Discourse Processing Strategies and Reading

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Research on text organization has demonstrated that reading is responsive to the number and complexity of idea units or propositions in a text and that the capacity of children to recall information is responsive to the relative importance of the idea units. This paper examines an extension of these propositions, namely, that reading is responsive to the reader's capacity for text recall. Earlier research suggested that the type of recall used by the reader would give insight into the manner in which a reader obtains meaning from print. The study supported this thesis. Readers using text-entailed recall strategies gained the most insight into the meaning of text. On the other hand, the more text-erroneous information that a reader gave, the less the reader comprehended text. Text-specific recalls were of marginal significance while the impact of text-external and text-experiential recalls on reading was negligible. The recall model proved a powerful predictor of reading comprehension, which suggests that recall ability is an important encoding strategy for readers in gaining meaning.

La recherche effectuée sur l'organisation d'un texte a démontré que la réaction à la lecture d'un texte dépend du nombre et de la complexité d'unités d'idées ou propositions et que la capacité qu'ont les enfants de se souvenir de ce qu'ils ont lu dépend de l'importance relative des unités d'idées. Dans cet article on examine les ramifications de ces propositions, en particulier celle qui dit que la lecture dépend de la capacité du lecteur à se souvenir du texte. Une recherche antérieure suggérait que le genre de rappel dont se sert le lecteur aiderait à comprendre la manière dont il obtient des connaissances à partir du texte imprimé. L'étude présentée ici soutient cette théorie. Les lecteurs qui utilisent des stratégies de rappel provoquées par le texte retirent plus de compréhension du texte. D'autre part, plus le lecteur recueille des informations erronées dans le texte, moins il le comprend. Le rappel de détails spécifiques dans le texte n'a guère de signification alors que le résultat de rappel de détails externes au texte ou expérientiels par rapport au texte est négligeable. On a prouvé que le modèle de rappel était un excellent moyen de prédire la compréhension du texte, ce qui suggère que l'habileté à se rappeler est une importante stratégie d'encodage dont se sert le lecteur pour comprendre le texte.

Over at least the past two decades, reading comprehension has been viewed as a process involving the use of abstractive and constructive strategies. In reading, text information is abstracted or selected and assimilated into an already existing repertoire of knowledge in order to be interpreted. One promising approach for examining how a reader

performs these operations is recall analysis – sometimes called discourse processing.

Kintsch and van Dijk (1978) specify the mental operations that underlie the processing of text and the subsequent production of that text. They claim that three sets of operations are involved.

> First, the meaning elements of a text become organized into a coherent whole, a process that results in multiple processing of some elements and, hence, in differential retention. A second set of operations condenses the full meaning of the text into its gist. These processes are complemented by a third set of operations that generate new texts from the memorial consequences of the comprehension processes. (p. 363)

Researchers of recall analysis (Bower, 1976; Fredericksen, 1975a, 1975b, 1977; Thorndyke, 1977; Tierney, Bridge, & Cera, 1978; van Dijk, 1977; and van Dijk & Kintsch, 1978, 1983) believe that, to perform these operations, readers transform, reproduce, and reconstruct text information during reading and during the retelling of what they have read. Tierney, Bridge and Cera (1978, p. 554) describe this process when they claim that readers attempt, first, to glean what might be considered relevant units from the text they read and, second, to summarize these ideas into a manageable form in accordance with what can be handled by the memory system. As they do this, readers construct meaning by associating text information with their background knowledge.

Recall analysis is based on the belief that by analyzing text and comparing a reader's recall of it to its actual structure, the nature of the reader's organizing procedures can be derived. That is, if readers' recalls are analyzed in order to determine the kind of information selected from the text and how it has been arranged, integrated, and summarized, it should give added insight into the processing involved in reading. Recall analysis, then, involves examining the abstractive and constructive processing of print. This paper will assess the extent to which recall analysis provides insight into how the reader gains meaning from print.

A THEORY OF READER-TEXT INTERACTION

In a reading situation, the information in a text is often a highly organized and interrelated set of statements consisting of concepts and their relationships. This semantic structure, or the interrelationship of the concepts of the text, represents the writer's underlying conceptual framework for the topic concerned. The reader must integrate this semantic structure into his existing knowledge base in order to understand the intent of the passage.

If readers intuitively attempt to integrate the structures of text discourse into their own knowledge framework, one might ask how a reader's existing knowledge is organized in order to accomplish this task. Frame theory (Minsky, 1975) has been proposed as a tentative explanation. The notion is that one's knowledge is organized into high-level structural units called *frames* which can be adapted to fit new experiences by changing the details of the frame. This view is rather like Piaget's idea of accommodation. Each frame consists of a network for representing situations such as visual concepts, experienced events, or the semantic content of linguistic messages. Frames contain slots, some of which are relatively fixed on the basis of the incoming information that rounds out or adds to the conceptual framework already in existence. Frames may be linked together to form systems which represent action sequences, cause-effect relationships, and additions to or extensions of knowledge structures acquired through verbal or written discourse (Minsky, 1975).

It seems then that organization is central to a reader's cognitive structure; one could say that a cognitive structure is an organized set of concepts and procedures which allows interpretation of the world. That is, repeated experiences of related events and situations generate mental structures which represent them. The mind tends to create order and structure out of incoming information. It seeks out regularities and expects to find them again in the future. These repeated experiences, through their internal representation into schemas (Kintsch, 1974; Mandler, 1979), lead to the phenomenon of familiarity. A schema is described by Mandler as a cognitive structure "formed on the basis of a past experience with objects, scenes, or events and consists of a set of (usually unconscious) expectations about what things will look like and/or the order in which they will occur" (1979, p. 7).

One can have a schema for anything with which one is familiar, from the detailed appearance of a physical object to the rules for playing a game to the notion that many stories have a common structure. An individual's knowledge of what constitutes a story appears to develop gradually as a result of generalizations based on repeated experiences. Thus, one becomes familiar with the format of stories through hearing many tales in many situations. A reader's understanding of story structure, then, may be considered a hierarchically arranged set of expectations about what will occur in a given situation, that is, a story situation. It seems from the research conducted by Mandler and Johnson (1977), Stein and Glenn (1979), and Thorndyke (1977) that older, and to a lesser extent younger, readers intuitively use their set of expectations about types of elements in a story and the relationships between the elements to assist them in synthesizing the incoming information. Such strong expectations produce what is referred to as *top-down* or conceptually-driven processing.

The synthesizing of incoming information is also based, in part, on the limitations of working memory. Only a few items can be held in the mind at one time; as new items come along, previous items must be recorded and organized into larger units or concepts in order to be retained. That is, they must be grouped and related to what one knows as a setting, event, or outcome. Evidence gathered by Fodor, Bever, and Garrett (1974) illustrated that words are maintained in working memory in relatively unchanged form until they can be grouped into a clause. At that point, their representation becomes more abstract, and precise words are less likely to be retrieved. Since stories are a series of sentences, the necessity for recoding into concepts increases accordingly. Thus, categorizing into larger, higher order units becomes imperative since the sheer quantity of words prohibits retrospective rehearsal of lower level word units for later recall. Presumably, the longer and more complicated the story, the more necessary a recoding into higher and higher levels of concepts associated with the underlying structure of the story.

To the extent that stories tend to have a rather set structure, there are considerable limitations on their possible formats. Readers can use a relatively small set of story structures to direct comprehension and retrieval in a top-down or schema-based fashion with incoming information being interpreted in terms of already activated story structures. Johnson and Mandler claim that "a story may be quite new in its content, yet the set of expectations about a story structure allows the listener [reader] to assign the incoming sentences to higher level categories, which are themselves organized into still higher level structures" (1980, p. 15).

In contrast, when new information cannot be predicted on the basis of one's existing knowledge of story structures, readers must engage in *bottom-up*, text-based or data-driven processing with an inductive understanding of the overall structure and meaning of the text being gradually built up. During bottom-up processing, a reader must hold a larger quantity of incoming information in working memory before figuring out how to chunk it into larger units which can then be related to existing schemata. This type of processing may be used more readily at a sentence level than at a story level. The shorter length of sentences makes bottom-up processing more realistic in terms of the load placed on working memory.

This is not to say, however, that readers do not use top-down processing for sentences. Obviously, they use their syntactic and semantic knowledge of language to guide sentence processing. However, this method of arriving at meaning by applying schemas or frames in a top-down fashion is likely to be more important in story processing simply because of the increased information load inherent within the continuous discourse of a story.

The more the reader's comprehension is directed by top-down processing, the more it takes on an inferential aspect. Since it is impossible to attend to all of a story's details, many are supplied by the reader's cognitive schema associated with the actual episode, rather than by the visual perception of all words. This inferential aspect of perception has been called *default* processing (Mandler, 1979), and it is simply instantiation or filling in with the most acceptable details.

Clearly, when reading, both types of processing will occur simultaneously. It would seem that when a reader encounters a story with a definite script format identifiable from the title or opening sentence, top-down processing will dominate the reading situation. However, if the story structure is less clearly defined at the onset of the reading, the reader must rely, initially, more heavily on bottom-up processing. As he employs his knowledge of a story plan, he determines approximately where the story is going and, once into the stream of the story, it is likely that a script for episodes or connected episodes will emerge. The reader can then utilize more top-down processing and consequently engage in more instantiation.

So, we have one theory that the reader is controlled by his stored knowledge and another that the reader responds to the text and the situation. It is likely that readers alter their approach to processing discourse to meet the demands of the particular reading situation as well as varying demands within the reading situation. The remaining question, however, is the extent to which discourse comprehension is text-based or schema-based.

RECALL CATEGORIES

Recall analysis is a recently developed procedure for assessing the extent of text-based and schema-based processing. Using this technique, subjects must read a passage with an identified semantic structure and recall the content of what they have read. In several such studies, it has been found that readers typically recall only part of the message conveyed in the passage (Crothers, 1972; Frederiksen, 1975a, 1975b; Meyer, 1974). Furthermore, the information recalled is not a random selection of individual bits of the content; rather, it consists of an organized and highly structured series of informational items from the text. That is, items are not recalled independently but in mutually dependent clusters that correspond to units of semantic information such as concepts, states or events.

Apparently, then, a text can be understood through analysis into interrelated semantic units which can be assimilated into an already existing

knowledge structure where it can be stored for later retrieval. Such semantic processing of units occurs at different levels; some units may be as small as single concepts, states, or events, and others as large as substantial portions of a text's content, which might include an entire episode within a story. Tierney and Bridge (1979), among others, claim that, by comparing a subject's verbal recall of the text to the structure of the passage itself, the reader's ability to analyze and assimilate text information can be assessed. The assumption is that a child's subconscious selection and organization of information while reading the passage will be portrayed in his organization and presentation of that passage in an unaided recall situation. A study of the kind of information that a child uses in his recall should indicate what information has been selected from the passage, how it relates to prior knowledge, and the way in which it is structured into a summary of the content of the passage.

Recall information gathered in this study was divided into five categories: (a) *text-specific information* which included verbatim information or information in paraphrase form from a single utterance of the original; (b) *text-entailed information* which was retrieved as a paraphrase from more than one unit of text, a summary, or a correct inference; (c) *text-experiential information* which was somewhat related to the text but embellished by the reader based on prior knowledge; (d) *text-erroneous information* which involved using text information which the reader had confused or combined erroneously; and (e) *text-external information* including vague generalizations or story-telling conventions. Descriptions of these classifications, which are basically those of Drum (1978) with slight modifications, are given in the appendix.

The recall analysis conducted here began by dividing the text into clauses. The reader's recalls were then also divided into clauses. Clausal units were preferred to smaller propositional units because when propositional units are used it is sometimes difficult to identify instances when readers have summarized or synthesized information. Yet, synthesizing is a constructive process underlying text organization. It is because clausal units are larger that the synthesizing element of discourse processing is less likely to be erroneously overlooked. Text units and recall units were compared by allocating the recall units into one of the five categories. The categories represented the amount of text compared to the amount of background knowledge that the reader used. They indicated, therefore, the extent of the reader's script- or text-based processing.

Text-specific responses, for example, are largely text-bound since they involve identical phrasing from the text or a lexical paraphrase. In this sense they reflect an abstractive processing which is necessary but

certainly not sufficient for complete meaning. Text-entailed responses involve the text's interacting with a reader's prior knowledge and, in this sense, reflect constructive processing. Text-experiential responses indicate greater reliance on prior knowledge than on the text. Text-external responses differ from the others in that they have little to do with knowledge of the text itself. They are story-telling conventions at best, but often merely represent vague generalizations. Text-erroneous responses involve either incorrect processing of text or inappropriate use of background knowledge.

One may infer from the recall categories what processes are involved in obtaining meaning. Recalls in the text-specific category result from memory reproduction and transformation processes which provide for lexical substitution. Text-entailed information is produced through a reconstruction process or by transformation involving explication of text relationships. The experiential category is less constrained by text information and more dependent on world knowledge than text-entailed information. Text-external responses are probably only minimally related to text since for the most part they seem to be conventions for dealing with information that has not been adequately stored or which cannot be retrieved. Finally, the text-erroneous category would indicate that some of the processes described have broken down during recall.

On the basis of this discussion of recall analysis the following hypotheses were formulated:

1. Text-specific, text-entailed and text-experiential recalls will be positively related to reading comprehension.
2. In contrast, because text-entailed recalls reflect both abstractive and reconstructive processes they are likely to be more closely related to reading comprehension than either text-specific or text-experiential recalls.
3. Text-erroneous recalls will be negatively related to reading comprehension.
4. Text-external recalls will have little relationship to reading comprehension.

METHOD

Sample and Materials

Ninety-five Grade 4 pupils from two urban schools constituted the case base for the study. It was decided that all subjects would be asked to read the same passage. In order to ensure that all would be reading at or above

their instructional level, only those able to comprehend at least 70% of what they read on the Maze 5 and Maze 6 of the Guthrie-Siefert Maze Task were selected. Seventy-four per cent of the Grade 4 children were selected – 47 boys and 48 girls.

The passage selected, entitled "Space Pet," was from the Goodman and Burke (1972) *Reading Miscue Inventory*. The passage had been found suitable in previous research (Beebe, 1976) and contained 741 words; hence, it was significantly longer than the passages used by researchers for recall analysis. It was, however, as long as the stories found in Grade 4 basal readers and therefore representative of the stories read by the children in their classroom setting.

The children were tested individually and told that, after reading the story aloud, they would be asked to retell the story in their own words. Immediately following the reading each child retold as much of the story as he could remember.

The Guthrie-Siefert Maze Task is a modification of the cloze procedure. Instead of a word in a blank, the reader must select one of three alternative words that are embedded for every fifth word in the story. The percentage of correct selections indicates the degree of comprehension for that passage. The instrument consists of seven passages graded from primer to 6.1 in difficulty. Maze 5 corresponds to a Grade 4.5 level and Maze 6 to a Grade 5.2 level. Each test has 28 items; hence, the total possible score for any child was 56. The cut-off point for inclusion in the sample was 40 points out of 56, meaning that the students comprehended at least 70% of what they read. Guthrie (1973) describes the reliability and validity of the instrument and demonstrates that it correlates 0.82 with the Gates-MacGinitie Comprehension Subtest.

The reading comprehension measure was a grade equivalent score from the administration of the Canadian Tests of Basic Skills (CTBS) (King & Hieronymus, 1974). Since the school year is 10 school months in length the mean reading score of 51.2 reported in Table 1 may be interpreted as follows: that the average student was reading at the Grade 5.12 level which in terms of Canadian norms equals 51.2 months of schooling. Test passages varied in length from a few sentences to a full page. Each passage was followed by multiple choice questions designed to evaluate the student's grasp of the author's meaning, in particular the ability to evaluate the ideas presented and to draw accurate conclusions. Students were required to answer 68 items in 55 minutes. King and Hieronymus (1975) report a split half reliability of 0.92 for the reading comprehension subtest. The CTBS was administered by the local school authority as part of a province-wide testing program a few days after completion of the audio taping stage of the research.

The question arises whether the assumptions underlying the reading comprehension subtest of the CTBS are the same as those underlying recall analysis and, therefore, whether the CTBS reading comprehension score is a suitable dependent variable. The philosophy of the CTBS is outlined in the *Canadian Tests of Basic Skills: Manual for Administrators, Supervisors and Councillors*, and the Reading Comprehension Subtest is summarized as follows:

> The reading process as defined by the items in this test is a complex one. Whether or not pupils are good readers depends not only on the extent to which they apprehend the author's meaning, but also on the degree to which they grasp the significance of the ideas presented, evaluate them and draw useful conclusions from them. This is true at all developmental levels. Children do not suddenly learn to read with comprehension at any particular age or grade. For these reasons, the items in all levels of the tests place a premium on understanding and drawing inferences from the reading selections. (King & Hieronymus, 1975, p. 43)

The skills underlying the reading comprehension test include: (a) understanding factual details and their relationships; (b) recognizing major ideas, which involves the synthesis of information; (c) organizing ideas within paragraphs, across paragraphs, and over time; and (d) evaluating what is read through making generalizations about a selection. It seems from this description of the dependent variable that it measures much the same kind of phenomenon as that underlying discourse processing. That is, the assumptions underlying recall analysis as described earlier in the paper and the assumptions underlying reading comprehension seem compatible.

Procedure

At the first step of the data-gathering procedure, the subjects read the selected passage and retold the story in their own words. The entire procedure was audiotaped. The second step involved replaying the tape in order to transcribe student recalls. In the third stage, the transcribed protocols were divided into clausal units and mazes. Maze units consist of false starts, repetitions and corrections, or voiced pauses ("um," "uh," and "ah"). They are believed to be stalling tactics used by speakers to provide time to mentally organize their information (Fagan, 1978). Mazes were not considered part of the information a child recalled and, therefore, were not used in the project's analysis phase to predict reading. The inter-rater agreement between two of the authors for dividing recalls into clausal units was 93.4% across six ratings. The Arrington reliability formula (Fiefel & Lorge, 1950) was used to estimate inter-rater agreement.

The fourth step consisted of comparing the clausal units to those of the original passage and the allotting of each unit to one of the five recall categories described in detail in the appendix. The inter-rater reliability score for this categorization was 93.7% across six ratings. For analysis, the scores for each category of recall were converted into percentages as follows. The number of recalls in each category was divided by a constant, and the resulting proportion was multiplied by 100. The constant selected was the total number of recalls across all 5 recall categories given by the student with the highest number of recall units. The constant was 59. Suppose, for example, an individual gave 10 text-entailed recalls; that individual's score would be (10/59) × 100, or 17%. If the same individual gave 5 erroneous recalls, his text erroneous score would be (5/59) × 100, or 8.5%. Descriptive statistics for the variables used in the subsequent analyses are presented in Table 1.

At the data coding stage of the research, two important decisions were made. First, it was found that Grade 4 students gave virtually no recalls which could be classified as text-experiential. This recall category was dropped from further consideration. Second, it was questioned whether to use the data in the text–external category. Text-external recalls were of two kinds: vague generalizations and story conventions. Most text-external responses fell into the story convention classification. They included expressions such as "I can't remember any more," "I forget what else is said," and "and that," "or something," and "at the end it said." This kind of information does not represent anything abstracted from the text for construction into meaning. Rather, it seemed to indicate that the child knew of information in the story but could not recall it or show how it related to information processed during the reading of the passage. Nevertheless, it was decided to proceed by including the text-external category in the model but to hypothesize that this information would not be related to reading comprehension (see Hypothesis 4 above).

RESULTS

Table 2 presents the matrix of correlations between the variables and their levels of statistical significance. As hypothesized, text-specific and text-entailed recalls were positively related to reading. The amount of erroneous information given was negatively related to reading. These results were all statistically significant. The relationship between text-external information and reading, as hypothesized, was not significant.

The results of an ordinary least squares (OLS) regression analysis are presented in Table 3. These are doubly interesting. First, when taking

TABLE 1

Descriptive statistics for variables in the recall strategies model

Variables	$\bar{X}$	SD	*Range*	*Low score*	*High score*	*Skewness*	*Kurtosis*
Text-specific	5.537	10.786	99	0.0	99	7.162	61.01
Text-entailed	9.653	10.816	98	1.0	99	6.135	49.68
Text-erroneous	3.937	10.164	99	0.0	99	8.890	83.67
Text-external	2.695	10.155	99	0.0	99	9.267	88.62
Reading comprehension	51.158	18.618	72	27.0	99	1.619	2.11

$N = 95$

TABLE 2

Correlation matrix of variables in the recall strategies model

Variable	X_1	X_2	X_3	X_4	Y
X_1 Test-specific	1.0000				
X_2 Text-entailed	.7140 ($p < .0001$)	1.0000			
X_3 Text-erroneous	.3032 ($p < .001$)	.2686 ($p < .004$)	1.0000		
X_4 Text-external	.4583 ($p < .0001$)	.3873 ($p < .0001$)	.2662 ($p < .005$)	1.0000	
Y Reading comprehension	.2712 ($p < .006$)	.3913 ($p < .0001$)	−0.2262 ($p < .019$)	.1429 ($p < .097$)	1.0000

TABLE 3
Ordinary least squares regression results[a]

Independent variables	*Dependent Variable Y (Reading Comprehension)*		
	Regression coefficient	*Standardized coefficient*	*t-values*
X_1 Text-specific	.056	.049	.342
	(.162)	(r = .271)	
X_2 Text-entailed	.418	.437	3.170
	(.132)	(r = .391)	
X_3 Text-erroneous	−.803	−.372	3.650
	(.220)	(r = −.226)	
X_4 Text-external	.146	.050	.459
	(.317)	(r = .143)	
Constant	42.51		
R-Square	.276		
D_{max}	.570		

[a]Standard errors are presented in parentheses below the partial regression coefficients. Zero-order relationships are presented in parentheses below the standardized coefficients. T-values GT 2.0 are significant at the $p \leq .05$ level.

into account the effects of text-entailed and text-erroneous information, the impact of text-specific information on reading comprehension is negligible. Because the effect of text-external information was also negligible, most variance in reading comprehension in the recall strategies model was accounted for by text-entailed and text-erroneous strategies of recall respectively.

The second interesting finding concerns the magnitude of the standardized beta coefficients for the text-entailed and text-erroneous parameters. Both coefficients are larger than the simple correlation values for the same relationships. This finding suggests that the OLS estimates are inflated and, hence, untrustworthy.

Beta coefficients larger than the underlying correlation coefficients are uncommon but consistent with two possibilities. The first is that the apparently inflated estimates are attributable to the problem of multicollinearity. The second possibility is that suppressor effects are operating. The first condition is commonplace in the social sciences. The second exemplifies a type of confounding effect. Confounding variables are also ubiquitous in social science research (Kish, 1975), but confounding in the guise of a suppression effect is rare. Logically, it makes most sense to

examine the data set in order to discern the presence or absence of multicollinearity before looking for suppression effects.

Multicollinearity denotes the existence of substantial correlations among the independent variables of a model. Its effect is to invalidate some basic assumptions underlying the mathematical estimation of simultaneous equations. For example, it produces large standard errors so that the estimates of the true model parameters become unstable. The parameter estimates will fluctuate from sample to sample, and often drastic changes in the estimates will occur after only minor data revision. All too often, then, conflicting conclusions will be reached from the usual tests of significance. There are numerous studies which verify these statements (e.g., Blalock, 1963; 1964; Christ, 1966; Farrar & Glauber, 1967).

Recently a technique known as ridge regression (RR) has been used to cope with the multicollinearity problem. RR involves introducing a modest amount of bias into an equation in an effort to reduce the harmful effects of the variance inflation usually accompanying attempts to analyze nonorthogonal data. Vinod (1978), in a review paper, notes that Monte Carlo simulation experiments have demonstrated the superior properties of RR compared to OLS regression for coping with collinearity-prone data. Unfortunately, RR is not a single technique but rather a family of methods, each of which will generate different parameter estimates, and no single method is guaranteed to give the best set of estimates under all conditions. In Table 4, four different RR methods are used to estimate the parameters of the recall strategies model of reading. The results of each method may be compared to those of other RR methods and to those of the OLS analysis.

The most noteworthy finding from the RR analysis is that the beta estimates differ very little from one RR technique to another. The ridge estimates differ considerably, however, from the least squares estimate. One may conclude from the results of the RR analyses that the standardized OLS coefficient of 0.437 for the effect of text-entailed information on reading is inflated; thus, the finding that this OLS coefficient is larger than the underlying correlation coefficient is spurious. Even so, the RR analysis, while reducing the magnitude of the OLS effect of text-erroneous information on reading, did not reduce it to a level below the magnitude of the zero-order relationship ($r_{3y}=-.226$). We conclude, therefore, that the text-specific and the text-entailed variables operate as suppressor variables; that is, they suppress the true effect of the text-erroneous information on reading comprehension. This conclusion requires further elaboration.

A suppressor variable is one which when controlled strengthens a previously suppressed association between an independent variable of interest and the dependent variable. In the present case, text-erroneous

TABLE 4

Regression coefficients, standardized regression coefficients, t-value, degree of multicollinearity, biasing constant and R-square goodness of fit for recall strategy model

Estimating Method	Text Specific		Text Entailed		Text Erroneous		Text External		D_{max}	*k-value*	R^2
	I	II	I	II	I	II	I	II			
1. OLS	.056 (.162)	.049	.418 (3.170)	.437	−.803 (3.650)	−.372	.146 (.459)	.050	.570	0	.276
2. Bulcock & Lee, 1983	.095 (.819)	.084	.337 (3.531)	.352	−.684 (3.620)	−.317	.133 (.509)	.046	.092	.132	.208
3. Kasarda & Shih, 1977	.093 (.781)	.082	.343 (3.506)	.358	−.693 (3.625)	−.321	.136 (.504)	.047	.128	.120	.213
4. Hoerl, & Kennard, Baldwin, 1975	.090 (.745)	.080	.348 (3.481)	.364	−.701 (3.630)	−.325	.136 (.500)	.047	.165	.108	.218
5. Lawless & Wang, 1976	.094 (.817)	.083	.338 (3.530)	.353	−.684 (3.621)	−.317	.133 (.509)	.046	.093	.131	.208

NOTE: *T*-values are presented in parentheses below the regression coefficients. *T*-values equal to or greater than 2.0 are significant at the 0.05 level. I = regression coefficients; II = standardized regression coefficients. The *k*-values refer to the biasing parameter introduced by the respective ridge regression (RR) procedure. Note that the largest bias introduced is .132 and that this may be regarded as a small amount. The D_{max} ratio is a reference to the degree of multicollinearity on a scale from 0 to 1. $D_{max} = 0$ represents no collinearity while $D_{max} = 1$ represents perfect collinearity. The $D_{max} = .57$ for the OLS procedure reported in the table indicates that the variance inflation of the estimated betas is a little more than twice as high as it should be if the data set were orthogonal. A $D_{max} = 0.57$, though undesirable, is not to be regarded as excessive. Note that each RR procedure reduces the D_{max} ratio closer to zero and that the modestly inflated beta coefficients for the OLS estimate are reduced in magnitude by using RR estimation. Just as RR estimation attenuates the magnitude of the partial regression coefficients, it also reduces the magnitude of the *R*-square goodness of fit values. A discussion of these and other matters related to the use of RR procedures for coping with the problem of multicollinearity may be found in Bulcock, Lee, & Luk (1981), Bulcock & Lee (1983), and Lee, Bulcock, & Luk (1984).

$N = 95$

recall information (TERR) is the variable of interest and the suppressor variables are the text-specific (TSPEC) and text-entailed (TENT) variables. The suppression occurs because TSPEC and TENT when uncontrolled dilute the association between TERR and reading. The suppressors which are positively related to TERR are not relevant to the relationship of interest but nevertheless manage to reduce the true relationship. In effect only a small portion of the TERR variable can affect reading.

In the present instance TERR correlates modestly with reading ($r = -.226$). But, when the TSPEC and TENT suppressor variables are controlled, a much stronger negative relationship between TERR and reading is revealed (standardized beta = $-.317$). The suppressed portion of TERR that is related to reading alone is allowed to contribute to the association of interest when statistical controls are imposed; this permits the true relationship between TERR and reading to emerge. Controlling the suppressor variables results in a refined TERR variable and so strengthens its association with reading.

The four RR analyses generated different estimates, but these were so similar to one another that each set of results virtually confirmed the authenticity of the other three sets. On the other hand, the RR analyses differed appreciably from the OLS analysis. As a result of the difference between RR and OLS analyses, it was concluded that the OLS estimate of the relationship between TENT and reading (standardized coefficient = .437) was artifactually high due to the presence of multicollinearity. Even so, the multicollinearity problem for the data set as a whole was not considered problematic. In general terms, erroneous conclusions would not have been drawn from the OLS estimates.

As a result of the RR analyses, it was also concluded that the relationship between TERR and reading (OLS standardized beta = $-.372$ compared to a simple correlation of -0.226) was not spuriously high due to multicollinearity. Rather, this unexpectedly powerful relationship was revealed because TSPEC and TENT operated as suppressor variables and masked the true relationship between TERR and reading comprehension. Both the RR and OLS results support the recall strategy theory of reading even though there were noticeable differences in the magnitude of the estimates generated by the two different estimating techniques.

DISCUSSION

In general, the results support the theory of recall analysis or discourse processing. Two strategies in particular were significant and powerful predictors of the reading comprehension scores on a standardized test. The more text-entailed information in a child's recall, the higher the standardized comprehension test score, and the more text-erroneous

information, the lower the score. The text-specific strategy was not important in and of itself when the effects of text-entailed and text-erroneous information were considered; rather, its importance stemmed from its relationship to reading via text-entailed information. That is, text-specific information influences comprehension because what is abstracted from a passage is integrated into the reader's cognitive structure and becomes part of what is reconstructed and retold as largely text-entailed information. The text-experiential category was eliminated as a model component of Grade 4 reading because few responses fell into this category. Conceptually, the text-experiential category seemed to involve processes similar to the text-entailed category.

In terms of the present analysis, one can make useful inferences from recall categories about what strategies readers use to gain meaning while reading. These inferences largely involve the processes used in the interaction between text information and the reader's prior knowledge. The effect of text-entailed information on reading comprehension confirmed the importance of the processes labelled by Tierney, Bridge, and Cera (1978, p. 554) as abstractive and constructive. This seems to involve the reader in using background knowledge either to synthesize units of information in the text or to make inferences which are constrained by text information. The results of the regression analysis were consistent with this conclusion – namely, that the role of text information lies not in how much specific information can be abstracted but in what the reader does with the information abstracted. Abstractive processes, then, were found to be necessary but not sufficient for reading comprehension to occur. It was when the reader related background knowledge to text information that comprehension was high. And when constructive processes broke down, there was a tendency to generate erroneous information that interfered with comprehension.

The method of recall analysis used in this research could prove useful to researchers, clinicians, and teachers for two reasons: it is easy to administer, and it has demonstrable predictive validity. Because this type of recall analysis can be used for both narrative and informational passages of varying length, it is more flexible than most methods. The insights gained through its use could help educators to determine an appropriate balance between comprehension tasks involving factual recall and those which encourage children to use their background knowledge to engage in constructive processes as they read.

APPENDIX

Comprehension categories for protocol analysis

The initial division of the clausal units is made on the basis of syntactic

criteria. Each unit is then analyzed into its semantic content and assigned to one of the categories described below. Each category is briefly described, and examples are given for purposes of clarification. The recall categories described are based on those of Drum (1978).

Text-specific. This category includes the verbatim recall of a single clausal unit from the original text or a paraphrase of the unit. Examples from this category follow.

1. *Direct recall of lexical items*
   Text: Claribel always got noisy.
   Recall: Claribel always got noisy.
2. *Substitution of pronouns*
   Text: That's why Claribel passed out.
   Recall: That's why she passes out.
3. *Synonymy of elements*
   Text: She came back to life at once.
   Recall: she came back to life again.
4. *Partial recall*
   Text: To our delighted surprise, she came back to life at once.
   Recall: she came back to life at once.

Text-entailed. These information units are either a synthesis of two or more units of information from the text, a generalization or summary subsuming information from more than one unit in the text, or an inference arrived at through logical reasoning or instantiation of ideas.

1. *Summary/Generalization*
   Text: As far as I know there has never been a rule against pets in a space station. We had just never had any pets until Sven Olson decided he wanted one. None of us ever figured out why he chose the pet he did.
   Recall: A fellow named Sven decided to take a pet into a space station.
2. *Synthesis*
   Text: Today, if you should visit a space station, don't be surprised to hear a canary singing.
   Recall: When you hear a canary up on a space station ...
3. *Inference*
   Text: Just then Sven appeared at the door. In his hand lay a tiny bunch of yellow feathers with claws sticking up in the air.
   Recall: He finally found the half-dead bird.

Text-experiential. Experiential information is added by the reader either on

the basis of experiences related to the theme of the text or from knowledge of the world. The information, however, is generally irrelevant, as far as the storyline is concerned.

1. *Experiential Intrusions*
   Text: All of us at the station were on duty for twelve hours at a time.
   Recall: My uncle is on call and may have to work all night.
2. *Storyline additions*
   Text: We gave Claribel more oxygen and she came back to life.
   Recall: Jim said, "Give her more oxygen. Keep the mask on." The man said, "I'm keeping it over her face."

Text-erroneous. These units include text information which the reader has confused or combined in an erroneous way. Examples of erroneous information conveyed in recalls are given below.

1. *Errors in names*
   Text: "Where's Sven?" I asked. "He's looking for Claribel," someone answered.
   Recall: Jim was looking for Claribel.
2. *Incorrect information or incorrect substitution*
   Text: "Where's Sven?" I asked. "He's looking for Claribel," someone answered.
   Recall: The men were looking for Claribel.
3. *Inaccurate summary or incorrect synthesis*
   Text: Claribel was put into a face mask. It was as large as an oxygen tent for her.
   Recall: And they put her into an oxygen tent.
4. *Faulty inference*
   Text: As far as I know there has never been a rule against pets in a space station ... We couldn't be sure if we were breaking any rule having her there. But we liked her too much to take a chance on losing her. We had a little trouble hiding her when important guests came.
   Recall: You are not allowed to have pets on the space station.

Text-external. Recall units of external information included information that was either so general that it did not convey any specific information or a convention of storytelling and oral recall.

1. *Vague generalizations*
   Text: During the night, part of an air line had frozen, and the alarm had failed to go off. Half a million dollars worth of engineering instruments had let us down.

Recall: One night half a million dollars of engineering parts (or something like that) had failed.

2. *Storytelling conventions*
   Text: No specific referents.
   Recall: And at the end of the story it says ...
   or
   That's all I can remember.

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Forschung über Textorganisierung hat gezeigt, daß das Lesen auf die Anzahl und Kompliziertheit der Ideeneinheiten oder Behauptungen in einem Text reagiert und daß die Fähigkeit von Kindern, Information zurückzurufen, reagierend auf die relative Bedeutung der Ideeneinheiten ist. Diese Arbeit untersucht eine Erweiterung dieser Behauptungen, d.h., daß das Lesen auf die Leistungsfähigkeit des Lesers, sich an einen Text zu erinnern, reagierend ist. Frühere Untersuchungen behupteten, daß die Art der von dem Leser angewendeten Zurückrufung eine Einsicht in die Art geben würde, in der ein Leser Bedeutung vom gedruckten Wort gewinnt. Die Untersuchung hat diese These bestätigt. Leser, die texterfordernde Zurückrufungsstrategien anwendeten, haben die größte Einsicht bezüglich der Bedeutung der Textinformation gewonnen. Andererseits, je mehr ein Leser falsche Information gab, desto weniger hat der Leser den Text verstanden. Spezifische textzurückrufungen waren von geringer Bedeutung, während die Wirkung von text-äußerlicher und text-empirischer Zurückrufung auf das Lesen unbedeutend war. Das Zurückrufungsmodell erwies sich als wirksamer Prophet des Lesenverstehens, was daraufhin deutet, daß Zurückrufungsfähigkeit eine wichtige von Lesern benutzte Encodierungsstrategie ist, um Bedeutung zu gewinnen.

La investigación acerca de la organización de los textos ha demostrado que la lectura responde al número y complejidad de las unidades de ideas o propuestas en un texto, y que la capacidad de los niños para acordarse de informaciones responde a la importancia relativa de las unidades de ideas presentadas. Este articulo examina une extensión de estas propuestas, es decir que la lectura responde a la capacidad del lector de acordarse del texto. Investigaciones anteriores indican que el modo de acordarse usado por el lector permite percibir cómo el lector adquiere significado de la palabra impresa. El estudio respaldó esta tesis. Lors lectores que usaban textos requiriendo el uso de estrategias de recolección obtuvieron las mejores percepciones del significado de la informacion en el texto. Por otro lado, cuanta más información errónea respecto al texto daba el lector, tanto menor era su comprensión del texto. Las recolecciones especificas de un texto tenian significado marginal, mientras que las recolecciones externas al texto y de experiencia del texto luego de su lectura eran insignificantes. El modelo de recolección resultó ser un predictor importante de la comprensión de la lectura, lo que indicaria que la habilidad de recollección es una estrategia importante de encodación usada por los lectores para sacar sentido.

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