THE EFFECT OF SIGNALING IN SCIENTIFIC AND TECHNICAL PASSAGES IN JAPANESE (1)

- The case for native readers -

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ABSTRACT

The purpose of this study is to develop a new reading method for foreign researchers. Our plan was to achieve the following three objectives: 1) the analysis of the reading activities of the native Japanese speaker under conditions with signaling and without; 2) the analysis of the reading activities of the non-native speaker under conditions of signaling and with a knowledge of technical terms; and 3) the implementation of a computer assisted technical reading system which applies signaling theory.

In Part I of this paper, we describe the results of the first of the three objectives. An experiment of 2 x 6 design was conducted using college students who are native speakers of Japanese. Two conditions were designed into the experiments, the first concerned with the types of signaling present in the passage, and the second dealing with whether the passage was expository in nature or scientific and technical. As a result, it was found that signaling which enhances text structure has a content promoting effect in the recall of scientific and technical passages, in addition to a structuring effect. The findings of this research are that signaling may be categorized into two types: structural signaling (S-signaling) and notional signaling (N-signaling). This has led us to expand the definition of signaling as follows: Signaling consists of not only structurally redundant elements, but also of notional cues for organizing target texts.

PROBLEM

Problem of teaching Japanese for specific purposes

What factors are important in the development of an effective teaching method which would help scientists who are not native speakers of Japanese to acquire the skills needed to read scientific and technical texts with ease? Exploitation of the reader's knowledge of the
format of a text and its content might provide information for utilization in the understanding of expository texts. If the reader is a scientist and needs to be able to read scientific texts at a level appropriate for research purposes, the type of knowledge mentioned above might prove a more important factor than is true in teaching reading for general purposes. In concrete terms, however, what type of method should be developed with regard to a student’s cognitive reading processes?

Factors of knowledge

The process of understanding a text utilizes not only the information explicit in the text but also that which is possessed by the reader (Goodman, 1967; Bartlett, 1932; Bransford, Barclay & Franks, 1972; Smith, 1973). In fact, there has been a great deal of research dealing with the relation between a reader’s knowledge and explicit text information (Bransford & Johnson, 1973; Thorndyke, 1977; Rumelhart, 1975; Meyer 1975, 1984; Meyer, Brandt & Bluth, 1980; van Dijk & Kintsch, 1978, 1983; Takagi & Maruno, 1980). Unfortunately, in most of these experiments, expository texts such as school science textbooks and product manuals were used less often than stories and narratives, therefore the characteristics of the understanding of expository text have not been made clear, even though such texts are of greater use in actual business and academic work (Kieras, 1985).

There has been research on reader skill and the process of understanding expository text which has focused on knowledge of text format (Meyer, 1975). In terms of content, however, there have been few studies of either expository or specific texts, including scientific papers.

Promotion of text understanding

While the above areas remain vague, there is, on the other hand, a well-defined approach for clarifying methods for promoting text understanding based on experimental results (study of preceding organizer: Mayer & Bromage, 1980; effects of titles: Dooling & Lachman, 1971; effects of viewpoint: Uchida 1981; effects of self-questioning on comprehension of an expository passage: Akita, 1988; relations between ‘point-of-view-operating ability’ and narrative involving explicitly point-of-view expressions: Fukuda, 1990). But when we integrate the findings of each of these studies, we find that we are still unable to explain in great detail the comprehension process from the perspective of the relation between format knowledge and content knowledge. There is one study which concerns the relations between a reader’s text format knowledge and text comprehension: the “organization of expository text” which deals with the manipulation of signaling, that is, cue words which indicate explicitly the content structures of whole passages (Meyer, 1975; Meyer Brandt & Bluth, 1980). It is shown in Meyer (1975) that explicit signaling words, which can be added and deleted in a text, are effective in improving the reading performance of thirteen-year-old middle school student un-
derachievers. Signaling has been defined as the information in a text which does not provide any new content on a given topic, but which places emphasis on certain aspects of the semantic content or highlights aspects of the content structure (Meyer, 1975). Meyer suggests that Signaling effects can be expected to interact with the mastery of structure strategies. Temma (1989) hypothesizes that two basic schemata are required for text understanding, one being a formal (structure) schema and the other a content schema. With this viewpoint, there arises a further problem with the cue words which promote content message in Meyer (1975), namely that we must make clear not only the effect of signaling which promotes the formal schema, but also the effect of signaling which promotes the content schema. Naturally, as a result of this, we should revise our definition of signaling from this new point of view.

Moreover, concerning the factor of subjects, Meyer (1975) conducted an investigation comparing the comprehension performance of experts and novices, and reported that for novices this factor had an effect. Therefore, an approach dealing not only with the factor of reading techniques at a particular stage of development but also with the factors of knowledge and the process of its use will no doubt prove necessary in the future. Moreover, there are many factors involving the quality of knowledge, such as the degree and process of text comprehension when a comparison is made of general knowledge and specialized knowledge, which remain for investigation and clarification.

**OBJECTIVES**

We discuss two problems: the first is that of the understanding of text structures guided by top-level structure or by content information; the second is that of the degree of familiarity of the reader with the text. In practical terms, the former involves the question of whether signaling is truly effective as a strategy for content-oriented reading; the latter, the question of whether or not a reader has a knowledge of the content. To clarify these two points, we prepared two sets of texts. The first set had the same structure with different levels of familiarity. The second consisted of texts with different structures but the same familiarity levels. The former set was used in the experiments reported on in this paper. Using experiments on text recall, we investigated the following four distinct points: 1) the effect of formal signaling and content signaling; 2) the influences on comprehension of the differences in familiarity between general expository and specific passages such as technical papers; 3) the effect of signaling in the level of comprehension not only of structure (Meyer, 1975) but also of content, of detail and of idea; and 4) the interaction of all the above. These results will clarify the most effective type of signaling, the necessary prerequisite level of reader knowledge, and the effective range of understanding.
METHODS

To examine the first problem above, we prepared two categories of signaling, as shown in Table 1: formal signaling, which activates a reader's knowledge of structure, and content signaling, which activates a reader's knowledge of the content of a passage. We investigated each reader comprehension level using signaling. In concrete terms, we prepared six experimental texts which included each type of signaling. Signaling was manipulated for three levels to determine the factors of its effects: signaling completely deleted, signaling included and signaling indicated explicitly. Also, two categories—explicit signaling of format (label, label-i) and explicit signaling of content (content, content-i)—were also prepared.

Additionally, two types of signaling layout were prepared to eliminate paragraph effects: a set of headlines such as those used in newspapers and textbooks (label, content), and a set of "in-line" uses of emphasis set, such as bold text within a given line (label-i, content-i, where 'i' indicates 'in-line'). 'NS' indicates Non-Signaled text in which signals were deleted from the original text. 'form' used a text identical with the original but divided explicitly into four parts: 'problem', 'objectives[cause]', 'methods', and 'result'. 'label' has used the same text as the original and indicated four signals explicitly: mondai[problem], mokuteki[gen'in] (objectives[cause]), houhou[methods], and kekka[result]. 'Content' used the same text as the original, with some of the phrases shown in Table 2 indicated explicitly.

To examine the second problem, which is the influence of familiarity on text comprehension, the expository prose used was a high familiarity text, of comparatively everyday general content for readers. On the other hand, a technical passage from a paper on Information Science was used as a low familiarity text. The differences in the recall protocols used in reading the two texts were investigated. The first text was the same as that used in the experiment by Meyer (1975), taken from a textbook for ninth grade students and translated into Japanese by the authors (Table 3). The second was the abstract of a paper concerning machine translation appearing in the Journal of the Information Processing Society of Japan (Table 4).

To examine the influence of familiarity, the formal structures and the content structures of the two texts must be harmonized with regard to 'Problem', 'Objectives[Cause]', 'Solution' and 'Result'. To do this, a 'Result' episode was added to the expository text.

To examine the third problem, structural analyses not only of factors such as 'Problem', 'Objectives[Cause]', 'Solution' and 'Result', but also of the category of comprehension level were prepared in the form of structure comprehension, ideal comprehension, content comprehension and detail comprehension.

With regard to the fourth problem, we considered the interaction between all the factors mentioned above.
EXPERIMENT

Experiment design
An experiment of 2 (expository, technical passage: intra-group) x 6 (signaling types: inter-group) was conducted. However, because of the number of subjects, the comparison of factors between the expository and technical passage was conducted within the group, and two sets of ANOVA (one way) were conducted as statistical testing for each experimental text. Using these results, the factor of familiarity of text was analyzed qualitatively.

Subjects
Subjects were undergraduate students majoring in Information Science and School Education. There was a total of 166 participants, to whom the six text variants were assigned at random: 103 Seniors at N university (NS:n=30, form:n=24, label:i:n=24, label(a):n=25) and 63 Freshmen at S university (label(b):n=21, content:i:n=21, content:n=21). The S university students had not yet received any specialized instruction in their major fields. Therefore, none had special background knowledge for the specific texts used in our experiment.

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>Six Types of Signaling Variation using the experiment of expository text and specific text</th>
</tr>
</thead>
<tbody>
<tr>
<td>signals deleted</td>
<td>signals not to indicate signals explicitly</td>
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<tr>
<td></td>
<td>formal signaling*</td>
</tr>
<tr>
<td>NS</td>
<td>label-i</td>
</tr>
<tr>
<td>no indicating paragraph</td>
<td>add signals on each paragraph</td>
</tr>
<tr>
<td>indicating paragraphs explicitly</td>
<td>separating by paragraph and numbering</td>
</tr>
<tr>
<td></td>
<td>form</td>
</tr>
</tbody>
</table>

*form signaling
**content signaling
### Table 2

<table>
<thead>
<tr>
<th>label</th>
<th>content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expository</td>
<td></td>
</tr>
<tr>
<td>問題 [problem]</td>
<td>スーパータンカー難破による被害</td>
</tr>
<tr>
<td>原因 [cause]*</td>
<td>性能およびパワー不足が原因</td>
</tr>
<tr>
<td>方法 [methods]</td>
<td>安全運航への3つの対策</td>
</tr>
<tr>
<td>結果 [result]</td>
<td>改善策実施後の安全運航の確保</td>
</tr>
<tr>
<td>Technical Passage</td>
<td></td>
</tr>
<tr>
<td>問題 [problem]</td>
<td>作業効率に悪影響を及ぼす</td>
</tr>
<tr>
<td>課題 [objectives]*</td>
<td>不要な曖昧性検出削減が重要な課題</td>
</tr>
<tr>
<td>解決策 [solution]</td>
<td>今までにない全く新しい解決策</td>
</tr>
<tr>
<td>結果 [result]</td>
<td>従来方式の1/2に削減</td>
</tr>
</tbody>
</table>

* cause and objective are different, but 2 discourse patterns consisted of each 4 parts can be regarded as same.

### Table 3

「スーパータンカー難破による環境破壊と安全運航の確保」

スーパータンカーの難破による被害が問題である。典型的なスーパータンカーは50万トンの原油を運び、その大きさはフットボールスタジアム5個分におよぶ。スーパータンカーが難破すると、原油が海に流出する。この原油が動物、鳥、微生物の生命を奪う。たとえばスーパータンカーがイギリス沿岸で難破した時、20万をこえる海鳥が海岸に打ち寄せられた。流出した原油は、また、海の生き物の死と、そして世界的な酸素の70％を供給している微生物の生命を奪う。

難破のほとんどは嵐などの緊急事態を処理するだけのパワーと船取装置が不足していることが原因となっている。スーパータンカーは動力をつくるためのボイラーを1つしかもっておらず、また船を動かすためのスクリューも1つしかもっていない。

この問題の解決策は、海で使われているタンカーを今すぐに止めることではない。なぜなら世界的原油供給の約80％は、スーパータンカーによって運搬されているからである。そのかわりに、解決策はスーパータンカーの航海士を訓練したり、よりよいタンカーを造船したり、沿岸でタンカーを誘導する地上管理ステーションを構築することに求めるべきである。第1に、スーパータンカーの航海士は自分達の船の操縦法について、最高の訓練を受けなければならな。第2にスーパータンカーは、特別な操縦のために複数のスクリューと、緊急動力のために予備のボイラーをもつのが、造船されるべきである。第3に、スーパータンカーが海岸に接近する場所に、地上管理ステーションが構築されるべきである。これらのステーションは、混乱した海域や海峡の通過を誘導して、飛行機の管制タワーのような働きをするだろう。

マリタイム研究センターでは上記機構を採用したスーパータンカーの開発に着手し、その第一号が間もなく出荷する。また、従来のスーパータンカーの運航状況によって、過去数海里に相当する事故区域であるマカヤ半島に地上管理ステーションを設置した結果、現在のところ事故はおこっていない。また、航海士らへのインタビューでは航海士の89％が同半島近辺の運航に際し、心理的不安が減ったと答えている。
TABLE 4  Experimental Text: Technical Passage

【機械翻訳における日本語係り受け構造の曖昧性検出方式】

機械翻訳用の前編集の作業効率を高めるために、原文中に存在する形態素、係り受け構造等の曖昧性を検出する機能が求められている。必要以上の多量の曖昧性の検出は、かえって前編集の作業効率に悪影響を及ぼすという問題点がある。

そのため、曖昧性検出においては、検出すべき曖昧性の検出の漏れを抑えながら、不要な曖昧性検出（前編集しなくても機械翻訳システムが正しく解釈する箇所に関する曖昧性検出）を少なくすることが重要な課題となる。

本論文では、日本語の曖昧性検出のうちで重要な係り受け構造の曖昧性検出について、この課題の解決策として、①機械翻訳システムと同一の解釈を行って機械翻訳システムの採用する係り受け構造の最優先解を求める、これに対して係り受けの非交差性条件がの非重複条件を満たす範囲に別解の検出を抑える、②係り受けの拡じを抑制する傾向のある読点や語句を利用して、不要な別解の検出原因となる範囲を別解探索範囲から除く、③語句ごとの固有の構文的性質を利用して不要な別解の検出を制限する、3点を特徴とした曖昧性検出方式を提案している。

この結果、本方式は、必要な曖昧性検出の漏れを実用上問題ない量に抑えながら、不要な曖昧性検出を、可能な構文構造をすべて検出する従来方式の1/2未満に削減でき、上記課題を解決できることが確認できた。

Experimental Procedure

Subjects were instructed to write down as much of the text content as they could remember without looking at the text again after reading it. To learn the procedure for recalling, subjects first practised using the short phrase 'atarashii tamago to furui tamago no miwake kara [how to distinguish a new egg from an old egg] as a rehearsal. After that, during the actual experiment, the expository text was read for 8 min. and recalled for 15 min. Next the technical passage was read for 8 min. and recalled for 15 min. The Reading time and Recalling time were set to lengths thought to be long enough for the reading and recall of the passage based on the performance of subjects in the preliminary examination. (TABLE 5).


**Table 5. Instruction for Recall Performance**

To cooperate in this survey,

Read the passages and write down as much as you can remember in detail.

Reading time is 8 minutes and writing time is 15 minutes for each passage. Do not look at the passage again while you are writing.

At first, there is a short passage for practicing. Next there are two passages for use in the actual test. The instructor will indicate when you are to begin Reading and writing. Don’t be nervous and simply follow the instructions given.

So, first let’s begin with the practice example.

**Scoring**

In Meyer, Brandt, and Bluth (1980), a Prose Analysis Scoring System was used. In this study, recall protocols were scored by structure comprehension (STR.), idea comprehension (IDEA), content comprehension (CONT.) and detail comprehension (DETAIL). Scoring was performed by one of the authors. However, to ensure the validity of this methodology, 24 recall protocols of 12 subjects were selected at random and scored by another scorer who specializes in psycholinguistics. From the results of the scoring, the ratio of correspondence between scores by the two scorers is high: 95.8% for structure, 90.2% for idea, 92.6% for content. For detail, the ratio of correspondence is not very high (76.3%), so these results have been excluded in the main analysis.

**Table 6. Scoring Level and Judgement and Calculation Method**

<table>
<thead>
<tr>
<th>scoring level</th>
<th>criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure (STR.)</td>
<td>Words and expressions related to the content structure of the experimental text in recall protocols.</td>
</tr>
<tr>
<td>Idea (IDEA)</td>
<td>Words and expressions related to the idea of the experimental text in recall protocols, but the idea need not be a correct recalling of the proposition of the experimental text.</td>
</tr>
<tr>
<td>Content (CONT.)</td>
<td>Words and expressions related to the idea of the experimental text in recall protocols, but the idea must be a correct recalling of the proposition of the experimental text.</td>
</tr>
<tr>
<td>Detail (DETAIL)</td>
<td>Words and expressions related to the idea of the experimental text in recall protocols and must be recalled correctly and in detail</td>
</tr>
</tbody>
</table>

Average Scores in Recall Performance(%) = \( \frac{1}{N} \sum_{i=1}^{N} \left( \frac{\text{Scores in Recall Performance}}{\text{Score in Original Text}} \right) i \)
RESULTS

Results for Expository Text

Separate one-way analyses of variance were conducted for each of the passages. The results for the expository text were not significantly different for either the factors of signaling (NS, form, label-i, label(a), label(b), content-i, content) nor the comprehension levels (total, structure, idea, content, detail): (N univ.: F(3,99) = .33, S univ.: F(2,59) = .14).

As shown in FIG.1, there was no difference between groups for the comprehension level. There were a few differences in the amount of recall protocols used between the students of N and S universities which were not, however, significant according to the results of an F-test.

Results for Specific Text

The differences for signaling proved to be significant between group NS, form, label-i, and label(a), with respect to total score (F(3,99) = 5.63, p<.01). With respect to comprehension level, group ‘label’ and ‘label-i’ performed significantly better at the level of STR. and CONT. At the level of IDEA, these signalings showed a significantly better performance tendency. A high amount of recall at the level of IDEA by Group ‘NS’ did not statistically entail better Group ‘label’ and ‘label-i’ performance. However, recall protocols at the level of IDEA for Group ‘NS’ included a great number of descriptions which were incorrect, and this is the reason why group ‘label’ and ‘label-i’ performed better significantly at the level of CONT. In other words, group ‘NS’ had a much greater amount of recall, but its recall protocols included incorrect content. On the other hand, the group including signalings such as ‘label’ and ‘label-i’ promoted recalling content correctly. At the level of DETAIL, there was no significant difference between groups (TABLE 7). There was no significant difference between groups (label(b), content-i, content) at any comprehension levels (total F(2,60) = .33).

Multiple comparisons (DUNCAN method) were conducted for significant groups (NS, form, label-i, label(a)). As shown in TABLE 8, the effect of signaling appeared not only in structure comprehension but also in idea comprehension and in content comprehension.

FIG. 2 illustrates the changes in amount of recall by types of signaling. With respect to total scores, ‘label-i’ ranked highest. With respect to structure comprehension, ‘label’ ranked higher than ‘label-i’. And for ‘content-i’, ‘content’ indicating content recorded lower scores than ‘label(b)’.
Fig. 1 The changes in amount of recall by types of signaling and by comprehension levels for expository text.

Fig. 2 The changes in amount of recall by types of signaling and by comprehension levels for technical passage.

Table 7 The result of ANOVA (one-way) of recall scores between signaling types (NS, form, label-i, label(a)) with respect of comprehension levels (total, structure, idea, content, and detail) when reading technical passage.

<table>
<thead>
<tr>
<th>SOURCE BETWEEN GROUPS</th>
<th>F</th>
<th>F Ratio</th>
<th>Prob.</th>
</tr>
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<tbody>
<tr>
<td>TOTAL</td>
<td>3/99</td>
<td>5.63</td>
<td>**</td>
</tr>
<tr>
<td>STRUCTURE</td>
<td>3/99</td>
<td>21.76</td>
<td>**</td>
</tr>
<tr>
<td>IDEA</td>
<td>3/99</td>
<td>2.40</td>
<td>+</td>
</tr>
<tr>
<td>CONTENT</td>
<td>3/99</td>
<td>3.09</td>
<td>*</td>
</tr>
<tr>
<td>DETAIL</td>
<td>3/99</td>
<td>55</td>
<td>ns</td>
</tr>
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</table>

** p < .01 * p < .05 + p < .10
TABLE 8  The results for multiple comparisons (DUNCAN method) of recall scores between signaling types (NS, form, label-i, label(a)) with respect to comprehension levels (total, structure, idea, content, and detail) when reading technical passage.

<table>
<thead>
<tr>
<th>Group</th>
<th>NS TOTAL</th>
<th>NS STRUCTURE</th>
<th>NS IDEA</th>
<th>NS CONTENT</th>
<th>NS DETAIL</th>
<th>form TOTAL</th>
<th>form STRUCTURE</th>
<th>form IDEA</th>
<th>form CONTENT</th>
<th>form DETAIL</th>
<th>label-i TOTAL</th>
<th>label-i STRUCTURE</th>
<th>label-i IDEA</th>
<th>label-i CONTENT</th>
<th>label-i DETAIL</th>
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<tr>
<td>label-i</td>
<td>*</td>
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<td>-</td>
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<td>*</td>
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<td>*</td>
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<tr>
<td>label(a)</td>
<td>*</td>
<td>*</td>
<td>*</td>
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</tbody>
</table>

* * p < .05  - ns

FIG. 3  Interaction between type of signaling (NS, label-i) and familiarity of text (expository, technical): Expository, F(3,99) = .33, n.s., Technical, F(3,99) = 5.63, p < .01

DISCUSSION

Effects of Formal Signaling and Content Signaling at Each Comprehension Level

The results indicate that the effect of signaling promotes different strategies for understanding depending on the type of signaling: with formal signaling (label, label-i), subjects might use predominantly structural strategies, while with content signaling (content, content-i)
they might use mainly content strategies.

In the investigation of the expository passage, as shown in Fig. 1, there was no major change according to signaling type at any comprehension level. From the viewpoint of each comprehension level, the ‘label(b)’ type performed better at the structure comprehension level than at other levels, promoting less efficiently by about 20 - 30 % at the idea comprehension level and at the content comprehension level than at the structure comprehension level. At the structure comprehension level, ‘content-i’ type promoted less well than the ‘label(b)’ type, and the ‘content’ type was the lowest of the three (‘label(b)’, ‘content-i’, ‘content’). At the idea comprehension level, the ‘content’ type promoted recall better than at the structure comprehension level, responsible for the same amount of recall as at the content comprehension level. In the end, we believe that the promotion of the comprehension level differs depending on the signaling type, such as ‘label’ type and ‘content’ type.

Investigation of the technical passage, as shown in Fig. 2, showed that the amount of recall is lower overall than that in the case of the expository passage due to subjects who had no special knowledge about the technical passage. Of course, the amount of recall at the content comprehension level was also low with the presence of any signaling. Nevertheless, at the structure comprehension level, ‘label’ type signaling showed a remarkable effect of promoting recalling. In proportion to this, the ‘label’ type also promoted recalling at the idea comprehension and content comprehension levels.

Subjects who did not possess any specialized knowledge were prompted to use a structural strategy for reading comprehension by ‘label’ type signaling. This structural strategy might promote some content comprehension significantly. On the other hand, the same subjects might not be able either to understand the four ‘content’ type signalings in themselves, or to organize the whole of the target text. For subjects like those used in this study, it would be better and easier to organize the target text by simple ‘label’ type signalings such as ‘Problem’, ‘Objectives’, ‘Method’ and ‘Result’ rather than ‘content’ type signaling. However, it is conceivable that it would be easier for those who do not have specific knowledge to understand technical passages if ‘content’ type signalings could be set up making the contents easy for subjects to infer. This is the problem of the method of signaling setting. In this study, formal signaling contributed to understanding through structural strategies. In upcoming studies, experiments should be conducted involving subjects who have technical knowledge using signalings understandable to them.

**Familiarity and Comprehension Level**

The data from when subjects who are not specialists read technical passages shows that signaling is significantly effective. In spite of the fact that the technical passage had the same structure as the expository passage, when dealing with technical content, subjects could not easily use the viewpoint of structural text organization. Actually, it should be easy for them to
process target texts structurally; therefore, when it comes to technical texts, it would seem that it suddenly becomes difficult for them to use the structural strategy.

The subjects who were all beginning students of information science did not possess any background knowledge about machine translation, and so in view of this, each group of subjects had equivalent amounts of specific knowledge. As can be observed from the results (Fig. 2 & Fig. 5), they in fact had great difficulties in using content-oriented reading strategies. The effect of signaling depends on the familiarity of content. This is proved by the results for 'label' type signaling which show that if familiarity with the content is high, then readers use the content strategy in understanding the target text, and if not, they use the structure strategy. The relationship between the two strategies is simply illustrated in Fig. 4.

However, the structure strategy does not involve handling the content of a text in order to understand it directly, but instead promotes understanding of the text content indirectly by means of the structure of the content. As a result, even if the structure strategy might assist readers in overall text understanding, it might not be a powerful strategy for understanding content per se.

In this study, we investigated the case in which readers were unable to use content strategy in their reading by using the expository passage and the technical passage as our experimental texts. From the perspective of familiarity, the factor that makes it possible for readers to read is not always that of content. In the case of non-native speakers, other kinds of familiarity, for example, language knowledge and skill in the recognition of the characters, word order, abbreviations, and language should also all be considered. Meyer (1975) and Meyer et al. (1980) conducted experiments from the viewpoint of development stage using expository texts with ninth-grade students as subjects. They may be considered as having proved that using structure strategies such as signaling to compensate for a lack of content knowledge improved reading comprehension. Therefore, the problem which was dealt with in Meyer (1975) and Meyer et al. (1980) must be also that of familiarity with content. Further studies dealing with the problem of familiarity should be conducted to clarify the understanding process of reading with respect to the area of foreign language pedagogy.

![Diagram](image)

FIG. 4 Utilization of Content Strategy and Structure Strategy Depending on the Familiarity with Text
Fig. 5  The relation of text structure based on recall protocols in IDEA level from subjects of group 'NS' when reading expository text.  
(■ = top level structure)

Fig. 6  The relation of text structure based on recall protocols in IDEA level from subjects of group 'label-i' when reading technical passage.  
(■ = top level structure)

Organizing Effect of Formal Signaling

Based on the results of the multiple comparison by total score for each comprehension level (Fig.6), the effects of signaling show mainly at the structure comprehension level and also significantly at the content comprehension level between 'NS' and 'label-i'. From this, it could be said correctly that signaling promoted the recalling of fact comprehension of explicit literal
expressions in the experimental text rather than the recalling of content comprehension. At least, from the result that the scores of 'label-i' and 'label' in idea comprehension are higher than those for 'NS', it is clear that signaling which promotes structure comprehension is useful for the organization of whole texts when remembering the experimental text.

Comparing FIG.5 with FIG.6, we can see that the condition of text comprehension is revealed by the recall protocols. The relationship between 'problem', 'solution' and 'result' shows a greatly different feature between 'NS' and 'label-i'. In particular, the 'label-i' signaling is remarkably effective for the phrase 'problem in paper' and 'result #1' which are easily overlooked. On the other hand, signaling is not effective for the phrases 'objectives' and 'solution' which include many technical terms such as "hi-kousa sei jouken" and "hi-choufuku sei jouken". It is also possible that the effect of signaling for the content comprehension of technical passages is influenced by specialist knowledge (i.e., technical terminology). Conducting the experiment using specialist subjects would point out what learners should know in advance in light of teaching methods for special reading applying signaling theory, if signaling promotes the recalling of the phrase 'objective' and 'solution'. And to explicate the effect of signaling with regard to organization in detail, we might need recall protocols by clue (the experimental method by which subjects recall the second part of a sentence after having been presented with the first part) to check the comprehension of individual sentences. Content comprehension in this experiment was that of inference by novice readers in the field who can be considered to have simply scanned the only explicit expressions in the experimental text.

In this paper, we will not address the question of whether such readers were able to infer the implicit content in the experimental text. Future experiments will have to prove whether signaling promotes accurate comprehension of content by including the inferences of specialist subjects. The study of signaling will be very meaningful if it is possible to promote not only the recalling of explicit content but also the comprehension of the implicit content of texts.

Relation between Signaling and Comprehension

Two kinds of signaling were used in this paper: that which indicates the structural frame information explicitly, such as 'label' type; and that which indicates the content relationship explicitly, such as 'content' type. Here, we call the former 'S-signaling' (structural signaling) and the latter, 'N-signaling' (notional-relational signaling). For university students, S-signaling was not effective when reading the expository passage but only when reading the technical passage in the experiment. In the experiment involving the technical passage, those who did not have any specific knowledge did not make use of N-signaling, but S-signaling was used effectively. Experiments should be conducted using subjects who have special knowledge in their own fields. From such could be expected the following hypothetical results: for subjects who do not understand a target text in a holistic manner but who can understand the content relationships by means of partial words, N-signaling will be effective, but S-signaling will not.
CONCLUDING REMARKS

Experiment involving non-native speakers of Japanese have already been conducted, with the result that signaling has been shown to be effective for this group as well.

The findings of the present study clearly indicate that the two types of signaling lead to differences in comprehension levels and to the use of different reading strategies, and that the effect of signaling promotes the process of reader memorization and recall of unfamiliar texts such as technical passages, and that this promotion improves text organization and content comprehension, even when subjects are university students. But to establish the effect of signaling in the experiment, it seems necessary to take into account not only the signaling effect for text organization but also the natural process of comprehension using N-signaling and S-signaling. For the nature of comprehension, the content strategy is used more than the structural strategy. But this does not mean that signaling is ineffective in content comprehension. Rather, it provides convenient cues because S-signaling involves words which make it easier for readers to whom the target text is unfamiliar to determine the content structure. And these words also appear very frequently in the common style used in papers (Yamamoto, 1993).

As a suggestion for teachers of science education who teach at junior and senior high school, and even college students, students should be led not only to the scientific concepts and logic directly, but also to the construction of scientific passages and to the description of scientific contents and logic in science passages such as papers, technical reports and dissertations. And this should be dealt with as language education for science education, especially because the Japanese university student subjects who read the technical passage with N-signaling, even if their major was not in the natural sciences, indicated a greater degree of recall than those who read the non-signaled technical passage.

In this study, two types of signaling were prepared, but the cues for readers were not fixed with regard to whether they were structural or semantic. The nature of cue words for readers should not be static but dynamic. Evidently, S-signaling words are static and easy to spot within a paper while indicators of dynamic signaling are less so. This question should be taken up and a formula for indicating N-signaling should also be pursued in next stage of research.
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Acknowledgements

We would like to thank Prof. Shizuo YOSHIZAKI of Japan Women’s University and Prof. Naoyuki FUTAMI of Shonan Institute of Technology and the students of Naruto University of Education and of Shonan Institute of Technology who cooperated in the experiment as subjects. Thanks are due as well to Prof. Takako SAKAI who cooperated in the examination of the validity of ‘recall scoring’ criterion.