INFERENCES IN STORY COMPREHENSION

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Abstract

Predictions were made about the types and the number of inferences to be found in the verbal protocols of subjects reading difficult to understand texts. The predictions were made on the basis of two alternative models of inference generation, the backward bottom-up inference and the forward bottom-up inference. It was also hypothesized that plan-goal and script inferences would be stored longer in STM than coreference and role identification inferences. This implies that plan-goal and script inferences are more likely to be reported than coreference and role identification inferences. The protocol analyses support the backward bottom-up inference model and support the assumed length of storage in STM of the different types of inferences.

1.0 Introduction

The study of the generation of inferences in text comprehension is important because it is believed to be one of the main mechanism by which a cohesive text representation is built. While inferences are not to be equated with expectations, it has not always been clear how inferences interact with top-down processing.

Some researchers have proposed a forward bottom-up inference model. The inferences generated at the input of a sentence are strictly determined by the local information in the sentence and they are unconstrained by the context (Rieger, 1975; Thorndyke, 1976). In Thorndyke's model (1978), diverse forward bottom-up inferences are generated from each new input sentence. Their number depends on the presentation rate of the text, the difficulty of the text, the purpose in reading, etc. Some of these inferences could then be compatible with an incoming sentence, facilitating its comprehension.

Other researchers have proposed backward, constrained models (Haviland and Clark, 1974; Kintsch and van Dijk, 1978; Wilensky, 1978). The inferences generated from the input sentence are constrained by the previous sentences. The inferences are produced specifically to establish a coherence relation between the semantic representation of the current sentence and the representation of the text. The type and number of inferences generated are constrained by the context.

Consider a simplified illustration of Wilensky's algorithm to explain events (1978). The inferences generated from an event are possible plans for that event. Those plans are checked to see whether one of these plans is a known plan, or is a plan for a know goal, or is a plan for a known theme, or is an instrumental plan for a know plan. Constraints are provided by already asserted or inferred themes, goals or plans, and by the fact that actions must be explained relative to them.

Experimental evidence seem to be somewhat more in favor of a backward, constrained generation of inferences. The results of Thorndyke's experiment (1976) were proposed as a support for a forward bottom-up inference model. However, this experiment might suffer an identifiability problem. Using previously experimentally derived inferences, a recognition test with those inferences and sentences of the texts is given. It is found that the false alarm rate for compatible inferences is greater than for incompatible inferences. However, such predictions can be derived as well from a backward bottom-up inference model than from a forward bottom-up inference model. A backward inference model will predict that the compatible inferences, that is, those which establish coherence, become part of the text representation and are likely to be falsely recognized as text sentences (see Keenan,McKoon and Kintsch, in Kintsch, 1974). Incompatible inferences, which do

not establish coherence, do not become part of the text representation and are not likely to be falsely recognized.

In an experiment by Miller and Kintsch (1980), subjects have to produce continuations for a sentence presented by itself, in a specific context establishing clearly a main topic, or in a non-secific context suggesting many topics. It is predicted and found that the subjects in the no or non-specific context will rely on the local constraints provided by the target sentence to produce these continuations. On the other hand, it is predicted and found that subjects in the specific context condition will produce continuations related to the main topic. Any model of inference generation, backward or forward, will predict the continuations to be determined by the local constraints in the no or non-specific contexts. However, a forward inference model cannot account for the fact that the continuations produced in the specific context condition are all related to the main topic (constrained), while a backward inference model predicts just that.

2.0 Method and Predictions

The study to be presented makes predictions over the types and the number of inferences likely to be found in the verbal protocols of subjects reading difficult-to-understand texts. These predictions are based on the two alternative models of inference generation, the forward and the backward models, they are based on assumed or known properties of the memory storage of inferences, and they are based on the theory of verbal reports (Ericsson and Simon, 1980).

Nine subjects were trained to make thinking-aloud and retrospective reports on their inferences on twelve practice texts. It was emphasized that they should not try to report all the inferences that they could eventually make, but only report the inferences they were making automatically, without effort. However, they were also instructed that some texts might be harder than others and that it would be normal to find the production of inferences more difficult in those cases, but still to report them.

The texts used were "Paul's Outing" (Collins, Brown and Larkin, 1977), "The Crowd", an adaptation of a text used by Bransford and Johnson (1973), and "Noon, Downtown", a short humourous narrative. In all the texts, the last sentence indicated clearly the topic of the text. The text "The Crowd" is more descriptive than narrative.

For an inference to be reported, it must be stored in STM and during a minimal amount of time (Ericsson and Simon, 1980). Inferences likely to be reported are inferences of plans and goals, and inferences of scripts (Schank and Abelson, 1977). In the protocols, explicit inferences of plans and goals would be like: "The driver went underneath the truck to repair it.". Explicit inferences of scripts would be like: "This is going to be about traffic." or "He seems to go to a movie.".

Inferences of plans and goals are likely to be reported because they are the major coherence relations in the text representation of narratives. They need to be stored long enough in STM (short term memory) to build the cohesive text representation and they become a permanent part of the text representation. Inferences of scripts are likely to be reported because the scripts are used to interpret a certain number of sentences and are the basis of the text representation.

Inferences not likely to be reported are coreference relations and role identifications. Coreference relations are the determination of the referent of a pronoun or a definite description. They are often made automatically, on the basis of the structure of the text, without requiring STM to store intermediate computations, and therefore, are not likely to be reported. Role identifications are the recognition that a story character or object correspond to a script character or object. The recognition is made on the basis of functional or categorical information provided by the text. Presumably, this is accomplised through direct pattern-matching and therefore does not use STM to store intermediate results and cannot be reported. However, if the inferred coreference or role identification reveals itself to be inadequate, it is likely that the reader will report the inadequacy and will report the new assignment.

For each text, a set of inferences were a priori derived and predicted to appear explicitly, either frequently or infrequently, in the protocols.

It is predicted that the most frequent explicit inferences will be those of plans and goals, and scripts. A related prediction is that the most frequently implicit inferences will be those of coreferences and role identifications. By implicit, it is meant that the protocol in icates rather certainly that the inference was made but only indirectly. For example, suppose two of the sentences were: "Paul plunked down $5 at the window....but he refused to take it.". Suppose also that the protocol contains something like: "Well, I couldn't understand why John wouldn't take the change.". It is clear that the reader made the coreference relation between "he" and "John".

According to the backward bottom-up inference models, plan-goal inferences should be reported only after the event they help to explain is read, and in most cases, only one coherence relation should be reported for that event. According to the forward bottom-up inference models (Thorndyke, 1976), numerous inferences could be reported when a sentence is read, potentially explaining an event in a future sentence.

The protocols were analysed in terms of the types and frequency of the explicitly and implicitly reported inferences. A simple consistency checking was performed on the classification of the inferences using a third of the protocols (9 out of 27). The consistency estimate was about .95.

In every case of a reported coherence relation, it has been reported after the event it explained, and in only one case has there een ore than one coherence relation proposed (there were two). This is consistent with a backward bottom-up inference model.

Table 1 presents the types, predicted frequencies and observed frequencies in the protocols of the a priori determined inferences.

The overall frequency of the predicted frequent inferences is .65, and of the unfrequent ones is .11.

As was predicted, plan-goal and script inferences are much more ferquently reported than coreference or role identification inferences.

Table 2 presents the frequencies of inferences explicitly generated, implicitly generated and of inferences for which there is no indication in the protocols that they have been made. The data are summed over the two methods because while there is a slight tendency for more inferences to be reported in the thinking-aloud reports, this is not true for all stories.

Script and plan-goal inferences are more often explicit than implicit or not mentionned, while coreference and role identification inferences are most often implicit.

The location and the number of inferred coherence relations support a backward bottom-up inference model. The greater frequency of reported plan-goal and script inferences is consistent with their assumed length of storage in STM and LTM. The relative unfrequency of role identification and coreference inferences supports their assumed automaticity and lack of use of STM to store intermadiate results.

The somewhat less good fit of the data to the predictions in "The Crowd" might be due to the fact that "The Crowd' is more descriptive than narrative anc that the models for inference generatior were devised for narratives.

Table 1
Observed frequencies of each instance of the predicted inferences summed over the two methods

NOON, DOWNTOWN (each on a total of 5)

Predicted frequent:

p-g	cause	p-s	p-s	p-g	p-g	p-g	
5	3	4	1	4	2	3	M= .6

Predicted unfrequent:
None of the 6 instances of coreferences has been observed in any protocol M= .0

PAUL'S OUTING (over a total of 6)

Predicted frequent:

p-g	p-g	p-g	p-g	
5	5	6	5	M= .9

Predicted unfrequent:

cor	cor	role	role	role	role	cause	
1	2	0	1	0	1	0	
role	cause						
0	2						M= .1

THE CROWD (over a total of 6)

Predicted frequent:

scr	scr	p-g	scr	scr	cause	scr	
1	3	4	2	4	1	3	M= .5

Predicted unfrequent:

role	role	cor	role	cor			
1	1	0	1	0			
impl	impl						
2	1						M= .2

p-g = plan-goal role = role-identification
scr = script impl = implicature
M = mean

Table 2
Types and frequencies of inferences as a function of stories and methods.

NOON, DOWNTOWN

EXPLICIT	IMPLICIT	NOT FOUND
21 p-g	6(2) p-g	3(5) p-g
0 cor	12 cor	

PAUL'S OUTING

EXPLICIT	IMPLICIT	NOT FOUND
20 p-g	3(2) p-g	1(0) p-g
3 cor	9 cor	
2 role	12 role	
1 cause		

THE CROWD

EXPLICIT	IMPLICIT	NOT FOUND
16(15) p-g	7 role	11(12) p-g
5(4) role	7 cor	
3 impl	1(0) p-g	
1 cause		
1(0) cor		

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