THINKING AS A COMPONENT OF LANGUAGE UNDERSTANDING

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ABSTRACT

In contemporary cognitive psychology the relationship between reading achievement and verbal processing abilities has been considered. Because receiving a text is a highly complex activity, it has been difficult to determine which component processes really are important in text understanding. In psychological research the components of verbal processing are usually borrowed from earlier studies and measured by well known psychological tests such as memory span, associative learning, semantic association and recording speed and accuracy. In addition to the ability to code verbal information, the ability to utilize coded information should be taken into account. People simply do not receive texts or other verbal messages in a mental vacuum, but the understanding of verbal information depends on the activation of earlier knowledge in memory. No standardized tests are available for measuring this.

In this study three tasks were developed. In a free elaboration task subjects were asked to produce elaborations on sentences. In a context inferencing task they put sentences in different contexts, and in a causal inferencing task they inferred alternative reasons for events. Language understanding was measured by using the number of essential ideas recalled from an expository text. The tasks were given to 138 elementary school pupils and 54 undergraduate students. The results indicate that elaborative thinking is one basic component of language understanding. The differences in the self-generated elaborations between good and poor text understanders are presented, and the possibilities for helping poor text understanders to practise their elaborative skills at school are discussed.

1. Introduction

The understanding of language depends on the activation of earlier knowledge in memory. By the aid of activated knowledge, vivid images are created from a few words, separated sentences are seen as the parts of a meaningful whole, and the reasons of actions are understood. This sort of thinking or commonsense reasoning is so characteristic for human beings

that it has not earlier been seen problematic or worth of scientific research.

However, people interpret language differently, hence they construct different kinds of representations of the same verbal information. This could result also in qualitatively and quantitatively different elaborations. The different possibilities to elaborate on a single sentence can be classified as follows:

At first, we can make descriptive elaborations by connecting properties of states with ACTOR, ACTION, OBJECT, INSTRUMENT or other cases of the sentence (see Figure 1). Secondly, we can make contextual elaborations by specifying the time or place of the whole event in question. Thirdly, we can make micro level causal inferences by telling why the ACTOR is doing the ACTION on the basis of the definition of the verb or some other word of the sentence. The forth possibility is to infer reason or cause of the ACTION at the macro level. In this case the elaboration is based on some wider context which the sentence has been put in. The fifth possibility is to continue the sentence by telling what will happen after the ACTION, or what the consequence of the ACTION is.

It can be said that elaborations come from schemata (Bartlett 1932), scripts, goals, and plans (Schank and Abelson 1977), frames (Minsky 1980), pseudo texts (Wilks 1980), or other high level knowledge structures of memory (Schank 1982). But who knows what these structures really look like, or how they are organized? It is also problematic how elaborations become active, ie. what the mechanism is which evokes them. Thirdly, how does the ability to elaborate develop? And furthermore, in what way is this ability connected with text understanding? Do children with different abilities to understand verbal information differ in how automatically they elaborate on sentences they receive? Are some elaborations more important than others, and if they are, then why?

Two types of elaborations will be considered here: CONTEXTUAL ELABORATIONS and CAUSAL INFERENCES. To elaborate contexts means to activate whole knowledge structures in memory, which structures in turn provide expectations and "interpretation routines" for further processing (see Schank 1982). In case of causal inferences the elaborated earlier knowledge gives an explanation for the event in question (see Anderson 1980).

Since texts are received sentence by sentence, it may be reasonable to look for connections between the ability to elaborate on single sentences and the ability to understand the essential information of a text. The

SENTENCE: Louise tickled the upper lip of the sleeping Mary with a stem of grass.

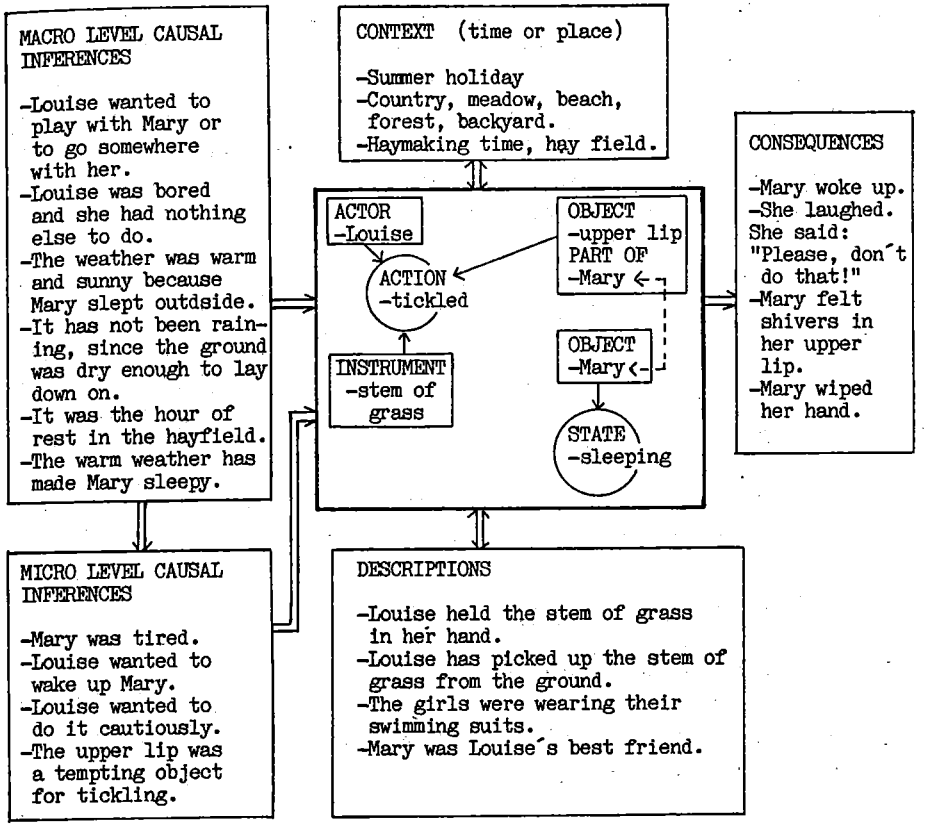


Figure 1. Some examples of different types of elaborations. The case relations of the given sentence are presented in the inner box of the figure.

purpose of the present study was to see whether students who are skillful in text understanding are able to produce more elaborations on single sentences, and which of the self-generated elaborations could contribute to text understanding.

2. Methods

How differences in sentence elaborations are reflected in language understanding was studied by using three types of elaboration tasks. In the free elaboration task subjects were asked to produce as many elaborations as they could on the following separate sentences:

1. The clock rang, John yawned and yawned, and fumbled for the light switch.
2. Their Volvo was also standing there among the other five hundred cars.
3. A town extended whitely everywhere, the snow covering the roofs of the houses was really sparkling.
4. Louise tickled the upper lip of the sleeping Mary with a stem of grass.

In the context inferencing task subjects were asked to put the following sentences into as many alternative situations as possible:

1. (S)he spread (something on something).
2. (S)he pressed the button.
3. A loud sound was heard.
4. (S)he checked that everyone had a ticket.

In the causal inferencing task alternative explanations for the following events were asked for:

1. The bike was broken because ...
2. (S)he became happy because ...
3. The man sawed industriously because ...
4. The bird made a long moaning sound because ....
5. (S)he stayed alone / (s)he was left alone / because ...
6. The train was late because ...

Text understanding was measured by using the number of essential ideas recalled from an expository text as a score. The content of the text selected was funerals in ancient Egypt, probably an unknown theme to Finnish schoolchildren. The length of the Finnish text was 232 words. In

the text five services for the deceased were described so that the reasons for those services were explained. It was stressed in the text that the quality of those services was dependent on how rich the deceased had been. In addition to the description of the services, the text included four beliefs or dogmas typical of the Egyptian religion of that time plus some unessential details and examples of the things found in ancient graves.

2.1. Subjects

All the second graders from an elementary school participated in this study. The number of them was 84, 36 girls and 48 boys. They were born during the same calendar year, so that they were 8 or 9 years old. The tasks were also given to 54 sixth graders, 26 girls and 28 boys, who attended the same elementary school. Three sixth graders participated only in the text understanding task, so the number of sixth graders in all the three inferencing tasks was 51. In addition to the elementary school pupils, 54 undergraduate students from an introductory course in psychology participated in this study.

2.2. Procedure and scoring

The subjects were asked to make a summary of the text immediately after it was read to them. After that, they answered nine questions concerning the essential ideas of the text. Each subject got one point for every correct answer, whether it was found in her or his summary, or in her or his answers to the questions or in both of them. After the subjects had answered the questions, the free elaboration task was given to them. The next task was the context inferencing task, and the last task was the causal inferencing task.

The second graders were tested individually and their responses were tape-recorded. The latencies of the elaborations were measured from the tape. The sixth graders and university students were tested in group situations so that they wrote their summaries, answers, and elaborations in an answering sheet.

The elaborations from the free elaboration task were classified in five categories: descriptive elaborations, contextual elaborations, micro and macro level causal inferences, and consequences (see Figure 1). The

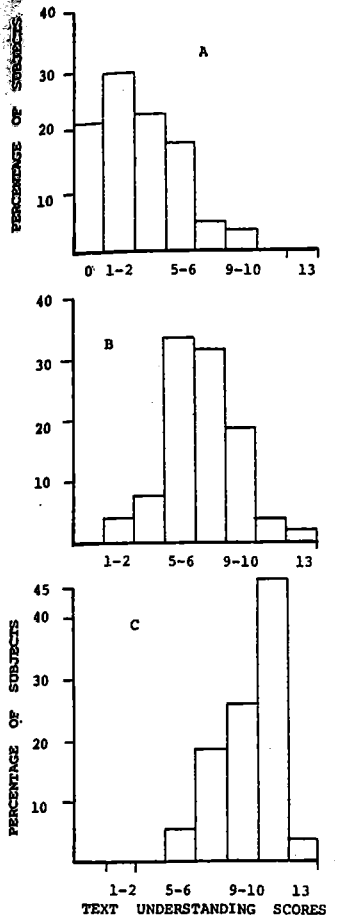
number of the elaborations in each category was counted over the stimulus sentences. The number of the alternative situations produced in the context inferencing task and the number of the alternative explanations inferred in the causal inferencing task were counted so that only those alternatives were taken into account which belonged to different content categories. Two independent judges classified and counted the responses. The correlations between them varied from .63 to .92 (mean = .81; standard deviation = .09).

3. Results

The frequency distributions of the text understanding scores in the groups of the second and sixth graders and university students are presented in Figure 2. In the second grade the average score was 2.94 (standard deviation = 2.54). A total of 18 of the second graders (21 %) scored zero, whereas the other extreme group, the good text understanders in the second grade, did the task almost as well as the university students. In the sixth grade the distribution of the text understanding scores was almost normal, as was expected.

Most of the 18 poor text understanders in the second grade were extremely slow in elaboration (see Figure 3). The average time needed to give the first elaboration to the stimulus sentence in the free elaboration task was 14.5 seconds in this group, while the respective latency was 5.3 seconds in the group of good text understanders. Similar results were found in the context inferencing task and in the causal inferencing task.

In the free elaboration task the second graders with zero score in text understanding made fewer elaborations than the other pupils. The distribution of the elaborations in the different content categories is presented in Figure 4. The difference between good and poor text understanders in the second grade is significant beyond the level 0.01 in the categories of descriptive and contextual elaborations, in the category of macro level causal inferences, and in the category of consequences (see Figure 4). The good text understanders in the second grade produced approximately as many elaborations in the different categories as the sixth graders on an average. The comparison between the good text understanders in the second grade and the undergraduate students, who are used to learning abstract expository texts, shows the superiority of undergraduate students



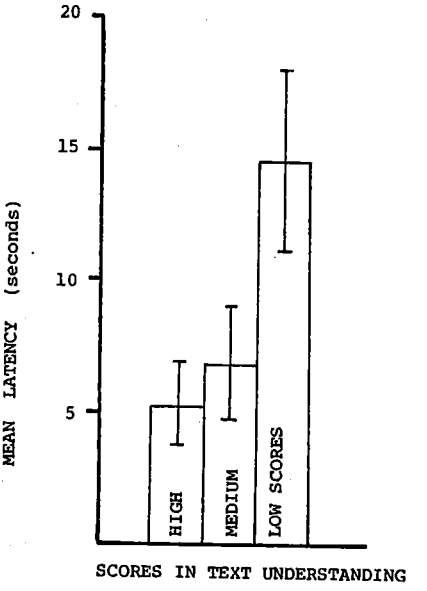


Figure 2. The frequency distributions of the text understanding scores in the second grade (A), in the sixth grade (B), and in the group of university students (C).

Figure 3. The mean latency of the first generated elaborations in the groups of second graders with high, medium, and low scores in text understanding. The difference between the groups with low and high scores is 9.26 seconds ($t = 5.11$; $df = 34$; $p < 0.001$).

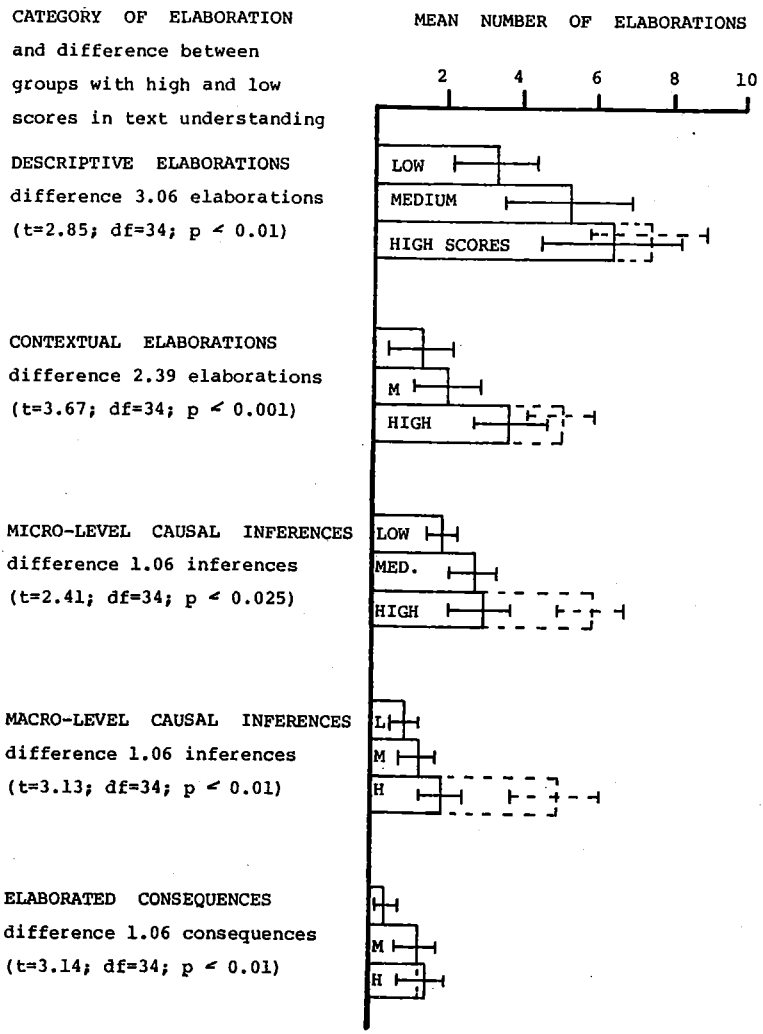


Figure 4. The mean number of the elaborations in different categories in the groups of second graders who got low, medium or high scores in text understanding. The figure (the solid columns) is based on 1,075 elaborations made by 84 pupils on 4 stimulus sentences. The dotted columns indicate the comparable means of the university students.

in the production of both micro and macro level causal inferences (see the dotted columns in Figure 4). This superiority is accentuated because these two groups do not differ significantly in the number of other kinds of elaborations.

In the causal inferencing task the good text understanders in the second grade inferred more alternative explanations than the poor text understanders, the difference between the means of the groups was 7.22 inferences ($t = 5.029$; $df = 34$; $p < 0.001$; see Figure 5). Also in the sixth

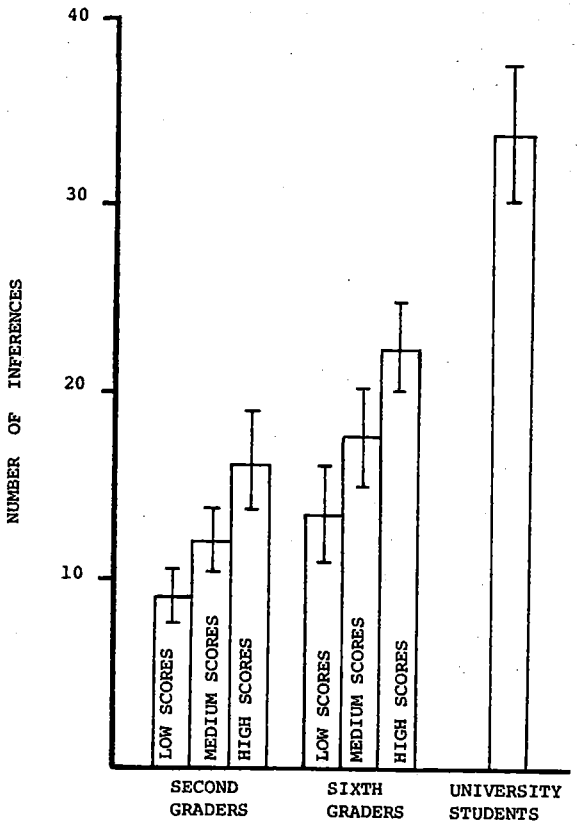


Figure 5. The mean number of the causal inferences which belong to different content categories in the groups of second and sixth graders and undergraduate students. The groups of second and sixth graders are further divided into three subgroups with low, medium, and high scores in text understanding. The figure is based on 3,764 inferences drawn by 189 subjects from 6 separate stimulus events. The bars represent one standard deviation.

grade the good text understanders produced more alternative explanations than the poor ones ($t = 4.149$; $df = 20$; $p < 0.001$; see Figure 5). Compared to the second and sixth graders the undergraduate students were superior in this task. In the group of undergraduate students the average number of the alternative explanations was 33.8, in the group of sixth graders it was 17.7, and in the group of second graders 12.4. However, there were no remarkable differences in the content of causal inferences between the groups.

In the context inferencing task the good text understanders in the second grade produced more alternative situations than the poor ones, the difference between the means of the groups being 4.34 alternatives ($t = 4.139$; $df = 34$; $p < 0.001$; see Figure 6). However, in the sixth grade the difference between the means of the extreme groups (2.55 inferences) was not statistically significant. The university students produced, on an average, 16.4 alternatives belonging to different content categories, when

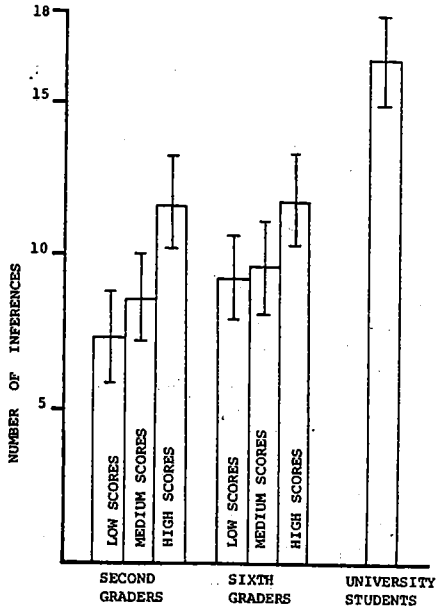


Figure 6. The mean number of the alternative contexts in different content categories in the groups of second and sixth graders and university students. The groups of second and sixth graders are further devided into three subgroups with low, medium and high scores in text understanding. The figure is based on 2,154 responses inferred by 189 subjects from 4 separate stimulus sentences. The bars represent one standard deviation.

the respective average was 10.0 in the sixth grade, and 9.0 in the second grade. Thus the difference between the university students and the school pupils was not so great in this task as in the causal inferencing task (compare Figures 5 and 6). There were no differences worth mentioning in the content of inferred situations between the groups.

The regression analysis where the text understanding scores are predicted by the number and latency of different types of elaborations was calculated from the scores of all 84 second graders (Table 1). The multiple regression model accounted for 53.6% of the total variance of the text understanding scores.

The number of the alternative explanations in the causal inferencing task was the best predictor in this model. The second best was the

TABLE 1

Stepwise Multiple Regression on Text Understanding

Step entered	Variable	R^2	Increase in R^2	F-value	sign. level
1	Alternative explanations in causal inferencing task	0.248	0.248	26.99	p<0.01
2	Contextual elaborations in free elaboration task	0.359	0.112	14.29	p<0.01
3	Latency of first responses in free elaboration task	0.452	0.093	13.78	p<0.01
4	Alternative situations in context inferencing task	0.455	0.002	0.342	-
5	Latency of first explanations in causal inferencing task	0.455	0.00001	0.001	-
6	Latency of first situations in context inferencing task	0.457	0.002	0.329	-
7	Elaborated consequences in free elaboration task	0.466	0.009	1.284	-
8	Macro level causal inferences in free elaboration task	0.476	0.010	1.463	-
9	Micro level causal inferences in free elaboration task	0.507	0.031	4.746	p<0.05
10	Descriptive elaborations in free elaboration task	0.536	0.029	4.636	p<0.05

number of contextual elaborations in the free elaboration task, ie. the number of the inferences by which the stimulus sentences were related to some time and/or place. The third predictor was the latency of the elaborations first given to the sentence in the free elaboration task. The next five variables did not significantly increase the amount of accounted variance in this model, due to the intercorrelations between the variables (see Table 2). However, the last two variables with the smallest correlations with the dependent variable, the number of the micro level causal inferences and the number of the descriptive elaborations in the free elaboration task have some effect on the coefficient of determination.

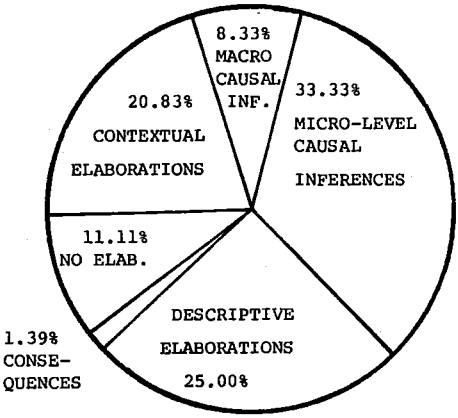
The correlation between the number of the alternative explanations in the causal inferencing task and the number of the alternative situations in the context inferencing task was 0.547 (see Table 2). The two tasks are quite similar, and they both measure the ability to activate and retrieve information from semantic memory. The rather high correlation (.562) between the number of the macro level causal inferences and the number of the contextual elaborations in the free elaboration task is not surprising, because it is not possible to produce macro level inferences without any wider context in mind. A wider context also gives more possibilities to describe events, which explains the rather high correlation between contextual and descriptive elaborations (r = .547).

The role of contextual elaborations in the free elaboration task is accentuated when the first elaborations are compared between the groups. Namely, the first thought which a sentence brings to mind may have the greatest effect on understanding in communicative situations, where texts go on at a normal speed without long breaks for elaborations. The percentual distribution of firstly generated elaborations is presented in Figure 7. In the group of poor text understanders the proportion of contextual elaborations is only about 20 per cent, whereas in the group of good text understanders nearly one in two of the firstly generated elaborations was contextual. The small proportion of contextual elaborations in the group of poor text understanders was compensated by the greater proportion of micro level causal inferences and descriptive elaborations. Some pupils in this group simply repeated some of the stimulus sentences without any elaborations; hence the percentage of no elaborations takes one sector in the circle (see Figure 7). The percentual distributions of first elaborations were nearly equal in the group of undergraduate students and in the group of good text understanders in the second grade (see Figure 7).

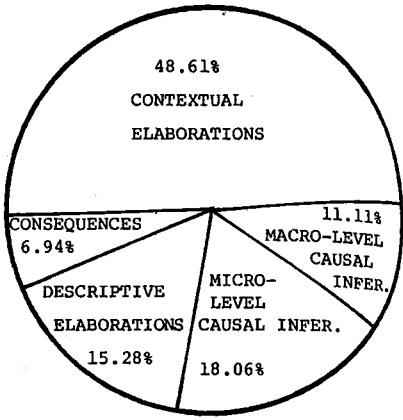
TABLE 2

The intercorrelations between the latencies and numbers of different types of elaborations and text understanding scores for all 84 second graders

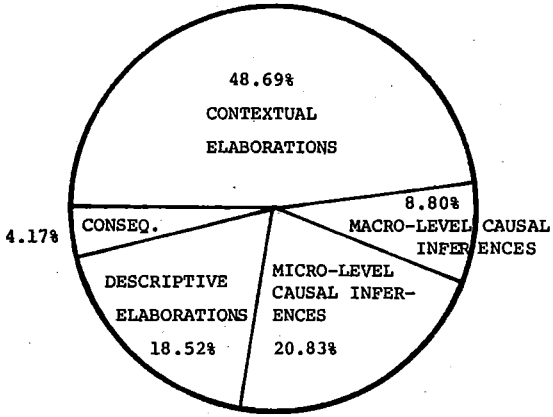
VARIABLE	2	3	4	5	6	7	8	9	10	11
1. Alternative explanations in causal inferencing task	.336	-.396	.547	-.317	-.288	.146	.258	-.062	.243	.498
2. Contextual elaborations in free elaboration task		-.128	.200	-.163	-.093	.184	.562	-.032	.547	.482
3. Latency of first responses in free elaboration task			-.335	.524	.659	-.234	-.240	-.223	-.233	-.475
4. Alternative situations in context inferencing task				-.363	-.497	.261	.245	.108	.250	.357
5. Latency of first explanations in causal inferencing task					.542	-.080	-.181	-.145	-.314	-.316
6. Latency of first situations in context inferencing task						-.235	-.217	-.225	-.178	-.307
7. Elaborated consequences in free elaboration task							-.019	-.027	.263	.274
8. Macro level causal inferences in free elaboration task								.198	.445	.250
9. Micro level causal inferences in free elaboration task									.116	.219
10. Descriptive elaborations in free elaboration task										.218
11. Text understanding scores										



THE GROUP OF SECOND GRADERS WITH LOW SCORES IN TEXT UNDERSTANDING



THE GROUP OF SECOND GRADERS WITH HIGH SCORES IN TEXT UNDERSTANDING



THE GROUP OF UNDERGRADUATE STUDENTS

Figure 7. The percentages of different types of elaborations generated first in the free elaboration task. The figure is based on 360 responses made by 18 good and 18 poor text understanders in the second grade and 54 university students on 4 separate stimulus sentences.

4. Discussion

These results suggest a hierarchical model of language understanding (Figure 8). Contextual and descriptive elaborations are at the first level of the hierarchy. To elaborate contexts means to activate whole knowledge structures in memory, which structures in turn provide both EXPECTATIONS for further processing and IMPLICIT CONNECTIONS by which the coherence of a verbal message can be improved. Descriptive elaborations provide vivid images of events mentioned in verbal messages. In case of stories and literature it is not actually the language which is enjoyable but the mental images that will be evoked in the mind through the language.

Even at this first level people differ in their spontaneous elaboration activity. This is indicated by the extremely long latencies of some subjects in the group of poor text understanders.

The next level in understanding (see Figure 8) is the causal level, where in addition to the temporal succession of events, the whole chain of events will become reasonable. The superiority of undergraduate students in producing causal inferences even on very simple sentences indicates that the elaborative process itself has become more causal in nature.

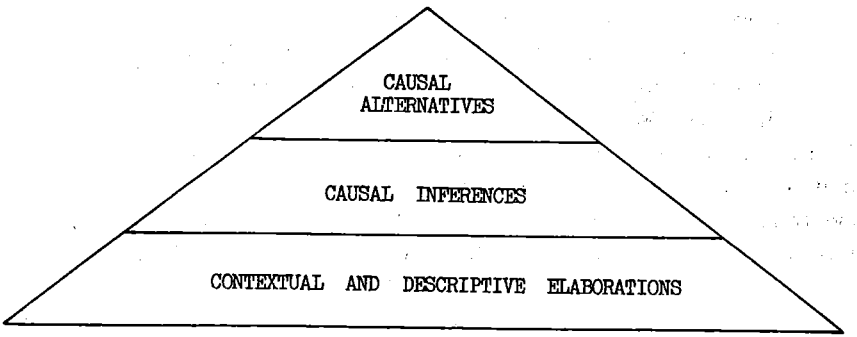


Figure 8. The hierarchical levels of language understanding.

At the highest level of understanding is the ability to infer and be aware of causal alternatives. Usually there is more than one possible reason for an event, and there are several ways to interpret the same event. In everyday life people can probably manage quite well without seeking interdependent, alternative or reciprocal reasons for events, but this skill is inevitably needed for the understanding of abstract expository texts. Furthermore, the ability to see alternative explanations may assist understanding by providing more possibilities to connect separate events or actions together.

In the present study poor text understanders were able to make all kinds of elaborations, although they made fewer of them than their classmates. This means that there is no need to be worried about how to teach pupils to elaborate and infer, but the point is how it is possible to make them think of the same kinds of elaborations and inferences as good text understanders make spontaneously. The studies by Stein et al (1982) and Hansen and Pearson (1983) also support this idea. Their results show that poor text understanders benefit from instruction to train elaborative and inferential skills, but good text understanders do not.

Quite simple instructional methods have proved successful in encouraging pupils to make spontaneous inferences in school classrooms. The activation of relevant knowledge structures in the memory of pupils has been guaranteed by asking them questions about their experiences and background knowledge of the topic before reading. Pupils have also been asked to guess what might happen in the story and to compare their prior expectations with the actual text. In discussions after the reading teachers have asked inferential questions focusing on the text information and its relationship to pupils' own experiences (see Hansen and Pearson 1983; Paris, Lipson and Wixson 1983).

Since poor language understanders are weaker in the production of all kinds of elaborations on simple sentences, it might be reasonable to teach and train them to elaborate. Pupils could be asked to infer some goals or reasons for the event mentioned in a sentence (like "the repairman went into the ironmonger's shop"). They could be asked to put this event in some time or place and describe both the actor and the other cases of the event. If pupils are also ready to tell some consequences of the event, they will end up having a story as a result of their elaborations. Further, pupils could make up their stories in small groups with different groups being given different contexts or reasons for the same events (eg. "the repairman needed some nails", "the ironmonger's shop was in bad

condition", or "the repairman was going to invite the ironmonger to his birthday party"). If the groups were asked afterwards to tell their stories to the other groups, the pupils would see how the same sentence can be interpreted in different ways in different contexts. The main difference between the ordinary story telling or writing situation and the elaborative situation is that the pupils' metacognitive knowledge about different possibilities to elaborate on sentences can be utilized in a systematic way. Especially poor writers can be predicted to benefit from this practice and enjoy it. Indeed, in a preliminary experiment this was found to be the case (Laurinen 1986).

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