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Inferring from language

Noordman, Leonard Gerard Maria

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CHAPTER 14

SUMMARY AND CONCLUSIONS

Summary

Comprehension in the present study is characterized as a process of integrating new information with old information. This process is considered to include inferential processes, as is discussed in the first chapter. The new information in this study is presented in the form of sentences. The study consists of three parts that differ with respect to what information is treated as old information. In the first part comprehension deals with the integration of information in sentences with information in other sentences. The materials that are studied are comparative constructions. The emphasis in the second part is on the integration of information in sentences with knowledge of the world. The verbal material consists of conditional sentences. The third part deals again with the comprehension of sentences with respect to knowledge of the world. In this part, the notion of old information is extended as to include pragmatic factors such as certain presuppositions and expectations. The verbal material consists of kinship terms.

Comprehension is studied from an information processing point of view. The dependent variable in most of the experiments is the reaction time (RT). The second chapter discusses the statistical analysis of the RT data, focussing, especially on the use of medians.

Part I: Comparative relations. The main question in this part is how reasoning processes are to be characterized and how the processes depend on the way the information is coded. This is studied

by varying the complexity of the information and by varying the time that is allowed for the coding process. The experimental material consists of three-term series problems. The items vary in complexity: the more complex items are negative equatives such as *Marc is not as small as Paul, Paul is not as small as Dave, who is biggest?*; the less complex items are comparatives such as *Paul is smaller than Marc, Paul is bigger than Dave, who is biggest?* The results of the first experiment in which the question is presented simultaneously with the propositions, give evidence for the following conclusions. The processing of the less complex items is characterized in terms of the semantic distinction between marked and unmarked adjectives. The processing of the more complex items on the other hand, is much more characterized by the syntactic surface characteristics of the sentences. The more complex items are analyzed in relation to the question, which reduces the complexity of the task. The information processed most recently is most available. A model is constructed that accounts for the data. On the basis of this model predictions are made for the subsequent experiments.

In the second, third and fourth experiment the question is separated from the propositions by a delay increasing in length from zero seconds to four and eight seconds respectively. Two latencies are measured for each item: the inspection time and the answering time. The inspection times are predictable on the basis of the model. The results of the answering times indicate that the longer the time available for the coding, the more the information tends to be coded in the basic representation of the positive, unmarked form. This code was reached for the comparative items earlier than for the negative equative items. When the time interval was eight seconds, both positive and negative information was coded in the basic unmarked form. After such an interval effects due to the surface structure of the sentences are no longer observed. The answering process for each experiment is characterized in terms of the congruence or incongruence of the question with the form in which the information is coded after the time interval.

In order to investigate whether the observed inference processes generalize to other material as well, a similar task was devised with non-verbal, pictorial information. The results of experiments

V and VI show that basically the same processes are involved as in the verbal tasks: the information processed most recently is most available; analyzing the information in relation to the question may reduce the complexity of the task. As was expected, no marked-unmarked effect of the question was found, which indicates that the information is coded in a different way than in the previous experiments. This confirms that the marked-unmarked effect found in the previous experiments is due to the congruence between the coding of the stored information and the coding of the question. The absence of the marked-unmarked effect suggests that such an effect depends on the foreground character of the feature on which the words differ.

Part II: Conditional relations. This part deals with the comprehension of sentences with respect to knowledge of the world. The first chapter of this part concerns the question to what extent the interpretation of conditional sentences depends on the meaning one attributes to the conditional conjunction and to what extent it depends on the knowledge of the world expressed in the sentence. As far as this latter aspect is concerned, three types of sentences are studied: sentences with a biconditional context, such as *if it is freezing, the temperature is below 32°F*; sentences with a conditional context, such as *if it is raining, the streets are wet* and sentences with an arbitrary context, such as *if the red light is lit, the blue is lit*. Sentences are constructed with the conjunctions *if... then, either ... or, unless* and *only if*. A reasoning experiment indicates that all the conditional conjunctions are interpreted predominantly as biconditionals in all the kinds of context, although this is true to a smaller extent for *if... then* than for the other conjunctions. Thus, the conjunctions establish a bidirectional link between the propositions in the clauses as well as between the negated propositions. This biconditionality is described in terms of old and new information. Each proposition and its negation can function as direct antecedent to which a subsequent sentence can refer.

The biconditional interpretation of conditional sentences is accounted for by pragmatic factors in communication, in particular by the knowledge that is presupposed by the speaker and listener

and which functions as background information.

The number of errors in this experiment indicates that the conjunctions *unless* and *either ... or* are the most difficult to handle.

In the second experiment six sentences dealing with the same event are judged as same or different in meaning. The results indicate a difference in the pragmatic function of a conditional sentence viz. between condition-consequence relations, e.g., *if John is ill, he is not going to his work* and inference relations, e.g., *if John is not going to his work, he is ill*.

The third experiment concerns the question as to how a conditional relation is stored and reproduced. The conjunction *if ... then* appears to be the most basic conjunction of those being studied, in the sense that conditional sentences tend to be reproduced as *if ... then* sentences. Moreover, it appears that the distinction between condition-consequence relations and inference relations is an important factor in the memory processes.

In the final experiment subjects have to verify conditional sentences. The RT for the judgments was measured. The factors found in the previous experiments could account for the RTs in the present experiment. The part on conditional relations closes with a model for the comprehension of conditional sentences. Comprehension in this model is described in terms of the following operations: the sentence is transformed into a cognitive representation; factual knowledge is retrieved in a representation as congruent as possible with the sentence representation; these representations are matched with each other.

Part III: Foreground and background information. This part is concerned again with the comprehension of sentences with respect to knowledge of the world but now conceived in a pragmatic way. The knowledge of the world that is studied consists of information that is presupposed and assumed by the speaker and listener. This information is called background information as opposed to foreground information which is explicitly communicated in the sentence. This foreground-background distinction is studied in inference tasks with kinship terms. It was assumed that the gender is the background information for these terms. This is confirmed by the first experiment in which riddles were given consisting of

a positive sentence containing a child term and a negative sentence containing a parent term e.g., *A is the son of B; B is not the father of A. How is that possible?* The negation in the second sentence of the riddle is hardly or never interpreted by subjects as applying to the gender of the kinship terms. But if the gender is affected by the negation, it is more frequently the gender female than male. Thus, there appears to be a male-female asymmetry: the feature male is more difficult to negate than the feature female. The difficulty of the negation is also affected by the context: if kinship terms of both genders are mentioned in the riddle, the gender is more easily affected by the negation; this is called the same-gender effect. In the second experiment the hypotheses are tested that a negation tends to affect only one meaning component (principle of minimal negation) and that this component is parenthood. These hypotheses are confirmed. Based on linguistic evidence it is expected that the asymmetry for kinship terms *father* and *mother* will be replicated by the terms *son* and *daughter* but not by *brother* and *sister*. This is found, indeed, in Experiment III. In all cases the gender appeared to be the background information.

In the following experiments the dependency of the foreground-background distinction on verbal and non-verbal context is illustrated. Experiments IV and V investigate the role of the affirmative i.e. the first sentence of the riddles in creating the background information. The factors which played a role in the previous experiments, the male-female asymmetry and the same-gender effect, are operative again. The results of Experiment V gave the possibility to compute the strength of the background information for the riddles of Experiments I and III. These strength scores correlate highly with the difficulty of solving these riddles. Furthermore, the personal orientation of the subject appears to be important: inferences about parents are more easily made than inferences about children. Experiment VI demonstrates the dependency of the foreground-background distinction on the task. The task stresses the gender of the terms. Consequently, the gender should be foreground information, and the male-female asymmetry should disappear. This is, indeed, found. The results suggest that subjects process kinship terms of their own sex earlier than kinship terms of the

opposite sex. Thus, the personal orientation of the subject affects the foreground information.

Background information appears to be very similar to the given information as studied by Clark and Haviland. It can be considered as a pragmatic extension of this notion. It differs from given information in the sense that background information is not identified as given in the sentence but is presupposed to be given. Secondly, background information as defined with respect to the expectations, can vary in strength.

Conclusions

The results of the present study lead to the following conclusions with respect to verbal information processing. The processing of information can be described as a process of complexity reduction. Comprehension processes depend on the congruence of the pieces of information that have to be integrated: comprehension is achieved by making the coding of the pieces of information congruent to one another. The processing of linguistic information cannot sufficiently be accounted for in terms of linguistic variables, but instead is relative to pragmatic factors. These conclusions will be illustrated in some detail.

Man as complexity reducer. The results of the experiments on comparatives indicate a gradual transformation of the coded information into a basic form: negative information is coded positively (the information was dichotomous); the information is ultimately coded in unmarked form. When subjects have to process complex information, they make use of strategies that reduce the complexity of the processing as indicated by the analysis of verbal and pictorial information in relation to the question.

Similar conclusions emerge from the experiments on conditional relations. *Unless* sentences are reproduced as *if ... then* sentences (Experiment II); the errors in the reasoning task of Experiment I and the RTs in Experiment IV indicated that *unless* is more complex than *if ... then* and even more complex than *if ... then* with an added negation. Again, negative information is coded positively if the information is dichotomous: the two negatives in *unless not* cancel each other. Furthermore, the basic form of the

coding of conditional sentences is the condition-consequence form. The coding of the more complex inference relations makes use of this basic form. Finally, if the information is very complex and confusing, the complexity is reduced by escaping from the task.

The principle of minimal negation, found in the third part, is an economic strategy to handle a negation: only the meaning component that is most in the foreground is negated.

Comprehension and congruence. The general and fundamental property of the comprehension processes, as described in all three parts, is that the nature of comprehension processes is determined by the extent to which the pieces of information are congruent to one another. In each experiment on the comparatives, the answering process is determined by the congruence or incongruence between the question and the form of the stored information. If the information is not congruent, an extra operation is required to make it congruent. Similarly, an important principle of the model for conditional sentences is that the representation of the conditional relation retrieved from stored knowledge is as congruent as possible with the representation of the sentence. This principle is true for the coding of the clauses. It is also illustrated by the difficulty of understanding an inference relation. This difficulty is described in terms of an incongruence between sentence code and stored knowledge.

Two more observations, both described in terms of given and new information, illustrate the importance of congruent coding in the comprehension process. The absence of a direct antecedent for given information can be considered as an incongruence between given information and available information. This incongruence can be handled by an extra operation e.g., bridging or reconstitution. The first observation concerns the comparatives. The RT is longer when, after the negative transformation, the new term is not the subject in the sentence than when it is the subject. The incongruence between what is actually new and old information and what is new and old information according to the structure of the sentence is handled by a reconstitution by which the new term is made the subject of the sentence. The second observation concerns the interpretation of conditional sentences. It is argued that *only if* es-

establishes a bidirectional relation both between the clauses expressed in the sentence and between their negations. The latter is not always true for *if ... then* sentences. In such a case, the negated clauses in the *if ... then* sentences are not given information, and an inference from such a negated clause will less likely be made, because it requires a bridging operation. The incongruence results in the positive equivalence interpretation of *if ... then*.

The importance of the congruence of the information is also illustrated by the experiments on kinship terms. An incongruence between presupposed information and intended information, as is observed in the negation experiments, greatly impairs the comprehension process; an inference can hardly or not at all be made.

Linguistic versus pragmatic factors. The processes in the comprehension of linguistic information are not only determined by the linguistic variables of the input but also, and to a large extent, by pragmatic factors such as certain presuppositions and expectations that constitute the background information. Thus, an essentialistic account of verbal processing in terms of linguistic structures will not be adequate. This is especially clear from the results in part III. The main results of these experiments are described in terms of foreground and background information: the difficulty of negating the gender, the greater difficulty to negate the male than the female component and the stronger tendency to infer a male term rather than a female term. It is demonstrated that the effects due to the foreground-background distinction can indeed be influenced by manipulating the foreground and background information. This has been achieved by stressing certain information in the task. Another non-linguistic variable which plays a role in determining what information is foreground and what is background and which, accordingly, influences the inference processes is the personal orientation of the subject.

The role of foreground and background is also found in the experiments on comparatives and on conditionals. Differences in difficulty between the processing of marked and unmarked words and between the processing of positive and negative information dis-

appears when the polarity of the adjective, respectively the positive and negative information is stressed by the task. Finally, the fact that conditional sentences are interpreted as biconditional sentences is accounted for in terms of background information. The meaning of a conditional sentence and of verbal information in general is not exclusively determined by the sentence, but all kinds of pragmatic factors play a role. Inferring from language requires inferring beyond language.