TEXT COMPREHENSION : MACROSTRUCTURE AND FRAME

J.P. ROSSI
Université de Poitiers
Laboratoire de Psychologie du Langage, CNRS U.A. 666

In the last 15 years, cognitive research on text comprehension has focused either on the description of the propositional content of texts (analysis of relationships between propositions or concepts), or the study of a pre-existing pattern stored in long term memory alternatively called : "frame" (Minsky, 1975; Frederiksen, 1986), "script" (Schank and Abelson, 1977), "scenario" (Sanford and Garrod, 1981) or "schema" (Rumelhart and Ortony, 1977).

These different terms correspond to varieties of schemas. The text schema is a semantic network which describes the common components of classes of texts and their interrelationships. These are composed of nodes and links. In Mandler and Johnson's (1977) story grammar theory the nodes are Beginning (B), Reaction (R), Goal (G), Attempt (A), Outcome (O) and Ending (E). In the Beginning (B) the protagonists are faced with a problem, they React (R), formulate a Goal (G), produce an Outcome (O). The Ending (E) is the conclusion. For the partisans of story grammars this typical network is progressively internalized by individuals through repeated exposure (hearing and reading) to stories (Denhiere, 1986). Few studies have been conducted on scientific text schema, with the exception of Frederiksen (1986), who introduced the notion of "problem frame". The principal nodes of this frame are: problem states, procedures, result states and goal. The problem frame will be employed in the experiment described below. Frames guide comprehension and govern the recovery of information stored in memory when the individual must recall or summarize a story, (Denhiere, 1986).

Current research aims at constituting text grammars and evaluating the role of schemas in text encoding, text comprehension and recall. Cross-cultural invariance of narrative structure has been attested to for literate and nonliterate societies as well (Mandler, Scribner, Cole & Deforest,1980). People recall stories through schemas (Glenn, 1978).

Comprehension is facilitated if the text fits in the schema (Kintsch and Yarbrough, 1982). In educational studies, Rahman and Bisanz (1986) showed that in reconstruction and recall tasks, both good and poor readers use a story schema when the story followed the canonical format but poor readers' story schema "was either not as well developed or as efficiently used as good readers'". Cuing poor readers to use a story schema does not facilitate their recall. These data are not informative as to how schemas intervene in reading comprehension because a good reader is an individual who constructs a good macrostructure and a macrostructure is good if it reflects the text schema. To evaluate the function of schema in text comprehension it is necessary to provide a description of what is theoretically happening as one reads. This requires opposing two basic modes of information processing: a top-down model and a bottom-up model. In the first mode, the top-down model, the reader activates a schema and searches for information to fit in each node (Adams & Colins, 1980). The bottom-up processing, works in the opposite direction: in the absence of pre-existing schemas, the cognitive system constructs a macrostucture to reflect the text schema.

The present experiments were designed to validate mode of information processing. If the activation of schema facilitates text comprehension, performance in comprehension and summarization tasks should be improved if the subject is given information on the schema. In contrast, if comprehension is independent of schema activation, information on the schema should prove inefficient, and only macrostructure information should have a positive effect. Similarly, if the schema is purely a means for constructing the macrostructure, the activation of an adequate schema should improve performance, but to a lesser extent than macrostructure information alone.

METHOD

Material

Two extracts from 5th grade school textbooks of were selected. The first, entitled "The Invention of The Printing Press" was composed of 208 words, 22 lines, 10 sentences, 126 propositions (Turner and Green,1978) and 5 paragraphs. It was used for practice, and as a pretest for matching subjects.

The second text used in the 5 conditions dealt with "How to Measure the Distance between Stars". It was made up of 237 words, 25 lines, 14 sentences and 142 propositions. The text was divided into 5 paragraphs : the first presented the problem, the second gave an explanation, and each of the three remaining paragraphs suggested a solution and provided an example.

The macrostructure appeared as the last sentence of each paragraph. Both texts were typed on sheets of paper.

A five-item questionnaire on macrostructure constituents was devised for each text. The first question dealt with the text topic (first paragraph), e.g. "What is the text about?". The second item dealt with the second paragraph and so on. Subjects were asked to respond in writing in the space provided below each question. A blank sheet was furnished to write a summary.

PROCEDURE AND DESIGN

Five conditions were tested :

Group 1. texts with no annotation (control group)

Group 2. texts with macrostructure sentences underlined

Group 3. texts where the frame (headings corresponding to the text structure) were indicated in list form inserted between the title and the beginning of the text (problem, explanation of problem, first solution and first example, second example, third example..)

Group 4. the frame headings were indicated in the margin next to each paragraph

Group 5. frame information identical to Group 4, plus macrostructure sentences underlined as in Group 2.

Hypotheses as to the role of the frame and the macrostructure were tested by comparing performances across groups. If the frame alone is important, then $G1=G2<G3<G4=G5$, if the frame has no effect, then $G1=G3=G4<G2=G5$. In contrast, if the schema guides the construction of the macrostructure, then $G1<G3<G4<G2<G5$.

The subjects read the text, wrote a summary and answered the questionnaire. They were informed that each text was scored on the basis of 20 points and that they would be allotted 25 minutes. Subjects were allowed

to have the text in front of them during the entire experiment and could consult it freely when writing the summary and answering questions.

The experiment was divided into two phases. In phase 1, all the subjects read the text entitled "The Invention of the Printing Press", wrote the summary and answered the questions. These results were then used for matching subjects who were assigned to each of the five conditions. Phase 2 was identical to Phase 1 except that the text used was "How to measure the distance between stars" and the information provided to the subjects varied across conditions. The two phases were administered at a two-week interval in the same school on Mondays and Tuesdays.

Subjects

The sample was composed of 100 children in the last years of French elementary school (5th grade). The mean age was 10,1 years +/- 6 months. The subjects were attending 4 schools which catered to similar socioeconomic backgrounds. As a function of scores on the first text, the subjects were assigned to one of the 5 conditions, to form matched groups.

Scoring

A grid indicating the correct answers to each item and the score was constructed by two judges. Each question was scored on the basis of a total of 4 points, yielding a maximum score for each text of 20 points. Scoring of the summaries was obtained by comparing subjects' responses with a model summary produced by two judges. Responses were weighted so that each of the five parts of the text had the same number of points. Maximum score was 20.

Responses to the questionnaire and the summaries were scored independently by two judges. Disagreements were easily resolved through discussion.

On the basis of performance on text 1, five homogeneous matched groups were formed. The means for these groups appear in Table 1. No significant differences were observed, and the Fs were all less than 1.

RESULTS

The means for the questionnaire and the summary for the 5 groups appear in Table 1.

TABLE 1. Means and standard deviations for scores of the 5 groups of subjects

Groups		G1	G2	G3	G4	G5
Quest.	M	9.05	12.20	11.00	11.35	11.95
	S.D.	4.70	4.26	3.93	3.54	5.81
Summary	M	9.35	13.60	11.25	11.15	12.35
	S.D.	5.52	5.51	5.28	4.34	3.60

Questionnaire Results

The control group (G1) performed significantly worse ($F(1,95)=5.19$ $p<.01$) than the other groups. The four experimental groups (G2,G3,G4,G5) exhibited equivalent scores ($F<1$). When the problem-frame was indicated in the margin, performance was not better than when the problem-frame was listed at the start of the text : $F<1$ for group 3 vs Group 4. Similarly, performance did not differ when the problem-frame information was added to the macrostructure (group G2 vs G5, $F<1$) or when macrostructure information was added to the problem-frame (G5 vs G3G4 $F<1$). Regardless of the type of annotation, problem-frame information was as efficient in improving performance as underlining the macrostructure (G2 vs G3 G3, $F<1$).

Summary Results

The summary means do not differ from those obtained on the questionnaire ($F<1$). The observed effects were identical : positive impact of aid in the form of annotation as compared to the control group text ($F(1,95) = 4.96$ p.<015); no significant differences between the experimental groups ($F(3,76) = 1.16$, ns).

The group x type of task interaction did not reach significance ($F<1$). The scoring system for the summary obviously generates this result.

The analyses presented above were based on group data. It is likely however that the efficiency of aid will vary according to the type of subject. Arguably annotation would be of little help to subjects who already implement the type of processes indicated, but on the contrary would be highly efficient in subjects who do not know how to proceed. Thus readers who scored low on the practice text were assumed not to have mastered adequate processing techniques in contrast to high scorers, who were assumed

to use efficient strategies. On the basis of the score for comprehension questions on the practice text, 2 groups of subjets were formed: Good Comprehenders (G.C.) whose comprehension scores were =/> 12; Poor Comprehenders (P.C.) whose scores were < 10. Summary scores were handled in the same way: scores for Good Summarizers (G.S.) were =/> 12; Poor Summarizers (P.S.) scored under 10. The number of subjects and the mean performances for these two groups appear in Tables 2 and 3.

The two groups differ significantly ($F(1,80) = 29.70$; $p < .001$).

All the aids improve performance significantly in Poor Comprehenders : $F(1,35) = 5.26$, $p < .02$ but the means for the four experimental groups (G2,G3,G4,G5) do not differ significantly ($F<1$).

In contrast, the performance of G.C. were significantly improved when the macrostructure was underlined. Only this condition, when compared to those where the macrostructure was not underlined, reaches significance ($F(1,27) = 13.15$, $p=.001$).

TABLE 2. Questionnaire results for good and poor comprehenders

Groups		G1	G2	G3	G4	G5
PC	n	9	8	7	6	10
	M	5.44	10.62	10.28	7.66	9.40
	S.D.	3.71	3.58	4.99	3.26	6.86
GC	n	7	9	10	11	8
	M	12.28	15.66	10.50	13.36	15.37
	S.D.	3.40	3.24	3.27	2.27	2.38

TABLE 3. Summary results for good and poor summarizers.

Groups		G1	G2	G3	G4	G5
PS	n	10	10	11	9	10
	M	5.60	10.60	9.81	9.33	10.20
	S.D.	4.27	5.08	5.47	4.06	3.01
GS	n	7	8	6	9	7
	M	12.85	18.25	13.50	13.37	14.57
	S.D.	4.56	2.05	3.67	4.65	3.45

The summary results (see Table 3) exhibit similar trends. All the aids significantly improve performance of Poor Summarizers whereas only the underlining of the macrostructure is significantly efficient for Good Summarizers ($F(1,27) = 5.07$, $p.03$).

CONCLUSION

Overall, the findings indicate that problem-frame knowledge is as useful as macrostructure knowledge for text comprehension and summarizing. The frame thus appears to have an effect similar to the macrostructure on text processing.The differences in efficiency of these two types of aids only appear when the subjects are classified as good or poor comprehenders/ summarizers.

All the aids tested in this study proved to be efficient for poor comprehenders and summarizers. Frame knowledge and the macrostructure are equally efficient for Poor Comprehenders but their processing strategies are apparently inefficient. All aids have the effect of improving performance and none interfered with their mode of processing. However the improvement observed in these subjects was not sufficient to bring them up to the level of the good comprehenders who received no aid. This seems to suggest that poor comprehenders/ summarizers use the information provided to them in the form of aids, but do not integrate this information into their processing strategies.

Only macrostructure information improves performance in Good Comprehenders and Summarizers whereas problem-frame information has no effect. There are three possible explanations for this. First of all, frame information may not be necessary to comprehension. Secondly, frame information was redundant because these subjects already had a problem-frame available. Thirdly, the frame provided was not sufficient for the construction of the macrostructure. This could have been because the problem-frame was inappropriate or because the operations necessitated by the activation of the frame were complex.

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