On Semantic Decomposition of Verbs

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Theories of semantic memory propose that the core meaning of a verb can be broken down into semantic components (e.g. Gentner, 1975; Miller, 1978; Miller & Johnson-Laird, 1976; Schank & Abelson, 1977). However , there exists some controversy about the psychological reality of these semantic components. The question is to what degree decomposition has to take place whenever a person uses or understands a verb.

Two differing points of view can be distinguished on the problem of decomposition. These views correspond to the processes of analysis and synthesis. Analysis is a process of abstraction which separates out parts of the meaning of one particular word. In related words similar parts are found. As an example, the notion of possession is a component of all HAVE verbs. The hypothesis of decomposition in the sense of an analytic process does not necessarily imply something about the format in which the meaning of a verb is stored. It merely says that it is possible to isolate components from the meaning of a verb that are also found in other words. It is like asserting that oak trees and apple trees have leaves which are similar although not identical. Research by Fillenbaum & Rapoport (1971), for example, documents that people can consistently carry out this process of analysis.

Synthesis, on the other hand, is a process for combining elementary components into word meanings. The system starts out with a set of fundamental components which are combined in different ways to create the different meanings of verbs. The same component is always identical even if used in different words. It is like placing identical parts into different cars, as e.g. batteries. This view of the decomposition hypothesis is found in psychological theories of semantic memory (e.g. Gentner, 1975; Grimm & Engelkamp, 1981; Sanford & Garrod, 1981). The view is even more prevalent in text processing systems of artificial intelligence (e.g. Schank & Abelson, 1977).

Several authors have argued against the hypothesis that the meaning of a verb is represented by a bundle of independent components, among them Fodor, Garrett, Walker, & Parkes (1980), Hörmann (1976), and Kintsch (1974, 1980). The present paper summarizes experiments that support the arguments of these authors.

In previous experiments we have already found some evidence against the synthetic version of decomposition theory (Wender, in press). In these experiments subjects had to decide whether the meaning of a given verb contained a specified component. Reaction times were measured. Pairs of components were used in which one component was included in the other. For example, INTENSION is embedded in INTENSIONAL ACTIVITY, when properly defined. We assume that search processes should, in principle, stay the same when different verbs are searched for these components. It was predicted that the difference in verification times between embedded and embedding components should remain constant across different verbs. Three successive experiments revealed significant interactions between components and verbs. That is, the difference in verification times depended on the particular verb being judged. Assuming that the search process in memory does not change its nature from verb to verb it was concluded that the structure of the embedding component cannot be the same in different verbs as claimed by synthetic decomposition theories. As an example, INTENSIONAL ACTIVITY is not the same in the verb "steal" as it is in the verb "buy". The present study investigates the same problem using a different

methodology.

Method

The method of paired comparisons was used to scale the relative importance of one component with respect to the total meaning of a verb. Six components were defined: GIVE, HAVE, TRAVEL, SPEED, INTENSION, INTENSIONAL ACTIVITY. Subjects were first given an explicit definition of one of the components. Then they were presented with two verbs and had to decide for which of the two the relative importance of the component was greater. Three sets of seven verbs each were used. Each set was judged with respect to two components. This resulted in six 7x7 paired comparison matrices.

Results

First the matrices were searched for violations of stochastic transitivity. Results did not accord with the predictions. Stochastic transitivity was never violated in the weak case, seldom in the moderate case, and rarely in the strong case.

In the next step we fitted a paired comparison model to the data. In this model the probability of choosing verb a over verb b when judging component c is given by

$$p(a>b/c) = 1 - (A-C) / ((A-C)+(A-B))$$

where A, B, and C are parameters corresponding to the "total amount of meaning" of a verb or a component, respectively. When applied separately to the six paired comparison matrices the model did a fairly good job. It had to be rejected in only one case on the 5% level of significance as measured by a Mosteller goodness-of-fit test. This result is taken as evidence that by and large the verbs may be represented on a one dimensional scale corresponding to the judged component. This is in accordance with decomposition theory.

Each set of verbs had been judged with respect to two different components. Within each pair of components there was one component embedded in the other. For example, HAVE is embedded in GIVE. Hence the two scales for each pair of components should be related in a simple fashion. To test this, the paired comparison model was applied simultaneously to the two corresponding paired comparison matrices. One additional parameter was included in the model which captured the difference in relative importance of the two judged components. The results of the Mosteller goodness-of-fit test were clear cut. The Chi-square values were 393.7 for the ACTIVITY verbs, 398.4 for the TRAVEL verbs, and 109.1 for the HAVE verbs with 29 degrees of freedom in each case. That is, the one dimensional model had to be rejected for all pairs of components.

Discussion

We found that the separate paired comparison matrices were scalable in accordance with decomposition theory but that the combined matrices were not. This is regarded as evidence against the theory. If one of two components is embedded within the other then the difference in relative importance should remain constant across different verbs in which both components are included. This was not the case. We suggest that this occured because the components do not have the structure that is assumed by synthetic decomposition theory. This is based, of course, on the assumption that judgemental processes do not change from verb to verb.

In conclusion we subscribe to the view of Bierwisch (1981) who distinguishes between a semantic and a conceptual structure in memory. The decomposition into semantic components is perhaps an essential part of the semantic structure which contains the rules of language. In the conceptual structure the meanings of words are represented in a Gestalt like manner. This notion resembles mental models as discussed by Johnson-Laird (1980). It must be admitted, of course, that this notion of a conceptual structure

has yet not been worked out to any satisfactory degree. The data of our experiments suggest that the decompositional theory, at least in the synthetical version, is not rich enough for representing the meaning of verbs.

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