task of the experimental group was explained to them, and on each trial they were shown the correct drawing and its name after they had written down three guesses. Thus, like the experimental group, they had an opportunity to learn what sorts of objects were used as probes. They had 20 seconds to write down their guesses. The same four orders of items used in the experimental condition were used with each subgroup of control subjects.

Scoring of Materials

Two analyses of the materials, one concerned with imagery and the other with semantics, were carried out after the experiment had been run but before item analyses were begun. The experimenters' judgments were used for both analyses. In the imagery analysis each sentence was given a score on a 7-point scale (later collapsed to 3 points) with respect to how easy it was to image. For example, (5) was rated low in imagery, and (6) was rated high.

(5) He was working hard to get a good grade.
(6) The cheerleaders threw their pompoms in the air.

The purpose of the analysis was to determine whether the RTs reflected an interaction between the imageability of the sentence and the modality of the probe.

In the semantic analysis each sentence-probe pair was placed in one of two categories, depending on whether there was substantial semantic overlap between the probe item and a word or phrase or implication of the sentence. For example, the sentence and probe in (7) are semantically related; the sentence directly involves the concept of travel or transportation, and an airplane is a means of transportation.

(7) They planned to go to London and then Paris. *Airplane.*

Similarly, the sentence and probe in (8) are related semantically.

(8) At the theater Sam checked their snowy wraps. *Coat*

In contrast the relation between *Adam and Eve* and *apple* in (3) or that between (1) and *monkey* is not semantic, but depends on general knowledge of the world (for discussions of the distinction, see Katz, 1972, and Fodor, Bever, & Garrett, 1974). The purpose of the analysis, like the imagery analysis, was to see whether there was an interaction between semantic relatedness (possibly encoded in a verbal system) and probe modality.

Scoring Guesses

A strict and a lax criterion were applied in scoring the guesses. The strict criterion required that the guess be the word actually used as the probe item or differ from it only by the addition or subtraction of the plural. The lax criterion required only that the guess be a synonym, part, superordinate, etc., or partially overlap in wording (e.g., "cherry tree" for "cherries") with the correct item. The first guess alone and all three guesses were scored. When all three guesses were scored, a given subject was credited with a maximum of one hit, even if two guesses met the criteria. The largest effects of guessing were obtained using the lax criterion and all three guesses, so only those results are reported.

RESULTS

The prediction that words and drawings would be equally effective probes was tested by comparing the RTs for correct responses in each condition. The mean RTs and also the percentage of errors in each condition are shown in Table 1. Since there were relatively few errors and there was no suggestion of a speed-accuracy tradeoff between word and drawing probes, the errors were not analyzed further. All the remaining analyses included correct responses only.

Analyses of variance were carried out on the RTs to positive (matched) probes, with modality of the probe as a within-subjects (F_1) or

TABLE 1

RESPONSE TIME AND PERCENTAGE ERRORS[a] TO DRAWING AND WORD PROBES THAT WERE MATCHED OR MISMATCHED TO THE SENTENCE

	Drawing	Word
Match	707 (7.3)	722 (10.7)
Mismatch	759 (4.2)	779 (3.6)

Note. The standard error of the difference between the means of drawings and words, for the 16 subjects, was 61 msec for matched and 75 msec for mismatched probes.

[a] In parentheses.

within-items (F_2) factor, $F_1(1, 15) = .99$, $p = .34$; $F_2(1, 95) = 1.84$, $p = .18$. Because there were no significant effects, *min F′* was not computed. To give an indication of the power of the present data to detect true differences between drawing and word probes, confidence intervals were calculated for the difference between the mean RTs to positive probes of individual subjects and (separately) items. There is a .99 probability that the true mean difference (word RTs minus drawing RTs) falls between −30 and 60 msec, for subjects, and between −14 and 47 msec, for items.

Imageability and Semantic Analyses

Although as we predicted there was not a significant difference between word and drawing probes, the possibility remained that differences between words and drawings were being masked because of either of two materials effects. The post hoc division of sentences into three levels of imageability and sentence-probe pairs into semantically related–unrelated was intended to test that possibility. Analyses of variance were carried out on the RTs on positive trials. For the imageability analyses, modality and imageability (high, medium, low) were within-subject variables for F_1, and imageability was a between-items variable and modality a within-items variable for F_2. For neither F_1 nor F_2 were the main effects or their interaction significant: that is, drawings were not selectively better probes for highly imageable sentences. The semantic-relatedness analyses were similarly computed and likewise failed to show significant main effects or an interaction.[3] That is, word probes did not have shorter RTs than drawings even when there was judged to be a semantic relation (rather than a relation that depends on knowledge of the world) between a sentence and its probe. Mean RTs for both analyses are given in Table 2.

TABLE 2

MEAN RESPONSE TIMES AFTER SENTENCES OF DIFFERENT LEVELS OF IMAGEABILITY AND FOR PROBES RELATED SEMANTICALLY OR IN SOME OTHER WAY TO THE SENTENCE

	n[a]	Drawing	Word
Imageability of sentence			
High	28	690.0	733.4
Medium	41	738.3	724.6
Low	26	695.6	717.7
Relation of sentence and probe			
Semantic	32	687.1	724.5
Other	64	721.7	726.4

[a] Number of stimulus items in each category.

Guessing

A final possibility we considered was that the differences between words and drawings may have been masked by the predictability of the probe, after a subject had heard the sentence. If the subject could guess what the probe item would be, he might image the item as a word or a drawing, depending on the

[3] In the imageability analysis: imageability, $F_1(2, 30) = .08$; $p > .5$; $F_2(2, 93) = .926$, $p = .4$; modality of probe, $F_1(1, 15) = .47$, $p > .5$; $F_2(1, 93) = 2.26$, $p = .14$; interaction, $F_1(2, 30) = .99$, $p = .38$, $F_2(2, 93) = 2.11$, $p = .13$.

In the semantic relatedness analysis: semantic relatedness, $F_1(1, 15) = 3.21$, $p = .09$, $F_2(1, 94) = 1.23$, $p = .27$; modality of probe, $F_1(1, 15) = .97$, $p = .34$, $F_2(1, 94) = 2.99$, $p = .09$; interaction, $F_1(1, 15) = .07$, $p > .5$, $F_2(1, 94) = 1.8$, $p = .18$.

modality of the block of trials, and simply perform some sort of physical match. The 16 control subjects were correct on .27 of their first guesses of the probe object, adopting the lax criterion, and were correct on one of their three guesses for .42 of the sentences. The sentences were divided into three groups: 29 sentences whose probe item was rarely or never guessed by the control subjects (2 or fewer of the 16 subjects included it among their three guesses), 39 guessed with moderate frequency (3 to 10 subjects guessed the probe), and 28 guessed very frequently (11 to 16 subjects guessed the probe).

Analyses of variance of the RT results of the experimental group were carried out for positive trials, with the three levels of guessability and the two modalities of probe as within-subject variables for F_1 and probe modality a within- and guessability a between-items variable for F_2. The main effect of guessability on RT was substantial ($F_1(2, 30) = 10.77$, $p < .001$; $F_2(2, 92) = 5.75$, $p < .005$, *min* $F'(2, 116) = 3.75$, $p < .05$). The main effect of modality and the interaction between guessability and modality were not significant.[4] A separate analysis of the 29 low-guessable items was carried out, on the assumption that the purest test of sentence representation is one in which the probe cannot be anticipated, so the subject has to compare the probe to the sentence representation itself. For the low-guessable items, the difference between words and drawings was significant across subjects, $F(1, 15) = 6.08$, $p = .027$, and across items, $F(1, 27) = 7.27$, $p = .012$ although *min* F' fell short of significance, *min* $F'(1, 36) = 3.31$, $p < .10$. Across items, drawings were 57 msec faster than words.

[4] Modality, $F_1(1, 15) = 1.81$, $p = .199$; $F_2(1, 92) = 2.46$, $p = .121$; the interaction between modality and guessability, $F_1(2, 30) = 1.29$, $p = .292$; $F_2(2, 92) = 2.90$, $p = .061$.

Recall

The principal reason for having subjects unexpectedly recall the probe items and then indicate their modality, was to find out whether the modality of a probe would be recalled correctly. If a drawing is named prior to comparison with the sentence, if a word is imaged, or if both are represented in the same abstract format, then the subject might be uncertain whether he had seen a drawing or a word. The results are shown in Table 3.

As many investigators have reported, recall was more probable for drawings than for words, Wilcoxon (16), $T = 16$, $p < .01$, and was also higher when the sentence and probe matched than when they did not, Wilcoxon (14), $T = 8$, $p < .01$. The modality of the probe was almost always remembered correctly and with a single exception the errors always consisted of a report that a word had been presented as a drawing.

TABLE 3

PROPORTION OF PROBE ITEMS RECALLED[a] WHEN THE PROBE WAS MATCHED AND MISMATCHED TO THE SENTENCE, BROKEN DOWN BY THE CORRECTNESS OF RECALLED MODALITY

	Presentation condition			
	Drawing		Word	
Recall of modality	Match	Mismatch	Match	Mismatch
Correct	.30	.21	.18	.10
Incorrect	.00	.003	.02	.02

[a] The proportion in each presentation condition is based on 384 trials.

Discussion

The results support the hypothesis that the representation of the meaning of a sentence is neither verbal nor imagistic, but abstract: an abstract conceptual representation of the sentence was compared with a similarly abstract representation of the probe, whether the latter was presented as a word or a drawing. Although many theories posit a single conceptual level of representation (Anderson & Ortony, 1975; Brewer, 1974; Pylyshyn, 1973; see also footnote 2) most of the previous empirical evidence for that level has been indirect, relying primarily on errors in recall or recognition some time after the sentence was heard or read. False recognition of synonyms of words (Anisfeld & Knapp, 1968), condensations and combinations of material presented in different sentences (Bransford & Franks, 1972), presuppositions of sentences (Offir, 1973), and pragmatic implications of sentences (Harris, 1974; Johnson, Bransford, & Solomon, 1973; Kintsch, 1974) or scenes (Baggett, 1975) have usually been taken to demonstrate that the memory representation of words and sentences is abstract rather than verbal or imagistic. An objection to that interpretation is that in a memory task subjects have time to elaborate the stimulus material in either a verbal code (for example, by some sort of associative structure) or in imagery.

The probe-reaction time procedure of the present experiments eliminates that objection by providing an immediate and direct measure of possible recoding from one format or code into another. Naming latency may be taken as a measure of time to activate a verbal representation. In an earlier study Potter and Faulconer (1975) measured the time to begin to name aloud the same 96 drawings and written words used in the present experiment. The mean naming latency for words was 655 msec and for drawings, 915 msec. The visual duration thresholds of the two forms of stimuli had been equated (see *Materials* section above) and the motor output of naming was the same for corresponding words and drawings, so the 260 msec difference is presumably the extra time required to retrieve the verbal code of a drawing. (It is unlikely that words were named prior to recognition by applying pronunciation rules, because relatively common words such as the present probes are named more rapidly than orthographically regular nonwords, as Forster & Chambers, 1973, and Frederiksen & Kroll, 1976, have shown.)

Suppose, then, that a spoken sentence results in a verbal representation that is directly accessed by words but only indirectly accessed by perceived objects or drawings via implicit naming. If subjects in the present experiment were representing the meaning of the sentence in such a verbal code, word probes should have been about 260 msec faster than drawing probes. If anything, drawing probes were faster than words, so the sentence could not have been represented in a verbal format or one only capable of being accessed by words. Even for those sentence-probe pairs that were related semantically (in contrast to those whose relationship rested on facts about the world), words were not better probes than drawings.

Suppose, on the other hand, that the representation of the sentence used to evaluate the relevance of the probe is an image, that is, some analog of the perception of the state of affairs described in the sentence. In that case the probe would have to be imaged to assess its relevance and drawing probes should therefore be faster than words. The advantage of drawings in the present experiment was too small and unreliable, however, to make the imagery theory plausible, given what is known about time to recode a word into an image. Although there is no single accepted task that measures the relative time to obtain an image of a word versus an image of a drawing or object, available estimates suggest that it takes about 500 msec longer to image than to perceive very familiar stimuli such as alphabetic letters (Weber & Harnish, 1974); further, good imagers take 1.8 seconds to image a concrete noun (Ernest & Paivio, 1971). Not only was the 50 msec advantage of unpredictable drawings small relative to estimates of imaging time, but the post hoc analysis of the effect of sentence imageability on reaction time failed to show a significant interaction between imageability and probe modality. The present experiment, then, makes it unlikely that the drawing or word probes were recoded into verbal or imaginal formats, respectively.

Finally, suppose that a listener represented the sentence either as an image (when he expected a drawing probe) or verbally (when he expected a word probe). In that case, one would have expected the imageability of the sentence (and perhaps its semantic relation with the probe) to interact with probe modality, and it did not (Table 2).

We conclude by elimination of the alternatives that the meanings of the sentence and probe are represented in an abstract format. This does not imply, however, that the more superficial modality-specific information is always lost. The literal representation of a sentence is maintained for at least a short time (Sachs, 1974): readers retain some memory of the physical format of a sentence or the operations required to read it for days or even years (Kolers, 1976). In the present experiment, after an unexpected free recall of the probe items, subjects were highly accurate in reporting whether recalled items had been words or drawings, even though recall itself was reported verbally. Thus, modality-specific information seems to be retained. Furthermore, it is retained somewhat more accurately for drawings than for words (Table 3).

Small differences between drawings and words are also seen in the RTs in the present experiment; drawings are slightly faster and more accurate. In a simpler category-matching task Potter and Faulconer (1975) found that drawings were 50 msec faster than words; about the same advantage for drawings was obtained in the present experiment, for sentences with unpredictable probes. Drawings differ from words in two respects, either or both of which might explain their slight advantage. As visual patterns (regardless of meaning), drawings are more distinctive than words. In addition, drawings (like images) are more specific in meaning than words; that is, they specify more properties of a concrete object than just its generic class. A pictured monkey is not simply a monkey, but is standing or sitting, has a certain expression on its face, can be seen to have a tail, and so on. Hence a drawing is likely to activate more conceptual detail than the corresponding word. The extra features specified by a drawing may provide additional matches to a sentence (as in the present experiment) or a category name (as in Potter & Faulconer, 1975).

The foregoing would lead one to predict that the advantage of drawings would be reversed were their additional features deliberately mismatched to the sentence—for example, if the pictured monkey following (1) were a stuffed toy. Potter and Faulconer (Note 2) obtained just that result in an experiment in which a drawing of an object was used as a semantic probe for the corresponding noun spoken in a sentence. A mismatch between an incidental attribute portrayed in the drawing and one specified by a prenominal adjective in the sentence slowed RT.

If a more detailed conceptual representation is activated by a drawing than by the corresponding word, that may also account for the superior recall of drawings, a finding reported in many previous studies (Paivio, 1971; Nelson, Reed, & Walling, 1976). If we suppose that recall requires that the particular experimental presentation of an item be discriminated from all previous occurrences of that concept, then the core concept of the item, shared by all exemplars, is not as distinctive as more peripheral or incidental features such as the particular style and details (including conceptual details) of the drawing used in the experiment. The visual details of a written word are not particularly distinctive in this sense, so a word would be expected to be more difficult to recall than a drawing. The match or mismatch between the sentence and probe also affected the probability of recalling the probe, as Craik and Tulving (1975) found. In the present experiment the advantage of matched over mismatched sentence-probe combinations did not interact with probe modality (Table 3). That lack of interaction is what one would expect if probe-sentence comparison took place at an abstract level of representation common to words and drawings.

Drawings, then, have two kinds of information that give them an advantage over words: a more distinctive visual pattern and richer conceptual detail. These, we propose, account for the better recall and the somewhat faster response to drawings. The RT advantage of drawings was eliminated, however, when the probe was an item that was guessed by 3 or more of the 16 control subjects. We have considered two possible explanations, not mutually exclusive. One is that when the probe has been guessed, the subject has the word in mind and simply matches it to the probe at a verbal level (e.g., Tversky, 1969). That strategy would not work well with a drawing because the features of a drawing never seen before are not as easy to anticipate as those of a word, and so the relative advantage of drawings would be reduced. There was, however, very little time after the sentence to guess the probe and even the predictable probes were the first guess of fewer than half of the control subjects. Hence, the guessing explanation is probably insufficient by itself.

The second explanation for the loss of the small advantage of drawings when the probe can be guessed is derived from the hypothesis that drawings are ordinarily comprehended faster because they convey more detailed conceptual information than the corresponding word. When the sentence-probe relation is close (as measured by the guessing results), the extra conceptual information in a drawing is unnecessary. The core concept activated equally by the drawing or the word is immediately sufficient to establish the relationship.

We began with the question of how the meaning and pragmatic implications of a sentence are represented. The results of the present experiment suggest that immediately after a sentence has been heard, its pragmatic relation to a probe object is evaluated at an abstract conceptual level. The rapidity and accuracy with which subjects responded suggests that a conceptual representation of the sentence was available by the time the probe appeared, 800 msec after the sentence.[5] Although the insignificance of the difference between word and drawing probes implies that the sentence and probe were compared at an abstract level, the relative advantage of drawings in recall and subjects' ability to remember the modality of the probe both suggest that in addition to an abstract conceptual representation, modality-specific representations are retained.

In sum, the representation of a sentence that is used to determine its pragmatic implications seems not to be verbal or imagistic, but is a more abstract conceptual representation common to language and perception.

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[5] The mean RT was only 60 msec longer than the RT to match the same picture and word probes to a previously-named superordinate category (Potter & Faulconer, 1975). The speed suggests that a sentence is processed to an abstract conceptual level automatically. In a different context, Forster (Note 3) has also concluded that a sentence is processed automatically to a level at which general knowledge is represented, even when the task in his experiment—a syntactic acceptability judgment—depended on a level of processing that was presumably computed earlier.

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