

The Four-Dimensional Model: Interaction of Schemata in the Process of FL Reading Comprehension

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This paper reports on a study which investigated the interactive effect of different types of schemata on successful text comprehension in a Foreign Language. The tentative model of the study is four-dimensional: the dimension of overall reading comprehension was assumed to be the result of an interaction of linguistic, content and formal schemata.

The following research questions were specifically asked: What is the combined effect of the three types of schemata? What is the relative weight

of each of the three types of schemata? What is the influence of schemata-inducing activities on FL reading comprehension?

The results of the study confirm that all the three types of schemata contribute to overall text comprehension, both separately and cumulatively, although to differing extents. It can also be assumed that schemata-inducing activities may indirectly affect overall text comprehension by arousing the reader's appropriate schemata.

The introduction of the schema-theoretical approach to the analysis of the reading process has had a profound impact on the study of reading comprehension. According to the advocates of this theory, reading is an interactive process in which the writer's perspective, ideas, development of arguments, intentions and conclusions are all interpreted through the reader's experiences, cultural background and biases. Well-organized background knowledge, i.e., a set of schemata, has a facilitating effect: the reader develops appropriate expectations integrating this knowledge with information derived from the text. (Adams & Collins, 1979; Anderson & Pearson, 1984); Rummelhart, 1980; Stanovich, 1980).

Three areas of schema have basically been acknowledged as playing a part in the act of reading: linguistic schemata (The skills of decoding and discourse processing), content schemata (knowledge of the content area of the text) and formal schemata (recognizing the rhetorical structure of the text) (Carell, 1983, 1984, 1985, 1991; Carell & Eisterhold, 1983).

The question arises then, to what extent the schema-theory of reading is appropriate also for Second Language (L2) and Foreign Language (FL) reading research or, in other words, to what extent the unique problems inherent in L2 and FL reading should be specifically addressed. Some research studies indeed suggest that reading in L2 and FL involves the same processes as reading L1.

Thus, Hudson (1982) examined Clarke's "short circuit" theory (Clarke, 1980), according to which "a language ceiling in L2 effectively prohibits the complete transfer of L1 reading skills to L2 reading". Hudson's research suggested that the readers' initial schemata override, to a great extent, their linguistic limitations. Carrell and Eisterhold (1983) drew similar conclusions, i.e., that only a few reading problems are related to the deficiencies in language skills. They claimed that what is crucial for reading comprehension is the reader's ability to apply the already existing background knowledge to the information derived from the text. A number of scholars, on the other hand, have maintained that, while for a fluent L1 reader the possession of appropriate language skills can be taken for granted, an L2 or FL reader's inadequate language proficiency may prevent the application of the reader's schemata to the reading of the text. Thus, Eskey emphasized the role of identification skills in L2 reading, i.e., the importance of "the straightforward recognition of the lexical units and the grammatical signals required for the simple decoding of the text" (1983, p. 36). A similar view on the role of language proficiency in L2 reading was expressed by Grabe, who stated that L2 readers must reach a stage of automatic text processing in order to possess, together with relevant content and formal schemata, "the critical mass of knowledge which would enable them to stop learning to read and only read to learn" (1988, p. 36).

So far L2 and FL reading researchers have examined either the effect of only one type of schemata or the combined effect of two types (Barnitz, 1986; Carrell, 1984; 1987; Johnson, 1982). Carrell (1984) examined the effect of rhetorical organization on reading, while holding the effect of content schemata constant. Two such studies in L2 reading were conducted: one with narrative texts and one with expository texts. The studies enabled the author to make a number of suggestions regarding text organization and the effect of the rhetorical pattern on text processing. It was found that tightly organized comparison, causation and problem/solution types of organization tend to aid the recall of text ideas. In her 1987 study, Carrell addressed the combined effect of both content and formal schemata in L2 reading and showed the "each component—content and form—plays a significant but different role in the comprehension of a text". The study was the first of its kind and the author concluded that "further research of the combined effects of content and form in ESL reading is clearly needed".

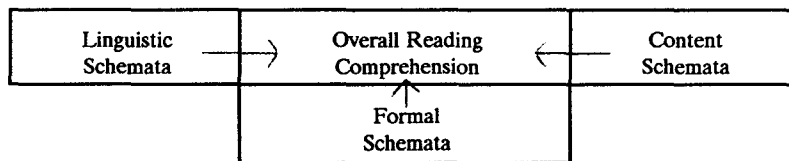
It should, however, be emphasized that although L2 reading has shown that language proficiency has a significant impact on

comprehension (Alderson, 1984; Clarke, 1980; Cziko, 1980; Devine, 1987; McLeod & McLaughlin, 1986), the schematic effect of linguistic skills in their combination with content and formal schemata on the process of FL reading has not been investigated. Thus the central issue in our present research is the interactive effect of all the three types of schemata (linguistic, content and formal) on successful text comprehension in the FL.

Another aspect examined in the present study was the extent to which FL reading is affected when certain types of schemata are induced at the pre-reading stage. Empirical studies of L1 and FL reading have both supported and disclaimed the facilitating effect of induced schemata on reading comprehension. While Hudson (1982) and Carrell (1984) found that the pre-teaching of relevant knowledge and the activating of appropriate schemata were beneficial, Johnson (1981) reported that the pre-teaching of target vocabulary, for example, did not significantly affect successful text processing. In fact, research on the effectiveness of pre-reading activities has shown that not all such activities are equally helpful. Thus, Hudson (1982) found that the pre-teaching of vocabulary was more effective for advanced students than for those of the intermediate or beginners' level. Lee (1986) reported that providing a title and a picture page enhanced comprehension only when the text was familiar.

Since the purpose of our study was to examine the role played by each of the three schemata, it was important to investigate if and to what extent readers would utilize different types of induced schemata and how the inducing of specific types of schemata would contribute to text comprehension. The tentative model on which the study is based is four-dimensional: the dimension of overall reading comprehension was assumed to be the result of an interaction to the three dimensions of linguistic schemata (skills of decoding and discourse processing); content schemata (knowledge related to the content domain of the text); and formal schemata (familiarity with the rhetorical patterns in which information is presented).

FIGURE 1



The following three research questions were specifically asked: (1) What is the combined effect of the three types of schemata on FL reading comprehension of academic texts of different rhetorical structures? (2) What is the relative weight of each of the three schemata in the interactive process of FL reading? and (3) What is the influence of induced schemata related activities on FL reading comprehension?

PROCEDURE

Ninety-five first-year university students enrolled in advanced EFL courses were the subjects of the study. During the course of instruction the subjects were tested in reading comprehension at regular intervals. Altogether nine tests were administered; the text organization in each test was descriptive (illustrative), analytical or argumentative—presented in random order to avoid any biasing effects. The texts were all evaluated by independent raters in order to ensure the same level of text difficulty. The raters based their text-evaluation on the criteria established by the previous research on the development of the criterion-referenced test (Reves & Levine, 1992), namely, subject-matter, cultural reference, various aspects of vocabulary, syntactic complexity, and implications requiring complex inferencing.

In order to examine the effect to the three types of schemata and the relative contribution of each of the three schemata to text comprehension, the test questions were specifically geared to the reader's application of each of the schemata in the process of reading comprehension. Thus, two questions referred to the structural features of the text (they were meant to tap the reader's awareness of text organization and its effect on comprehension, i.e., formal schemata). Two questions referred to the linguistic aspects of the text (they were meant to tap the reader's application of decoding and discourse skills, i.e., linguistic schemata). Two questions were geared to the content domain of the text (they were meant to tap the reader's text-oriented and background knowledge, i.e., content schemata). Each of the six questions was followed by the task of justifying the given answers. These justifications were coded by independent raters according to the specific schemata type. The scores on the two questions on each of the schemata were combined into a single score (Cronbach-alpha formula was used to check their internal consistency). The seventh item on the test was the task of writing a summary of the whole text with reference to the main idea(s), supporting idea(s), author's intention and

conclusions. The validity of this type of summary as a reliable measure of the reader's overall mastery understanding of the text was suggested by the findings of the previous research (Reves & Levine, 1992). The score on this item was considered the score of overall reading comprehension (OS). To capture full comprehension of the text and to avoid the stumbling block of the FL written expression, all the answers to the questions, including the summary, were given in the reader's L1. All the tests were piloted on a group of seven high-school teachers of EFL.

In order to test to what extent schemata induced in the pre-reading stage could influence successful text comprehension (see Research Question 3), the Treatment- and Control-group design was used. In an attempt to arouse schemata, the Treatment-group was given pre-reading, schemata-activating materials, while the Control-group answered the test-questions without any preliminary schemata-inducing activities. The schemata-inducing activities were of three types: For linguistic schemata, we used pre-test questions related to decoding, discourse, and vocabulary items in minimal context; for content schemata, we used independent association questions referring to the content area of the text to be read; and for formal schemata, we used the pre-reading of a text in L1, the rhetorical structure (text organization) of which was the same as that of the FL (English) text to be read.

The schema-inducing activities, as well as the texts of different text-organization, were presented in random order, to avoid a biasing effect of the same rhetorical structure always receiving the same induced schema-treatment. Information on the reader's text-processing activities as well as on individual variations in readers' schemata was gathered from two sources: (1) Readers' immediate retrospection reports, referring to each question on all the tests (A sample group of subjects were asked to justify their answers, referring either to the text or to any source they chose.); and (2) Interviews conducted with randomly chosen subjects immediately after the completion of the test; they were meant to capture information on whether and how the three types of schemata were applied to the reading of the text. These two sources were intended to provide specific information on each reader's individual implementation of schemata as well as to shed some light on the issue of variation in readers' schemata.

DATA ANALYSIS

The questions on all the tests as well as the questions which the Treatment-group had to answer as part of the pre-reading schemata activating treatment were rated by two sets of raters (inter-rater reliability: .91). The transcripts of the interviews were categorized and analysed by independent raters. To find out to what extent the three schemata contributed to overall text comprehension, regression analysis on the scores obtained on questions related to specific schemata was performed. To examine the interaction among the three types of schemata, regression and correlational analyses among the combined scores on each type of schemata were done. In order to find out if the reader's application of schemata was similar or different in the processing of texts of different rhetorical structures, correlational and regression analyses were carried out. To see to what extent induced schemata in the pre-reading phase could or could not render a more effective text comprehension, the test results of the Treatment and of the Control-group were correlated. To identify the readers' actual application of the schemata and their metacognition of them, the retrospection reports and interview questions related to specific schemata were analysed. All the results presented below are statistically significant, at a .0001 or .001 level.

RESULTS AND DISCUSSION

Text Comprehension and Schemata

Regarding the question of the contribution of each of the three types of schemata to successful text comprehension the following findings can be reported. The Stepwise Regression Analysis, carried out on tests on all texts, ignoring the subjects' justification of their answers, showed that overall text comprehension was best predicted by content schemata (45%). The second best predictor was the linguistic schemata (27%), while the formal schemata predicted overall text comprehension only very weakly (2%).

These findings are partly supported by correlational analysis: the highest correlation observed is between the mean scores on questions geared to content schemata and the mean overall score (OS) ($r=.67$). The correlation between the mean scores on linguistic schemata geared questions and the mean of the overall score is slightly lower: $r=.54$. The correlation between mean scores on formal schemata geared questions and the mean of the overall score is even lower (.26).

TABLE 1
Stepwise Regression Analysis
of Prediction of Overall Text Comprehension by Schemata
 (the data were analysed with no reference to specific text organization)

Predictor Variables	B-value	Partial R**2	Prob/F significant
Content schemata	1.32	0.45	0.0001
Linguistic schemata	0.51	0.27	0.001
Formal schemata	0.39	0.02	0.001

TABLE 2
Correlations Between Scores on Schemata-gearred Questions and Overall Score

	Content schemata	Linguistic schemata	Formal schemata
Overall Score	.67 <i>p</i> =0.001	.54 <i>p</i> =0.003	.26 <i>p</i> =0.03

Regression analysis indicates that the scores on the questions related to specific schemata mutually predict one another (all around $R^{**2}=.36$). This *interaction* among the three types of schemata is also supported by high correlations among the scores on the three types of specific schemata-gearred questions (all around $r=.52$).

Rhetorical Structure and Schemata

To find out whether readers' application of schemata is affected by the *rhetorical structure of the text*, separate analysis was carried out with reference to each of the three types of text organization. In this analysis both the answers to the questions and their justification were considered.

The analysis shows that in tests on *descriptive texts* the overall text comprehension is best predicted by the linguistic schemata (50%). The content schemata is the second best predictor (19%), while the prediction of text comprehension by formal schemata is not of statistical significance. Likewise, in tests on *analytical texts* both

linguistic and content schemata predict overall text comprehension, with linguistic schemata being here, too, a slightly better predictor (Li: 24%; Co: 18%). The prediction by formal schemata is not statistically significant in this case either. When the rhetorical structure of the texts was *argumentative*, however, the prediction of text comprehension by the formal schemata is the strongest (52%). In this case, the second best predictor is the linguistic schemata (21%), while the content schemata did not significantly predict overall text comprehension.

TABLE 3
Stepwise Regression Analysis of Prediction of Scores
on Overall Text Comprehension by Schemata
 (the data were analysed with reference to specific text organization)

Text	Predictor Variables	B-value	Partial R**2	Prob/F significant
Descriptive	Linguis-tic schemata	1.00	0.50	0.0001
	Content schemata	0.97	0.19	0.0001
Analytical	Content schemata	0.55	0.18	0.0001
	Linguistic schemata	0.59	0.24	0.001
Argumentative	Formal schemata	0.98	0.52	0.0001
	Linguistic schemata	1.00	0.21	0.001

The difference between the results of data-analysis, when specific text organization was not considered (Tables 1 and 2) and when it was (Tables 3 and 4), can be accounted for in three ways: only in the second case was the subjects' justification of the answers included in the evaluation; the subjects made extensive references to linguistic markers in justifying their answers, thus adding weight to the contribution of linguistic schemata; and the raters coded some of the justifications as being of linguistic character, even when the questions themselves were geared to the content area of the text.

TABLE 4
Contribution of Schemata
Related to Different Text-organization

Descriptive texts	Analytical texts	Argumentative texts
content schemata	formal schemata	linguistic schemata
19	18	21
descriptive schemata	linguistic schemata	formal schemata
50	24	52

One of the surprising findings is the increase in the weight of the linguistic schemata and the decrease in that of the content schemata, when the data were analysed with regard to texts of different rhetorical structure. A tentative explanation which can be offered here is that the content schemata-gearred questions on the tests may have been too closely text-bound, rather than being geared to a more general content domain. Answering these questions probably required close text-decoding, which by itself is of linguistic character.

Correlations between the mean of the overall scores on each of the three sets of tests (i.e., on descriptive, analytical and argumentative texts) on the one hand, and scores on schemata-gearred questions on the other, show that in tests on descriptive texts the scores on linguistic schemata-gearred questions correlate significantly with the overall score ($r=.34$). In tests on *analytical* and *argumentative* texts, scores on questions geared to all three types of schemata yield high correlations with the score on overall reading comprehension (all ranging from .43 to .51).

Induced Schemata and Text Comprehension

Referring to the overall effect of *induced schemata* on FL text comprehension, the comparison of the mean of the overall reading comprehension score of the Treatment-group with that of the Control-group show that the treatment produced only a mild effect on overall comprehension (Treatment-group: $X=19.27$, $SD=2.49$; Control-Group: $X=17.98$, $SD=2.59$). The Treatment-group also scored only slightly higher on specific schemata-gearred questions; on linguistic schemata-gearred questions, the difference in the mean score was 0.8, on content schemata-gearred questions 0.6 and on formal schemata-gearred questions the difference was 0.2.

Correlations, on the other hand, suggest that the relationship between the schemata-inducing activities and overall text comprehension is rather impressive in the case of the Treatment-group: correlations between scores on specific schemata-g geared questions and the overall score are higher in the case of the Treatment-group than in that of the Control-group. The difference is biggest in the correlations between questions geared to the linguistic schemata and the overall reading comprehension score (Treatment-group: $r=.79$; Control-group: $r=.30$). Correlations between questions geared to content schemata and the overall reading comprehension score are weaker (Treatment-group: $r=.76$; Control group: $r=.63$) and no difference is found between the Treatment-group and the Control-group in the relationship of formal schemata-g geared questions and the overall reading comprehension score.

Correlations between the scores on schemata-inducing activities and the scores on questions geared to specific schemata indicate a clear relationship between the inducing activities of linguistic nature, on the one hand, and the questions geared to linguistic schemata ($r=.53$) and to content schemata ($r=.51$), on the other.

Regression analysis indicates that induced linguistic schemata well predicted the score on the linguistic schemata-g geared question ($R^{**2}=.28$), while induced content and formal schemata predicted the score on the schemata-g geared questions only to a very small degree (Fo: $R^{**2}=.15$; Co: $R^{**2}=.06$). These findings are confirmed by Stepwise Regression analysis: the overall reading comprehension score is predicted only by the induced linguistic schemata (43%).

Regarding the texts of different rhetorical structures, it seems that only the induced linguistic schemata affect overall text-comprehension in tests on all the three rhetorical structures: the correlations between the scores on induced linguistic schemata and the overall reading comprehension score are high, ranging between .42 and .70. The relationship between induced content and formal schemata and overall text-comprehension, on the other hand, vary according to the rhetorical organization of the text. Thus, inducing content schemata shows a rather strong relationship with the overall reading comprehension score of both descriptive and analytical types of texts ($r=.63$), while the inducing of formal schemata seems to have no relationship with the reading of the same types of text (no significant correlations were found). There is, however, a clear relationship between the reading of a tightly organized argumentative text and induced formal schemata ($r=.54$). The

immediate retrospection reports ("justification" of answers) of the sample group of subjects were evaluated by independent judges to assess the application of the three types of schemata. The data shows that 58% of justification of the answers is of linguistic character (e.g., vocabulary items, discourse markers); 36% referred to the content of the text or to background knowledge; and 6% to the rhetorical organization of the text.

Interview Results

The *interviews* with the 17 randomly chosen subjects were carried out according to a fixed interview schedule. The subjects were asked 22 questions, which were categorized according to the criteria of formal, linguistic and content schemata and motivation. The last criterion was chosen on the assumption that readers' motivation (interest) in reading might affect their text-comprehension. Thus questions such as "What types of texts do you read in L1 or in FL?" or "Did you have problems defining the rhetorical structure of the text?" referred to the application of the formal schemata. Questions such as "Did you have any language problems when reading the text?" or "Would your reading be the same or different if the text were in L1?" related to the linguistic schemata. Questions such as "What was your prediction regarding the content of the text?" or "Did your previous knowledge of the topic of the text help you?" referred to the application of the content schemata. Questions such as "Did you find the text interesting?" related to the reader's motivation. The analysis of the interview transcripts reveals the following: (1) The main difficulty reported by the subjects is the language of the text. Subjects to the number of unknown words, complexity of sentences as problem areas (linguistic schemata). (2) As to the content of the reading passage, the lack of previous knowledge of the topic of the text is reported as hindering text comprehension; e.g., the reader's failure to predict the content of the text after skimming it, seems to have made the reading more difficult (content schemata). (3) The rhetorical structure of the text was not referred to as causing reading problems. Even those subjects who found that the reading of the text was difficult, did not report having any rhetorical problems. It should be noted that the few who mentioned having problems with the rhetorical structure of the text, referred only to argumentative texts (formal schemata). (4) The subjects whose answers indicated higher motivation, i.e., interest in the subject of the text, were also those who reported having learned new facts and ideas from the text, who found the task easy and who successfully predicted the development of the

ideas in the text. They were also those who reported being bilingual or multilingual.

CONCLUSIONS

The results of the study confirm that there is interaction among the four dimensions: all three types of schemata contribute to overall FL text comprehension, both separately and cumulatively, although to differing extents. The FL reader's knowledge related to the content domain of the text (content schemata) as well as previous linguistic knowledge (linguistic schemata) seem to be the determining factors in global text comprehension, when the text types are not differentiated in the analysis. This finding is consistent with the observed relationship between the induced linguistic schemata and overall text comprehension, irrespective of the rhetorical organization of the text.

The relative importance of these two types of schemata is also supported by the interactive relationship found between induced linguistic schemata on the one hand, and linguistic and content schemata-gearred questions, on the other. The FL reader's knowledge relative to the rhetorical organization of the text, the formal schemata, however, seems to be of minor importance to overall text processing. These findings are partly confirmed by the justifications the readers provided in their retrospection reports: they do not evidence extensive use of formal schemata.

A further conclusion which can be drawn from this study is that the relative weight and cumulative interaction of the three schemata differ with regard to different types of text organization. In our research, which investigated three types of text organization, descriptive, analytical and argumentative, it was observed that the FL readers who possess the appropriate linguistic schemata perform better on all three types of text, although to differing degrees.

The FL reader's format schemata, on the other hand, is effective only when the text is of a tightly organized, argumentative structure. In such texts the reader's ability to follow the logically structured argument carries more weight than in descriptive texts. (See also Carrell, 1984). The FL reader's content schemata is apparently "swamped" by the linguistic and formal schemata, so that its contribution seems to be much weaker.

Interviews with subjects reveal a similar tendency: whenever the readers reported on difficulties in reading, they referred to problems of a linguistic nature with regard to all three types of texts. This indicates an apparent unavailability of linguistic schemata. Whereas

difficulties in the processing of the rhetorical structure, i.e., unavailability of formal schemata, were reported only in the reading of argumentative texts.

Regarding the effect of induced schemata on FL text comprehension, our findings suggest that schemata-inducing treatment at the pre-reading stage contributes mainly to the reader's performance on the specific schemata-gearred questions; performance on overall text comprehension is, however, only slightly affected. It can be assumed, therefore, that schemata-inducing activities may improve certain aspects of reading comprehension by arousing the reader's appropriate schemata, and thus may indirectly affect overall text comprehension. Further research along the lines of our study will probably shed more light on the complex issue of the role of schemata and their individual variations in FL reading comprehension.

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