Colloques Internationaux du C.N.R.S.
N° 206. — PROBLÈMES ACTUELS EN
PSYCHOLINGUISTIQUE

THE CHRONOMETRIC STUDY OF MEANING COMPONENTS *

Herbert H. CLARK
Stanford University

When a person has heard and understood a sentence, he has formed a semantic representation of that sentence in immediate memory. We can assume this because he is able to answer detailed questions about the content of this sentence, verify whether it is true or false, and deal with its meaning in many other ways. What I will be concerned with in this paper is (1) the form of this semantic representation in immediate memory, and (2) the mental processes by which one derives certain simple deductions from this representation. I will be especially concerned with the representations of several lexical items and will argue that their representations consist of distinguishable semantic components rather than of unanalyzed wholes. Specifically, I will argue that certain inherently negative lexical items (e. g., *absent*, *different*, *conflict*, and *unrelated*) are represented in immediate memory in terms of at least two components ; a positive nucleus and an embedding negative. The argument will proceed as follows. Explicit negatives have already been shown to consist of these two semantic components. The evidence for this comes from the latencies of tasks in which people are required to make true-false judgments of positive and negative sentences. Certain inherent negatives, however, behave in exactly the same way, and this implies that they too contain these two components. In short, I will present an extensive example of how latencies can be used to study the components of single lexical items, as they are represented in memory.

This paper consists of five sections. First, I will review a model, recently proposed by William Chase and myself, that accounts quite accurately

---

* The preparation of this paper has been supported in part by Public Health Service Research Grant MH-20021 from the National Institute of Mental Health. I wish to thank Patricia Carpenter, Eve V. Clark, and Marcel Just for their comments on earlier versions of this paper.

and stores this representation in immediate memory. The true negative sentence *B isn't above A*, for example, might be represented as in (1) :

(1) false (above [B, A]).

The claim here is that a negative sentence consists of two parts, a positive proposition *B is above A*, represented here as a function with two arguments *above* (*B*, *A*) and another proposition into which the first proposition is embedded, namely *It is false that S*, represented here as the single-argument function *false* (*S*). At Stage 2, the subject must represent the picture in some form that he can compare to the representation in (1). Thus, the picture of an A above a B is represented as in (2) :

(2) above (A, B).

The crucial comparison process occurs at Stage 3. There, the subject must keep track of a truth index that tells him whether the sentence is ultimately true or false ; the value of this truth index is determined by how the representations in (1) and (2) match each other. The model assumes that the truth index has only two possible values, *true* and *false*, and that the initial value is *true*. Then stage 3 consists of the two simple production rules in (3) :

(3) Rule 1 : If the embedded functions do not match, change the truth index.
Rule 2 : If the embedding functions do not match, change the truth index.

For the true negative sentence represented in (1), the process would go as follows. First, Rule 1 would compare *above* (*B*, *A*) of representation (1) against the *above* (*A*, *B*) of representation (2), find a mismatch, and change the truth index from *true* to *false*. Secondly, Rule 2 would compare the *false* (*S*) of representation (1) to the absence of an embedding function in (2), find a mismatch, and change the truth index back from *false* to *true*. Similar processes would be carried out for the other types of sentences. At Stage 4, the outcome of Stage 3—the final value of the truth index—would be converted into an overt response, e. g., the press of a " true " or " false " button.

The important property of this model is that each of the component processes is assumed to consume a fixed and additive amount of time. Specifically, negatives take longer to represent at Stage 1 than affirmatives by an increment of time *b* for the extra complexity. At Stage 3, Rule 1 takes an increment *c* whenever it is required, and Rule 2 takes an increment *d* whenever it is required. All the time not included in these increments is thrown into a " base time " t_0. Thus, this model predicts that the latencies of True Affirmative, False Affirmative, True Negative, and False Negative sentences are composed of components as shown in Table 1. For example, this model predicts—unsurprisingly—that negatives should take longer than positives, and this by an amount equal to $(b + d)$. But the unique prediction of this model is that whereas true should be faster than however, it is not so obvious that single lexical items like *absent*, *different*, and *conflict* should be represented in the same way just because they are inherently negative. Nevertheless, with the next several examples I will give, we will see that they too must be represented in two components.

INHERENT NEGATIVES

Present-absent

The first items I will examine are the words *present* and *absent*, since *absent* appears to be an inherent negative. [1] Note that *John isn't present* and *John is absent* will always have the same truth value and can always make reference to the same physical situation. That is, there is an extensional equivalence between the two sentences, even though there is a semantic difference that I will not discuss here. Furthermore, *absent* as opposed to *present* specifies properties in a negative way, and it is normally paraphrased by a negative. This suggests that if *John isn't present* is represented as in (4):

(4) false (present [John]),

then so should *John is absent*, since the evidence required to verify or falsify the one sentence will be the same as that for the other. The main alternative is to assume that *absent* remains unanalyzed and that *John is absent* is represented as in (5):

(5) absent (John).

Under the Clark and Chase model outlined earlier, these two assumptions make different predictions. Under the assumption that *absent* is equivalent to *not-present*, *absent* should pattern like a negative, but under the assumption that *absent* remains unanalyzed, it should pattern like a positive sentence.

In several recent unpublished experiments, I have confirmed that *absent* patterns as if it were represented as *not-present*. The method I used was to give subjects sentences like *The star is present* and *The star is absent* and pictures of a star (*) or a plus (+) and require subjects to verify whether the sentence was true or false of the picture. I assumed that *The star is present* and *The star is absent* were represented, respectively, as *present* (*star*) and *false* (*present* [*star*]), but that the picture, which was either a star

---

[1] In this paper, I have avoided the issue of how the "inherent" negatives should be classified with respect to various syntactic criteria of negation as discussed, for example, by Klima (1964). Some of the words to be discussed (e. g., *forget*) do fit some of the syntactic criteria, but others (e. g., *absent*, *different*, and *conflict*) are less readily, if at all, classifiable as "syntactic" negatives. This issue, however, is irrelevant to the present arguments.

for *present* is nearly the same as the advantage of false over true for *absent*. This is most easily accomplished by assuming that *present* and *absent* have a component in common—the one represented as *present* (X)—and that the same mental processes are carried out in dealing with this component. This is exactly what the model I have just described does, and that is how it can account for these data.

Same-different

The second pair of lexical items to be examined is *same-different*, where we might want to claim that *different* is an inherent negative. To test this hypothesis, I will refer to latencies that Seymour (1969) measured for quite a different purpose. His task was extremely simple. He presented subjects with one of two nouns—*circle* or *square*—and with one of two geometrical figures—a circle or a square. He told one group of subjects to decide whether the word and figure were the same or not, and the other group of subjects whether they were different or not. The positive or negative instruction, therefore, is comprehended just once before the experiment begins, but it is used implicitly each time the subject has to decide whether to say " yes " or " no. " Assume that the " same " and " different " instructions are represented as in (6) and (7), respectively :

(6) same (X, Y),
(7) false (same [X, Y]).

The subject's task is to read the word—say, *circle*—and to code the picture—say, as *circle*—and then to insert these values into the functions in place of X and Y. At the " comparison " stage, the subject must evaluate the function by a series of steps. One possible evaluation scheme is shown in (8) :

(8) Rule 1 : If the arguments of *same* (X, Y) do not match, change the truth index.
Rule 2 : If the embedding function is *false* (S), change the truth index.

These two rules are almost identical to those of the model of negation given previously, and we can attach the latency increments c and d to Rules 1 and 2, respectively. The components of latency for this model are given in Table 3.

Significantly, the latencies Seymour found, shown in Table 3, are fully consistent with this model. From the latencies, one can calculate the parameters t_0, c, and d, and hence the predicted latencies. Obviously, the predicted latencies are very close to the actual latencies, with average deviations of only 10 msec. Seymour's results, therefore, support the hypothesis that *different* is an inherent negative represented as something like *not-same*.

TABLE 4. Latency components, actual latencies, and predicted latencies (in msec.) based on data from Trabasso *et al.* (1971) on instructions containing *agree* and *conflict*.

Type	Components of Latency	Actual Latencies	Predicted Latencies
Yes : Do they agree ?	t_0	828	833
No : Do they agree ?	$t_0 + c$	959	955
Yes : Do they conflict ?	$t_0 + c + d$	1,159	1,163
No : Do they conflict ?	$t_0 + d$	1,046	1,041

Note :
t_0 = 833 msec.
c = 122 msec.
d = 208 msec.

other reasons for carrying out this experiment as well, it can serve to test the hypothesis that *unrelated* is an inherent negative represented as *not-synonymous*—at least in this particular task. According to this hypothesis, these two instructions would be represented as in (11) and (12), respectively :

(11) synonymous (X, Y),
(12) false (synonymous [X, Y]),

TABLE 5. Latency components, actual latencies, and predicted latencies (in msec.) from Hayden and Clark (unpublished) on instructions containing *synonymous* and *unrelated.*

Type	Components of Latency	Actual Latencies	Predicted Latencies
Yes : Are they synonymous ?	t_0	1,117	1,123
No : Are they synonymous ?	$t_0 + c$	1,266	1,259
Yes : Are they unrelated ?	$t_0 + c + d$	1,547	1,553
No : Are they unrelated ?	$t_0 + d$	1,423	1,417

Note :
t_0 = 1,123 msec.
c = 136 msec.
d = 294 msec.

(15) a. If John remembered to let the dog out, then the dog is in.
b. If John forgot to let the dog in, then the dog is out.
c. If John remembered to let the dog in, then the dog is supposed to be in.
d. If John forgot to let the dog out, then the dog is supposed to be in.

Sentences (15a) and (15b) required subjects to access the implications of *remember* and *forget*, whereas sentences (15c) and (15d) required subjects to access the presuppositions. Although *supposed to* in (15c) and (15d) was perhaps not the best paraphrase of the presuppositions of *remember* and *forget*, it was certainly adequate for our purposes and did not bother any of our subjects. In this task, we timed the subjects from the moment they began reading the sentence to the moment they pushed a " true " or " false " button.

TABLE 6. Latency components, actual latencies, and predicted latencies (in msec.) from Just and Clark (1973) on statements containing *remember* and *forget*

Type	Components of Latency	Actual Latencies	Predicted Latencies
Implications :			
True *remember*	t_0	2,814	2,829
False *remember*	$t_0 + c$	3,252	3,226
True *forget*	$t_0 + c + (b + d)$	3,670	3,807
False *forget*	$t_0 + (b + d)$	3,536	3,410
Presupposition :			
True *remember*	$t_0 + e$	3,564	3,639
False *remember*	$t_0 + c + e$	4,100	4,036
True *forget*	$t_0 + (b + d) + e$	4,183	4,220
False *forget*	$t_0 + c + (b + d) + e$	4,664	4,617

Note :
t_0 = 2,829 msec.
c = 397 msec.
$b + d$ = 581 msec.
e = 810 msec.

The mean latencies in this task, shown in Table 6, bear out these predictions. When the subject was required to access the implications, then *remember* patterned like a positive sentence, with true faster than false, and *forget* patterned like a negative sentence, with false faster than true. But has noted the same pattern for the comparatives *more* and *less*, where presumably *less* would be the inherent negative.

The failure of *short* to pattern like other inherent negatives has, perhaps, a relatively simple explanation. First, if *long* and *short* were represented in the same manner as *present* and *absent*, then *The line is long* and *The line is short* would be represented as in (16) and (17) :

(16) long (line),
(17) false (long [line]).

Representation (17) would in turn imply that *The line is short* is equivalent to *The line isn't long*, an equivalence we know to be false. *Long* and *short* are contraries, not contradictories. The representation in (17) is therefore incorrect semantically, and there is no reason to think that subject should represent *The line is short* in that way. Second, the probable codings of the pictures for *long* and *short* also contrast with *present* and *absent*. Consider *The line is short*, which is true of the picture of a short line. It is quite reasonable to assume that this short line can be coded directly as *short* (*line*), and this representation is congruent with the sentence code *short* (*line*) for a fast " true " response, in agreement with the data. But consider the parallel with *absent*. *The star is absent*, represented here as *absent* (*star*), is true of a plus. To strick to the parallel, this plus would have to be represented as *absent* (*star*), and this seems highly implausible indeed. Rather, as I argued above, a plus ought to be represented in terms of its presence, i. e., as *present* (*plus*) ; this is incongruent with the sentence code *absent* (*star*), or even with *false* (*present* [*star*]) and should lead to a slow " true " response, which is in agreement with the data. Thus, *short* is positive in the sense that a picture could be coded directly in terms of shortness ; *absent* is negative in the sense that a picture must normally be coded in terms of the presence of something, not its absence (Clark, in press).

Long and *short*, nevertheless, will almost certainly have to be represented so as to indicate their common element " length. " Subjects know, for example, that *The line is long* and *The line is short* both refer to the same aspect of the line—its length—and that both statements cannot hold at once. But just how the common element and incompatibility of *long* and *short* are represented mentally will have to wait on future research.

CONCLUDING REMARKS

Up to this point, I have examined three types of inherent negatives : (1) words like *absent* which pattern just like explicit negatives ; (2) the word *forget* whose implications pattern just like explicit negatives, but whose presuppositions do not ; and (3) words like *short* which do not pattern like explicit negatives. Throughout, I have attempted to show that to account for the pattern of latencies in each of these cases (except the last), we must assume that subjects represent inherent negatives with at least two is represented in immediate memory in terms of an *Aspects*-like deep structure. Under this " deep-structure theory, " the representations would consist of deep-structure propositions that retain all the lexical items of surface structure intact ; the theory would disallow the representation of *John is absent*, for example, as two underlying propositions.

The main point of this paper, however, has been that such a deep-structure theory is incorrect, at least given the present definition of semantic representation. The crux of the issue, indeed, lies with this definition. As I have used it in this paper, the semantic representation of a sentence has been tacitly defined as that structure which contains all the detail necessary for the comparison stage. In the present scheme, for example, it is necessary to know that *The star is absent* means *false* (*present* [*star*]) because at the comparison stage the subject must try to match this representation against, say, *present* (*star*) and compute the answer " false. " The subject cannot do this unless he knows that *present* and *absent* are related in this particular way. If we had made the deep-structure-theory assumption instead, *The star is absent* would have been represented as *absent* (*star*), and the picture of a star would have had to have been represented in terms of absence too, namely as *false* (*absent* [*star*]), in order for the correct answer to be computed. But as we saw previously, this model of the process predicts an incorrect pattern of latencies—with true faster than false for sentences with *absent*. Indeed, all of the arguments showing that single lexical items must be represented in terms of two components are incompatible with the deep-structure theory. Thus, it follows that the deep-structure theory, under the present definitions of semantic representation, is incorrect.

The rejection of the deep-structure theory, however, should not be construed as having decided the linguistic issue of whether or not there is an autonomous level of deep structure in the grammar of English. The only conclusion we can draw from the present evidence is that it is not this level of representation that is used in the comparison process of a verification task. Obviously, one could suppose that *The star is absent* is represented first as *absent* (*star*) and that the latter structure in turn is " interpreted " or re-represented as *false* (*present* [*star*]) where the subject has made reference to his semantic knowledge about the word *absent*. It is just that this extra level of representation does not have any empirical consequences for the latencies in the verification tasks I have discussed.

Conclusion

In the present paper, therefore, I have attempted to pursue both a general and a specific goal. The specific aim is easiest to summarize. I argued that certain inherently negative lexical items are represented in immediate memory, not as unitary wholes, but rather as complexes containing at least two components, a positive core and an embedding negative. The form of this argument was important. It began with a model that accounted for

Flores d'Arcais, G. B., On handling comparative sentences. Unpublished Research Report, Center for Cognitive Studies, Harvard University (1966).

Flores d'Arcais, G. B., Semantic factors and perceptual reference in the comprehension of comparatives. Paper presented at the Second Meeting of the Psychologists of the Danubian Countries, Smolenice (1970).

Fodor, J., and Garrett, M., Some reflections on competence and performance. In J. Lyons and R. Wales (eds.), *Psycholinguistics Papers*. Edinburgh : Edinburgh University Press (1966).

Just, M., and Carpenter, P., Comprehension of negation with quantification. *Journal of Verbal Learning and Verbal Behavior*, **10**, 244-253 (1971).

Just, M. A., and Clark, H. H., Drawing inferences from the presuppositions and implications of affirmative and negative sentences. *Journal of Verbal Learning and Verbal Behavior*, **12**, 21-31 (1973).

Karttunen, L., Implicative verbs. *Language*, **47**, 340-358 (1971).

Klima, E. S., Negation in English. In J. A. Fodor and J. J. Katz (eds.), *The Structure of Language*. Englewood Cliffs, New Jersey : Prentice-Hall, 246-323 (1964).

Miller, G. A., Some psychological studies of grammar. *American Psychologist*, **17**, 748-762 (1962).

Seymour, P. H. K., Response latencies in classification of word-shape pairs. *British Journal of Psychology*, **60**, 443-451 (1969).

Trabasso, T., Rollins, H., and Shaughnessy, E., Storage and verification stages in processing concepts. *Cognitive psychology*, **2**, 239-289 (1971).

Watt, W. C., On two hypotheses concerning psycholinguistics. In J. R. Hayes (ed.), *Cognition and the Development of Language*. New York : Wiley, 137-220 (1970).