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ABSTRACT

The purpose of this study was two-fold: (1) to investigate the effects of visual information, background knowledge, and academic reading experience, and (2) to identify the non-native readers' problems in comprehending Japanese academic texts. Sixty-three foreign students studying at universities and graduate schools in Japan participated in this study. Major findings were as follows: the exhibition of charts and text diagrams did not promote reading comprehension; the students' past experiences of academic text reading influenced the score of the reading comprehension test and strategies of activating visual information; and there was not significant correlation between the amount of background knowledge and the score of reading comprehension tests. Moreover, the cluster-analysis of descriptive data seemed reasonable to support that there would be differences of activating visual information between advanced and novice readers. (Contains 13 references.) (Author/AEF)

Development of a Japanese Reading Support System based on Activating Visual Information

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Abstract: The purpose of this study was two-fold: 1) to investigate the effects of visual information, background knowledge and academic reading experience and 2) to identify the nonnative readers' problems in comprehending Japanese academic texts. Sixty-three foreign students studying at universities and graduate schools in Japan participated in this study. Major findings were as follows: 1) the exhibition of charts and text diagrams did not promote reading comprehension, 2) the students' past experiences of academic text reading influenced the score of the reading comprehension test and strategies of activating visual information, and 3) there was not significant correlation between the amount of background knowledge and the score of reading comprehension tests. Moreover, the cluster-analysis of descriptive data seemed reasonable to support that there would be differences of activating visual information between advanced and novice readers.

1. Introduction

In Japan, there are many foreign students studying at graduate schools of science and technology who have already completed some academic courses or researches in their major fields, but do not have sufficient Japanese language ability for the Japanese academic life. Due to the rapid increase in the number of such foreign students, language institutes and international student centers provide intensive language courses and arrange tutoring programs. Supporting systems like this, however, do not work effectively, due to the fact that students don't have enough time to use such opportunities, as they have to devote most of their time to doing research work in their laboratories.

To solve this kind of problem, some of language learning support systems on the Web have been developed, and proved to be of great help. Indeed, many universities and institutions created such Web-based language learning support systems that are free and open to all users. Unfortunately, almost all systems that have been developed by technological researchers include various complex functions, such as morphological analysis and structure analysis, or use such techniques as natural language processing (Tera et al, 1998; Kitamura et al.1999; Ochi, 1999; Nishina, 2000). Although all of these proprieties are attractive at the first glance, these systems do not have sufficient functions based on real teaching experience and on the insights of language teachers. A possible solution is to base the new language learning systems development on empirical studies of the learners' problems, difficulties and needs.

From the standpoint of a Japanese language teacher, Yamamoto (1995) suggested that intermediate and advanced level learners had some troubles in understanding the parallel structures and long sentences rather than the technical terms (from the results of a Japanese language course for scientists and engineers). She also indicated that the learners needed some help to understand the standard report parts of introduction, conclusion and discussion, which include a complicated structure of sentences and show the relations among many concepts and ideas (Fukako, 1994; Yamamoto, 1995).

On the other hand, it has been proposed in a guidebook of technical writing that readers could grasp the whole structure of a scientific text by using charts and diagrams effectively (Nakajima & Tsukamoto, 1996; Yamazaki et al.1992). It has also been demonstrated in psychological researches that annotated illustrations promoted learners' understanding of scientific explanations (Harp & Mayer, 1997; Mayer et al., 1995; 1996; Shah et al., 1999). Although a large number of researchers have mentioned the effects of visual cues, the question of how to use such information effectively is still open (Shah et al.,1999).

2. Research Goal

Our goal with this research is to investigate whether visual information, learners' background knowledge and academic reading experience influence the reading comprehension of Japanese scientific texts. This study was developed, in part, to provide preliminary data for the development of an effective academic reading support system, which implements instructional devices for nonnative readers.

The following problems were investigated in this study via a questionnaire, designed to analyze the effects of visual cues, learners' background knowledge and experiences on the reading comprehension:

1. *How does the presentation of visual cues promote the learners' reading comprehension on scientific texts?*
2. *How does the readers' experience in academic text reading influence the score of the reading comprehension of scientific texts?*
3. *What is the relationship between the amount of learners' background knowledge and the scores of the reading comprehension tests?*

3. Method

3.1 Subjects

The subjects were 63 foreign students studying at Universities and Graduate Schools in Japan. They were intermediate and advanced learners of Japanese who had received 1-2 years of formal instruction and passed the Japanese proficiency test. There were 42 students majoring in humanities and social sciences, and 21 students majoring in natural sciences and engineering. The percentages of males and females were 63.5% and 36.5% respectively.

3.2 Materials

The testing materials consisted of two parts: (1) a participant questionnaire, (2) a reading passage with some corresponding comprehension tests. The participant questionnaire was designed to investigate the learners' background information and academic experience, such as major, learning experience of Japanese language, existent knowledge on mobile computing, and experience of academic text reading. For the reading passage, we used one chapter from an article that appeared in the Journal of Information Processing, which concerns the application of mobile computing in disaster and emergency situations. The comprehension tests were designed to examine the comprehension achievement corresponding to each of the 3 paragraphs of the reading chapter.

In order to investigate the effects of visual information, we revised the first and third paragraph of the original chapter. First, we divided the students into 2 groups, an *experimental group* and a *control group*. The original, unaltered chapter was used for the experiment group, and the revised one, which had less charts and diagrams than the original one, was for used for testing the control group. The second paragraph was used as a pre-test, to examine the hypothesis of similar Japanese language ability between the two groups above. The details are shown in table 1.

Table 1: Elements of the two tests

Control group	Experimental group
Paragraph1 *No Diagram*	Paragraph1 *Diagram1*
Paragraph2 *Chart1*	Paragraph2 *Chart1*
Paragraph3 *No Chart*	Paragraph3 *Chart2*

3.3 Procedure

Subjects were tested individually on both parts of the testing material in a single session. In the first part, subjects answered a participant questionnaire aimed at determining the background knowledge and academic experience related to the academic field of the text sample. In the second part, each subject had to fulfill three

different tasks: (a) filling in the blanks of an incomplete text, with the adequate words from the chapter text, (b) describing the main characteristics contained in the charts and diagrams, and finally (c) summarizing the whole reading chapter. Data were collected from students from various universities and graduate schools in Japan by mail. There were 21 subjects in the control group and 42 subjects in the experimental group.

4. Results

We classified the subjects of the experimental group into two sub-groups, based on their reading experience of academic journals:

- experimental **group 1**: novice reader, and
- experimental **group 2**: advanced reader.

4.1 Results of the pre-test

To examine the Japanese language proficiency, we first analyzed the scores of pre-test (the second paragraph) that was common to all three groups. There were no significant differences among them, as could be seen in Table 2. The scores were from 0 to 5, with 5 being the best grade and 0 the worst.

Table 2: Means and Standard Deviations at Pre-test

Group	Group 1	Group 2	Control group
Number	20	22	21
M	4.59	4.80	4.85
SD	1.10	0.41	0.36

M: mean; SD: standard deviation

4.2 Analysis of Comprehension Tests

We also examined the comprehension tests of the two remaining paragraphs (paragraph 1 and 3) in order to investigate the effects of the presentation of visual information (see Table 3). The presentation of visual cues produced significant differences between the experimental group 1 and the control group ($t(41) = -2.77$, $p<.01$). There was not significant difference, however, with respect to the comprehension score of the paragraph 3 and the summary writing capacity between the control group and the two experimental groups. This suggests that the students' previous experience of academic text reading would influence the scores of reading comprehension with the diagram for scientific texts.

The analysis of test data indicated that the subjects, who have already experienced academic journal reading in Japanese language, were able to interpret the main ideas of the chapter correctly. On the contrary, less experienced subjects could not connect the information from visual cues with textual information.

Table 3: Means and Standard Deviations for Paragraph 1 and 3, Summary

	Paragraph 1	Paragraph 3	Summary
Group•	2.95	3.64	3.07
(n=20)	(1.84)	(1.56)	(1.31)
Group•	3.95	4.05	3.59
(n=22)	(1.90)	(1.50)	(1.05)
Control	4.62	4.05	3.73
(n=21)	(1.98)	(1.16)	(1.30)

Note. Standard Deviations are in parentheses.

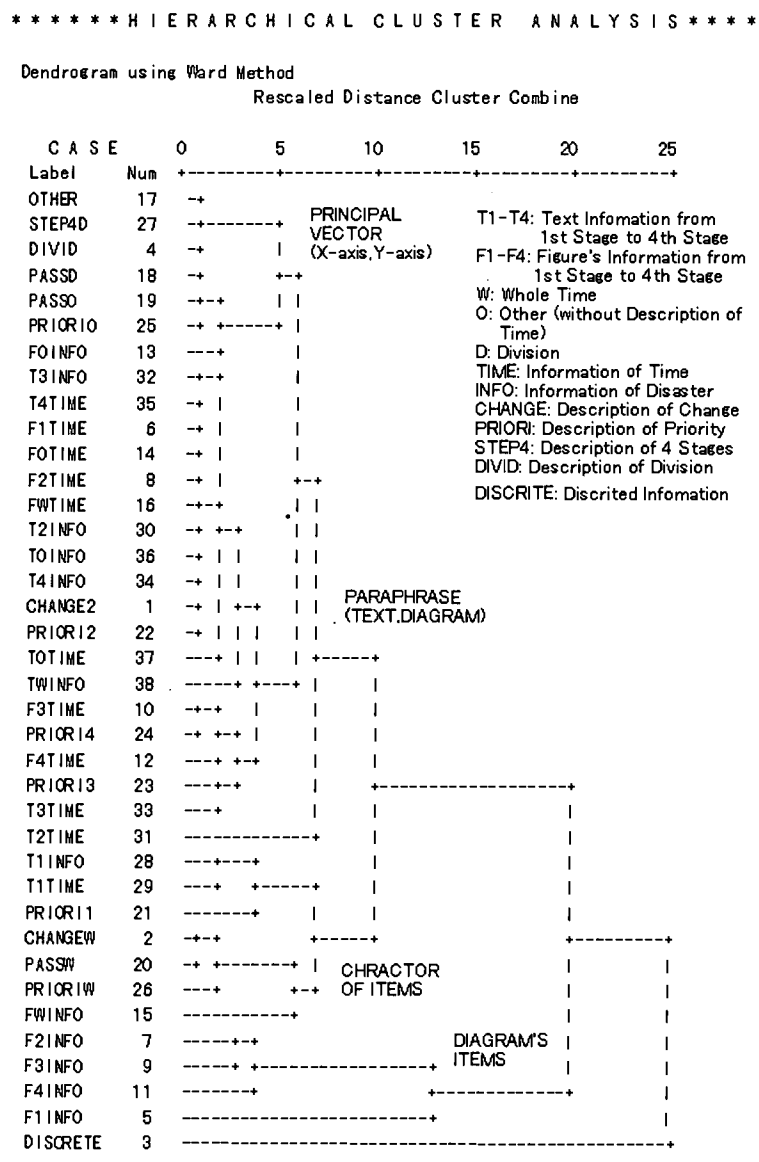
4.3 Analysis of descriptive Data

We collected the descriptive protocals explaining charts(paragraph 3) and diagrams(paragraph 1) in order to investigate effective strategies for activating visual information.

The following procedure employed in this research was as follows. First, the subjects of experimental group were told to describe the characteristics of the diagrams embedded in the paragraph 1. Second, the written protocals were collected from each subject and divided into a word as an idea unit. The number of words summed up 573 units totally. Third, 573 units were • • • • classified by their sources and content and placed into 38 categories. Forth, Ward's hierarchical clustering procedure was conducted to compute a distance matrix among

categories (i.e. time information category, disaster information category) As a result of cluster analysis, the dendrogram suggested four distinct categories in Figure 1.

Figure 1. Dendrogram of Cluster Analysis



4.3.1 Description of the Four Clusters

As stated above, four clusters were identified form the hierarchical clustering techniques. *Claster1* consisted of seven categories concerning both X-axis and Y-axis of the diagram. In the diagram, X-axis showed the time series and Y-axis indicated the priority of information. *Claster2* included both textual and visual information of the same time series, which summed to nineteen categories. *Claster3* consisted of seven categories concerning the characteristics of individual items in the diagram. *Claster4* consisted of four categories, which demonstrated the items of the diagram. All four clusters should be regarded as the meaningful factors to affect activation of the visual information.

4.3.2 Data Analysis

We collected the descriptive data form subjects of experimental group in order to identify the effective strategies for activating visual information. To investigate strategic differences between the advanced readers and novice readers of experimental group, in regard as the comprehension scores of paragraph 1. We divided both group 1 and group 2 into high-scored readers and low-scored readers. The Table 4 showed that the means and standard deviation associated with this analysis.

We conducted a 2 (level: high-score or low-score) x 4 (strategic clusters: strategic clusters: principal vector, paraphrase, characteristics of items, diagram's item) analysis of variance (ANOVA) to examine the relationship between the readers' level and four response categories. The Table 4 showed that the means and standard deviation associated with this analysis. The result of ANOVA were indicated the interaction between level and cluster variables reached significance, $F(3,112) = 2.69$, $p<.05$, $MSE=5.67$. Compared with the simple effects on two variables, the results were displayed inTale5. A post hoc test using Fisher's least significant difference (LSD) procedure revealed that high-scored readers used significantly more Cluster2 (paraphrase) than both Cluster1(principal vector) and Cluster4(diagram's item). And it was also showed that they used Cluster3 (characteristics of items) significantly more than Cluster1. On the contrary, low-scored readers used significantly more Cluster3 than the remaining three clusters *(MSE =5.67, 5% level).*

Table4: Means and Standard Deviations on Response for the Four Clusters

	Cluster1	Cluster2	Cluster3	Cluster4
High-Scored Group	1.93	5.13	3.67	2.67
(n=15)	(1.84)	(3.07)	(2.66)	(1.80)
Low-Scored Group	1.33	2.27	4.20	2.07
(n=15)	(1.80)	(2.15)	(3.08)	(1.58)

Table5: ANOVA results

	SS	df	MS	F
A (level)	23.41	1	23.41	4.13*
B (cluster1)	2.70	1	2.70	<1
B (cluster2)	61.63	1	61.63	10.87**
B (cluster3)	2.13	1	2.13	<1
B (cluster4)	2.70	1	2.70	<1
B (cluster)	107.89	3	35.96	6.34**
A(high-scored)	86.32	3	28.77	5.07**
A (low-scored)	67.33	3	22.44	3.56*
A x B	45.76	3	15.25	2.69*
Error	634.93	112	5.67	
Total	811.99	119		

Note. Standard Deviations are in parentheses. p<.05* p<.01**

4.4 Correlation Analysis

The correlation matrices reported in Table 6 were computed for both control and experimental groups. Subjects' knowledge correlations were calculated between the amount of background knowledge and the knowledge represented by the scores of the reading and comprehension tests, and the summary evaluation. There was no significant correlation between the amount of background knowledge and the scores for reading and comprehension.

Table 6: Correlation Matrices for Subjects

	KN	C.1	C.2	C.3	SAM
KN	1.00				
C.1	-.15	1.00			
C.2	.12	.05	1.00		
C.3	-.03	.27	.10	1.00	
SAM	.16	.29	-.01	.40**	1.00

KN: background knowledge; C.x: comprehension of paragraph x; SAM: summary P<.01**

5. Discussion

The present study investigated the effects of textual cues, learners' knowledge and experience and tried to identify the nonnative learners' problems in Japanese academic reading.

Concerning the first research question, our results suggest that the presentation of visual cues does not always promote reading comprehension. In other words, It seems that original charts and diagrams embedded in the text may interrupt the reading comprehension of nonnative readers.

Related to the second question, the analysis of the descriptive data related to the charts and diagrams indicated that the experienced learners could integrate textual and visual information and deduce therefore the main ideas of the chapter. On the contrary, less experienced learners just picked up the raw information from the visual cues and could not comprehend the relation between the various pieces of information. This was due to the fact that less experienced learners had the tendency to choose the words embedded in visual cues as the keywords of the text. In the first text paragraph, however, the diagram showed just examples of the key ideas. As a result, the beginner students were inclined to consider this peripheral information as representing the main concepts.

Related to the third research question, there was no significant correlation between the amount of background knowledge and the scores for reading and comprehension. However, the way to examine the learners' background knowledge could be inadequate, because it just checked whether subjects knew the definition of the technical terms frequently used in the text. Useful knowledge should not be represented only by lists of discrete words and phrases.

In order to develop an effective reading support system, we should closely analyze readers' difficulties in academic texts reading and construct an effective learning/teaching model for nonnative Japanese language learners.

From the viewpoint of reading pedagogy, we have to reconsider how to teach the vocabulary and to show learners how to access visual information. Especially, in order to build up the background knowledge that they need for academic reading, we have to relate the new concepts and knowledge with their existing knowledge. As a future research, we study the design of a method and implementation to relate the new vocabulary with existing knowledge. Moreover, we consider decreasing the difficulty of reading charts and diagrams by showing only a part of the visual information at a time, via simulations and animations.

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