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**Retrieval from semantic memory.**

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## CHAPTER 8

### SUMMARY AND CONCLUSION

#### *Summary*

The present study has been concerned with the retrieval of semantic information. Retrieving semantic information is a fundamental process in almost any kind of cognitive behavior. The introduction presented the main experimental paradigms and results found in the literature on semantic memory as well as an outline of the most important models.

The tasks that generally have been used are simple verification tasks. In one type of tasks subjects are required to judge whether there exists a relation between two concepts. The concepts are presented in a sentence, e.g., *a canary is a bird* or *a canary is a sparrow*. The sentences have to be judged as true or false. In another type of tasks two concepts are presented, e.g., *oak beech* or *oak sparrow*, and the subject has to judge whether both concepts are exemplars of a prespecified category, e.g., *tree*. The concepts have to be judged as same or different with respect to the prespecified categories.

The main results of such studies can be summarized as follows. The reaction time (RT) is a function of the semantic similarity between concepts. The RT for judgments on true or same items is shorter the more similar the words are: e.g., the RT for *a canary is a bird* is shorter than the RT for *a canary is an animal*. The RT for judgments on false or different items is longer the more similar the words are: e.g., the RT for *a canary is a fish* is longer than the RT for *a canary is a flower*. These phenomena are

called semantic distance effects for same and different judgments respectively. Furthermore, it is observed from the results presented in the literature that the RT for true (same) items is shorter than the RT for false (different) items, e.g., the RT for *a canary is a bird* is shorter than the RT for *a canary is a fish*. This phenomenon is termed the same/different effect.

Chapter 2 discussed the statistical analysis of the RT data, focussing specifically on the use of medians.

The main body of this study consists of three parts.

*A model for verifying semantic relations.* The first part has dealt with a hierarchically organized domain. The task used in this part required subjects to judge whether two concepts are same or different with respect to prespecified categories. The selection of the material for these experiments has been discussed in chapter 3. The material consisted of concepts that constitute a three-level hierarchy, viz. exemplars of the categories *tree*, *flower*, *bird* and *insect*. In this way several types of same and several types of different relations between the concepts could be obtained. In the first experiment production frequency data on exemplars from the categories *tree*, *flower*, *bird* and *insect* were obtained. In the three subsequent experiments of chapter 3 it was established that the selected high frequency exemplars did indeed form four groups in the perception of the subjects (Experiment 2); that *tree*, *flower*, *bird* and *insect* are natural category names of the exemplars (Experiment 3); and that *plant* and *animal* are natural supercategory names of the exemplars (Experiment 4). The former four categories appear to be more salient than the latter two.

The results of the first two verification experiments of chapter 4, in which the prespecified categories were *tree*, *flower*, *bird* and *insect* for the first experiment and *plant* and *animal* for the second, confirmed the same/different effect and the semantic distance effects for different judgments as well as for same judgments. These effects were found not only for items in which both words were exemplars (Ex-Ex items) but also for items in which one word was an exemplar and the other one a category (Cat-Ex items). Furthermore, the RT for Cat-Ex items was shorter than the RT for Ex-Ex items, although this difference did tend to disappear very

rapidly in time.

A two-stage model that accounts for the data has been described. The process can be characterized by the following two principles. First, the process starts searching for positive evidence with respect to the criterion to be verified (stage 1: verification stage). If such evidence is not found, evidence must be obtained for the conclusion 'different' (stage 2: falsification stage). Second, the order of information retrieval within these two stages appears to depend on the structure of the semantic domain as actualized by the task and the criterion.

The third verification experiment did exclude the possibility that the same/different effect found in the Experiments 1 and 2 is due to the fact that the different-unrelated words are rather related after all: the same/different effect occurs just as well when the different-unrelated words are actually far apart in meaning. The fourth experiment showed the same/different effect as well as the semantic distance effects in a slightly different condition: there is only one target at a time with respect to which the judgments are made. Furthermore, it appeared that when words have to be judged which both differ substantially in meaning from the target a shortcut is made in the process. Finally, no evidence was obtained for a left to right processing of the words. The results of the experiments have been discussed in terms of the model.

*Generalization to another task.* In part II the question has been studied whether the principles of the model can be generalized to a task different from the verification task. In the experiment of chapter 5 the task required judgment of semantic similarity between two words on a seven-point scale. This task does not stress the hierarchical organization of the material. A high correlation has been found between the similarity judgments and the a priori classification of the item types on the basis of their hierarchical relations. The RT is shortest for the extreme similar judgments, significantly longer for the extreme different judgments, and the longest for the intermediate similarity judgments. These RTs, however, do not only depend on the overall judged semantic similarity between the concepts, they are also substantially determined by the hierarchical relations in the material. The results, therefore,

indicate that the principles of the model developed in part I can be generalized to a non-verification task.

*Generalization to another semantic domain.* Can the principles of the model also be generalized to a different semantic domain, a field with a paradigmatic organization? To study this, two verification experiments were performed in part III on the kinship domain with terms of the nuclear family. First, however, the organization of the domain had to be studied: in chapter 6 the retrieval order of the kinship terms was investigated by requiring subjects to name the words that denote family members and relatives. Both the production frequency and the mean position in the naming sequence indicate that *father* and *mother* are salient terms, immediately followed in saliency by *brother* and *sister*. *Son* and *daughter*, however, are very low in saliency for these subjects.

In the first verification experiment in chapter 7 subjects had to judge whether two kinship terms were same or different with respect to the criterion sex. The two main principles of the model developed in part I have been confirmed: a clear same/different effect is found and the findings of the naming experiment in the kinship domain are reflected in the RTs. Furthermore, it turns out that subjects process kinship terms of their own sex earlier than terms of the opposite sex. No effect of semantic similarity, conceived of in terms of feature overlap, is found.

In the second verification study on the kinship domain subjects had to judge whether the two terms expressed a parent-child relation or not. Again, the two main principles of the model developed for the verification of hierarchical relations have been confirmed. Furthermore, if both terms have no relation to the criterion, the process is shortcircuited similarly as in the corresponding case in the hierarchical domain. Moreover, the same result as found in the first kinship verification experiment turns up: subjects process parent terms of their own sex earlier than parent terms of the opposite sex. For the other terms, however, a male-female asymmetry is found: male terms are processed earlier than female terms, irrespective of the sex of the subject. Finally, the RT for 'yes' answers is shorter when both terms are of the same sex than when they are of different sex; this semantic similarity effect can be

attributed to the interaction of the sex of the subjects and the sex of the terms.

### *Conclusion*

*Relation to other studies.* Most of the studies in semantic memory have especially paid attention to the semantic distance effects for same and for different judgments. A phenomenon that has not been paid attention to is the shorter RT for same judgments than for different judgments. The present research has dealt extensively with this same/different effect as well. The model that has been proposed accounts for all three phenomena.

Most studies in the field of semantic memory deal with verification tasks in a hierarchical domain. The present research has extended this in two directions: first, it has dealt with another task as well, viz. similarity judgments; second, not only hierarchically organized domains were studied but also a paradigmatic domain. For both extensions substantial evidence was found confirming the more general validity of the principles of the model for the hierarchical domain.

On the other hand, however, the model has not been worked out for some phenomena that have been found in other research. One such phenomenon is that the RT for same judgments depends on the types of different items with which the same items are presented in a block. Another phenomenon is that the RT for a different judgment is relatively short if the judgment is on high frequency contradictory concepts.

*Relation to the network/set-theoretic distinction.* As has been indicated in the introductory chapter, network models and feature models can be translated into each other. The present model is neutral with respect to this distinction, although the operations are mainly described in the terminology of a network model. But this is not necessary. For example, instead of 'retrieve category' one may read 'compute category' just as well.

A difference between current network models and set-theoretic models is that the relations between the concepts are not of equal importance according to existing network models, whereas similarity in available set-theoretic models can be defined in terms of all

possible features. In the latter type of model the semantic similarity is determined by a variety of relations (features), the hierarchical being just one of them. The hierarchical relations, however, are of outstanding importance in judgments on the hierarchical domain. Theories, such as the current set-theoretic models, that do not allow for this influence of the structure of the material and the role of the criterion in actualizing this structure will be inadequate as has been demonstrated in chapter 5 and 7: similarity between concepts defined in terms of all possible features cannot sufficiently account for the data on the similarity judgments; the results on the kinship domain demonstrate at most only a marginal interaction effect between verification judgments and the similarity in terms of semantic features.

*Relation to cognitive functioning.* The processing of semantic information as revealed by the present studies, is characterized by two basic factors. The first may be called a set for verification. If one has to judge semantic information, there appears to be a tendency to search for evidence that justifies the answer 'true'. It is only when this evidence is not found, that evidence is searched for which enables one to conclude 'false'. The second factor is the organization of the semantic domain as actualized by the task and particularly by the criterion. In the experiments on the hierarchical domain, the criterion is a feature from the hierarchy that is itself related in terms of set-superset relations to the other features of the domain. In the kinship domain, however, the feature that is the criterion is not related to the other features. Accordingly, the role of the criterion in actualizing the structure of the domain is illustrated especially by the kinship experiments.

These two basic factors characterize the process as a goal-directed process. At each step in the process one has to search for verifying or falsifying information, depending on the stage of the process. The information to be searched for at each step depends on the actualized organization of the semantic domain.

Evidence for the conclusion that subjects try first to verify information and only then try to falsify information, has also been reported by Johnson-Laird and Wason (1970) in experiments in which

subjects had to indicate which information they needed in order to decide whether a conditional sentence is true or false (but see also Brée, 1973).

This description of the semantic processes fits in nicely with the research of Bruner, Goodnow and Austin (1956) on concept attainment tasks. These authors make a distinction between direct tests and indirect tests. A direct test of a hypothesis is a test of what the hypothesis is about. The result of an indirect test requires a transformation in order to yield evidence on the hypothesis. Bruner et al. claim that "the most characteristic feature of cognitive activity [is that] human subjects prefer a direct test of any hypothesis they may be working on" (p. 86). The processes in the present research may be described in terms of direct tests. The criterion with respect to which the information has to be judged specifies the hypothesis to be tested. This hypothesis is tested with a direct test. First, verifying evidence is searched for. If no such evidence is found, a falsification stage follows as a kind of double check. The double check itself can be considered as a direct test again. Bruner et al. conclude that "we do not fully accept the possibilities of correctness and incorrectness being mutually exclusive" (p. 86). Using their terminology the conclusion of the present research is that retrieval processes of semantic information can be characterized as the successive testing of hypotheses by means of direct tests.