An Analysis of Eye Movements while Watching Educational TV Programs

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Abstract

This study examined subjects' eye movements while watching educational TV programs to characterize audiovisual information processing through the media. College students, wearing an eye camera, watched various scenes from sample programs. The programs were presented in each of the following three conditions: In Condition AV_1, pictures with sound were presented; in Condition V-AV_2, pictures without sound were followed by pictures with sound; in Condition A-AV_2, sound without pictures was followed by pictures with sound. Analyses of the videotaped eye movements revealed that most viewers tend to pay much attention to 1) human faces, 2) captions, and 3) moving objects in the pictures. Generally, patterns of eye movements were similar in Conditions AV_1, V, and AV_2. Eye movements on graphic presentations indicated greater individual differences. These results could be used to improve the production procedures for educational TV programs.

Keywords

educational media, broadcasting education, audiovisual education, audiovisual information processing, eye movement.

Recent advances in media technology and its increased diffusion have changed our learning environments. We can get so much information without direct experience that our understanding of the world is very much media-dependent. Basic study of human cognitive processes while learning from media is one of the important topics in the field of education.

Educational TV programs present visual and/or auditory information, and yet we do not know precisely what we are actually learning through sight and hearing. Study of the interaction between senders and receivers of information is necessary: for the former, analysis of the structure of educational programs, for the latter, how it is processed and acquired.

An analysis of eye movements of receivers watching educational TV programs is one methodology for studying audiovisual information processing.

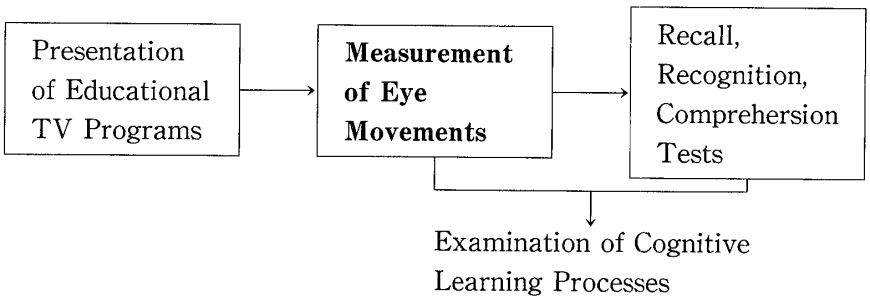


Figure 1 Process of the study of cognitive learning processes.

Figure 1 shows the process of the study. Combined with the results of recall tests, recognition tests, and comprehension tests, cognitive learning processes can be examined. The effects of sound and pictures on learning can be examined by comparing eye movements and recall under three different conditions —— pictures with sound, pictures without sound, and sound without pictures. These findings will be useful in improving TV programs by providing insights on viewer reception to program directors.

The aims of this study were:

1. To characterize individual scanning patterns while watching educational TV programs,
2. To examine the effects of visual and auditory presentations on viewers' learning,
3. To provide information for production of effective programs.

METHOD

Subjects

Subjects were 16 university students. They were randomly assigned to one of the three conditions described later. Each subject watched one to three programs. Number of subjects for programs 1, 2, 3, 4 were 6, 7, 8, 6, respectively.

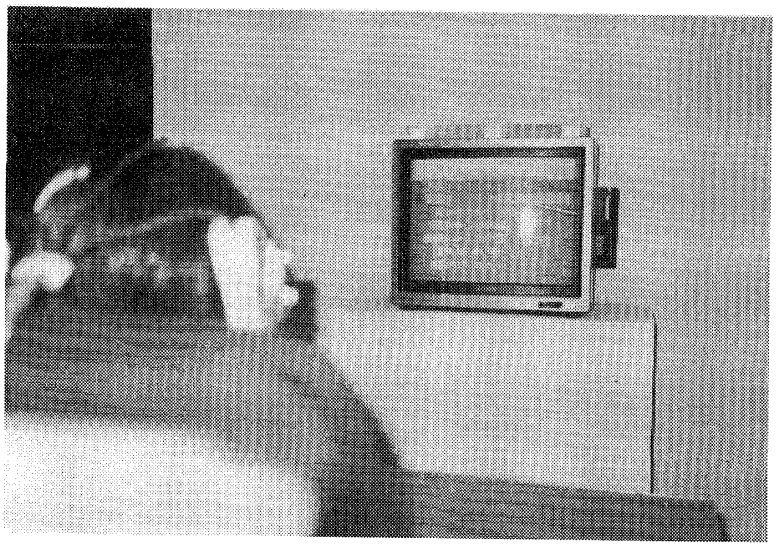
Apparatus

Figure 2-a shows the experimental situation. The television screen used for presenting the materials was 20 inches diagonal. The NAC Eye Mark Recorder, Model V (See Figure 2-b), was used for measuring eye movements. Movements of the eye were superimposed on the subject's visual field and recorded on a videocassette.

Materials

Instructional materials were four sample videotapes edited from TV programs of the University of the Air, Japan. Titles of the programs were as follows:

a.



b.

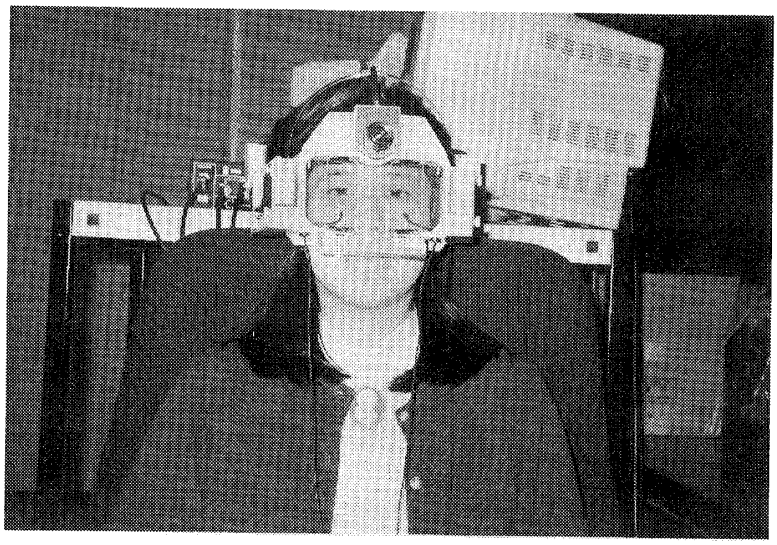


Figure 2 a) Experimental situation and b) Eye Mark Recorder.

Program 1, "Roll call," deals with guidance for teachers in which the student is made to feel at home in the classroom by showing a roll call in comparison with other two types.
Program 2, "Shoplifting," deals with goods, prices, motives concerning shoplifting by girls compared with boys.
Program 3, "From a fetus to a neonate," deals with the change of breathing function before and after birth.
Program 4, "Health for mother and child," deals with the present health of Japanese mothers and children compared with that just after the WWII.

Procedure

Subjects were tested individually. The subject was seated 110 cm from the television screen. After the eye-camera was put on the subject, one of the four videotapes was presented. The subject was asked to watch it freely.

Prior to the program, a viewing tendency check panel was shown to each subject for 10 seconds.

The programs were presented in the following viewing conditions:

In Condition AV_1, pictures with sound were presented.

In Condition V-AV_2, pictures without sound were followed by pictures with sound.

In Condition A-AV_2, sound without pictures was followed by pictures with sound.

After watching the programs, the subject was asked to answer questions concerning what they saw, heard, felt and thought.

RESULTS

The eye movement data were individually analyzed for each shot, which is defined by Fujita (1989) as the interval between two consecutive cuts or between a cut and the beginning or end of the program.

Fixation Points

Analyses of eye movements revealed that most viewers tended to pay much attention to 1) the human face, 2) the caption, and 3) moving objects in the pictures.

Human face

Figure 3 indicates a) a scene of shot 2, Program 4, b) scanpaths, and c) three-dimensional distribution of fixation time for one subject. There is a great deal of eye movement around the lecturer's face. Similar patterns occurred in scenes in which two lecturers and ordinary people appeared. Generally, viewers tended to focus on the human face, especially the eyes and mouth.

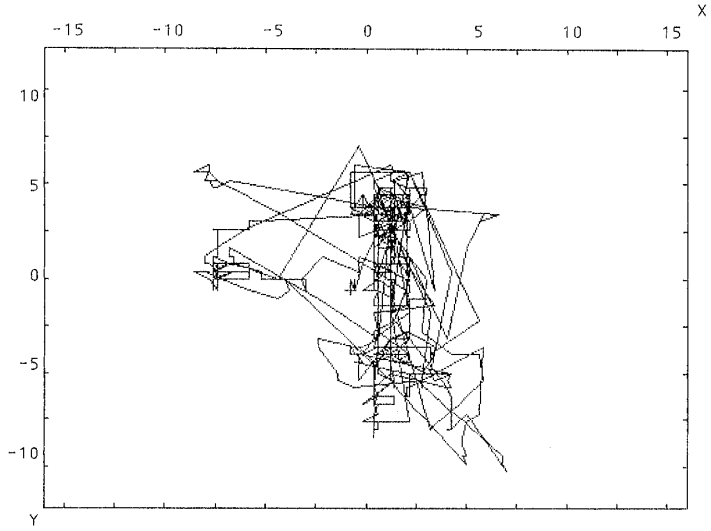
Captions

As soon as captions appeared on the screen, viewers fixated on them. Figure 4 clearly shows the change of scanpaths a) before and b) during presentation of the caption.

Figure 5 gives examples of scanpaths and fixation time distributions in the earlier (9.3 seconds) and the latter half (9.2 seconds) of the time during caption presentations. Qualitative examination of patterns of the distributions for 8 cases under V and AV conditions revealed the following 3 types of viewing

a.

b.



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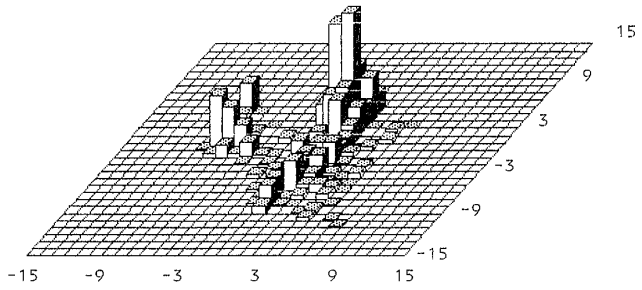
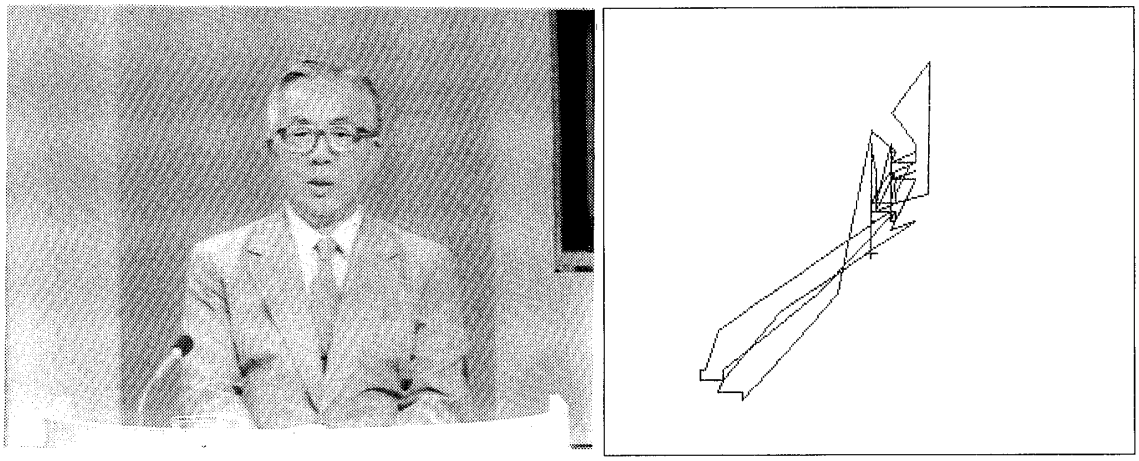


Figure 3 a) A scene of shot 2, Program 4, b) scanpaths, and c) three-dimensional distribution of fixation time (S43, Condition V).

a.



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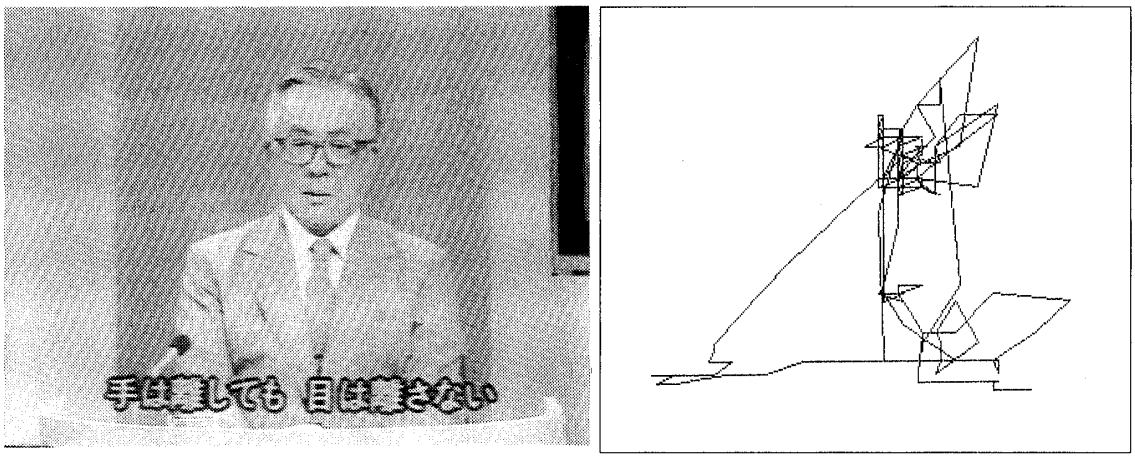


Figure 4 Change of scanpaths a) before and b) during presentation of the caption on shot 1, Program 1 (S14, Condition AV_2).

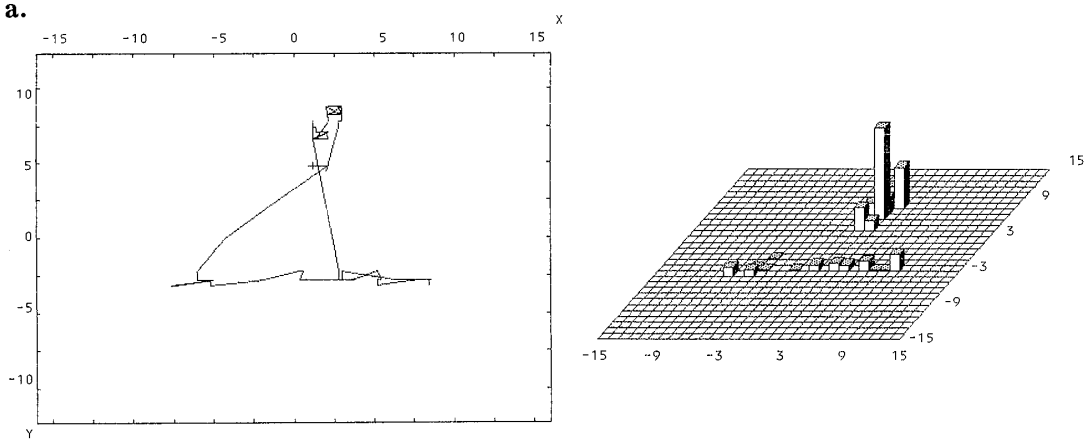
patterns: Type A subjects mostly paid attention to the caption in the earlier half of the time. In type B, fixations on the caption decreased in the latter half. In type C, there were almost equal amounts of fixations on the caption during the earlier and the latter halves of the time. The number of cases of types A, B, C were 5, 2, 1, respectively. Most viewers appeared to have read the caption consisting of 12 Chinese and Japanese characters within 18.5 seconds.

Moving objects

Figures 6-a and b show scenes in which two types of roll call in a junior high school are introduced. Scanpaths for the pictures are also provided. In both cases, eye marks move between the teacher and the student whom the teacher is addressing. In general, viewers tended to pursue moving objects in a picture.

Type A (S14, Condition V)

a.



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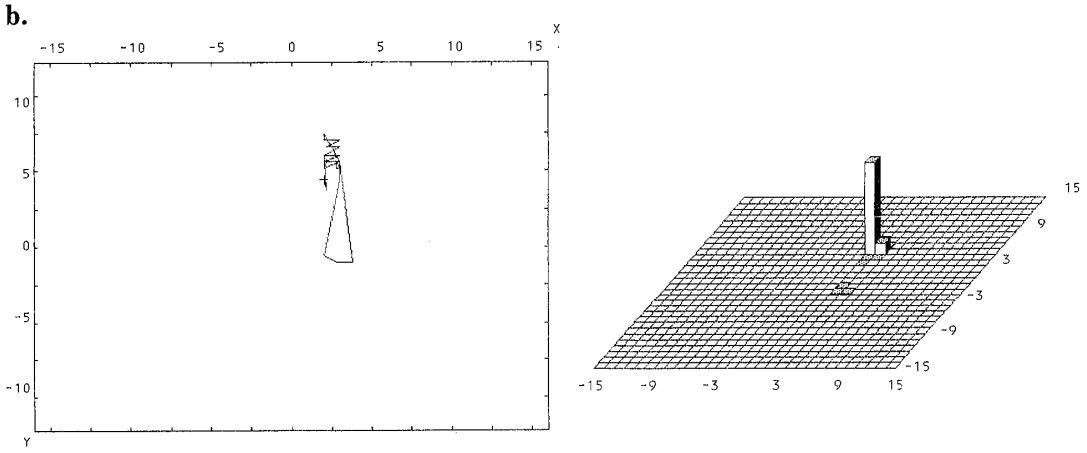
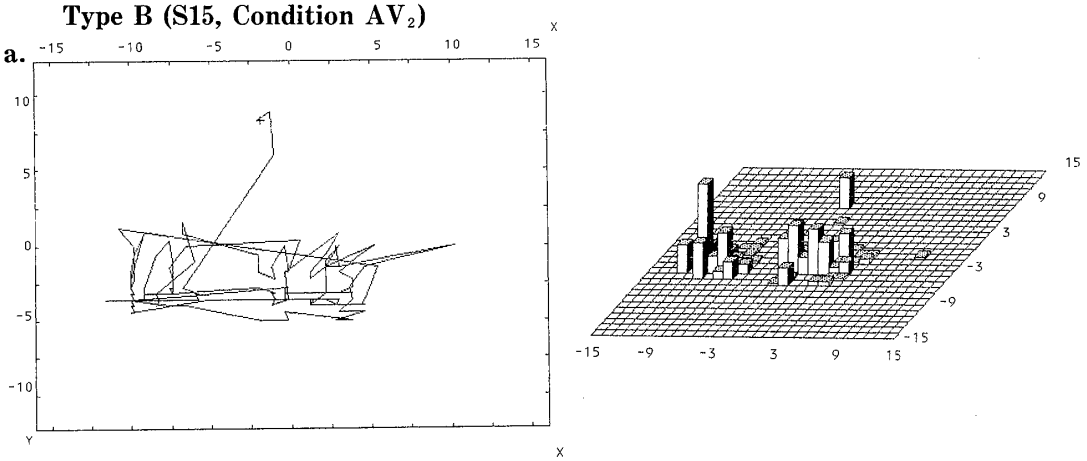
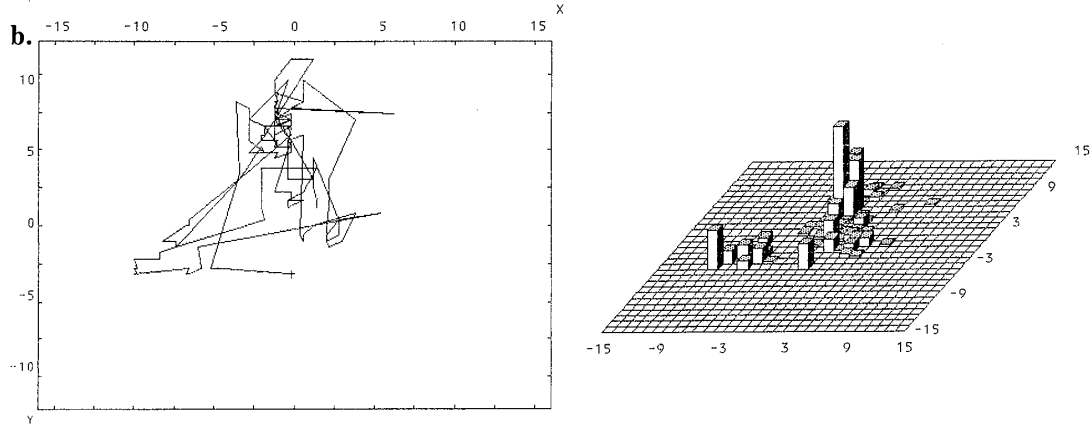


Type B (S15, Condition AV_2)

a.



b.



Type C (S13, Condition V)

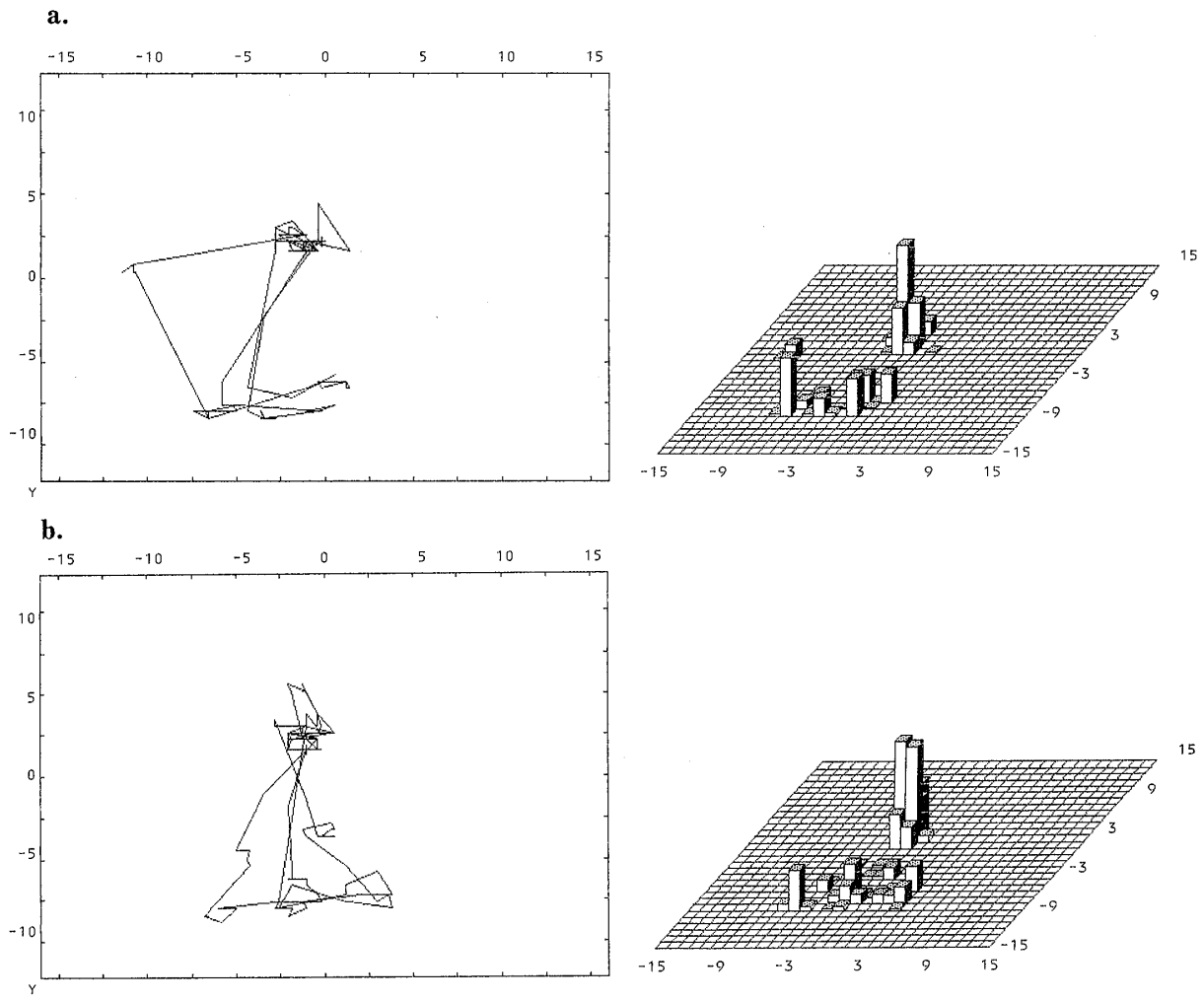
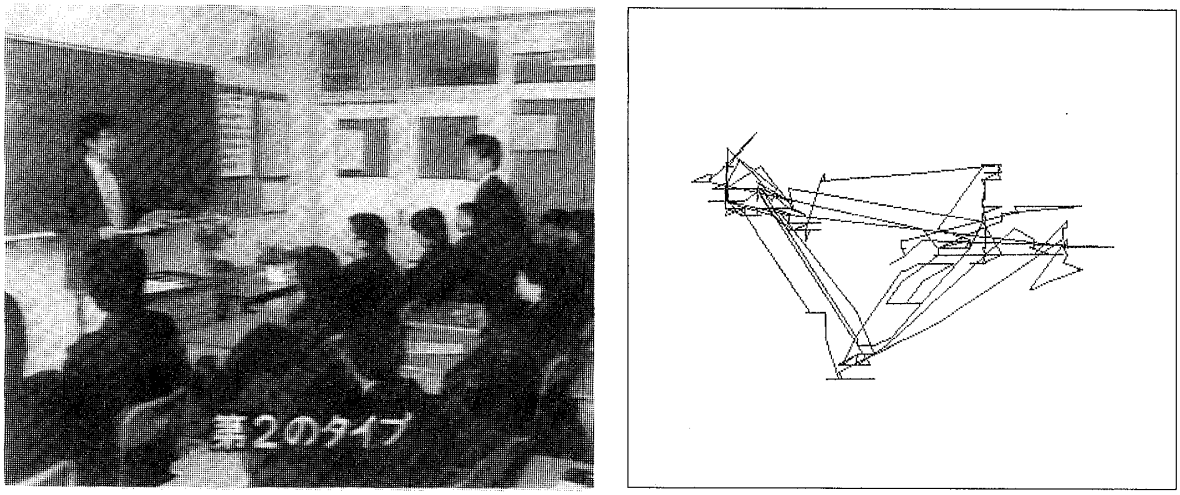


Figure 5 Three types of the scanpaths and fixation time distributions in a) the earlier and b) the latter half of the time during presentation of the caption.

a. S13, Condition V



b. S13, Condition V

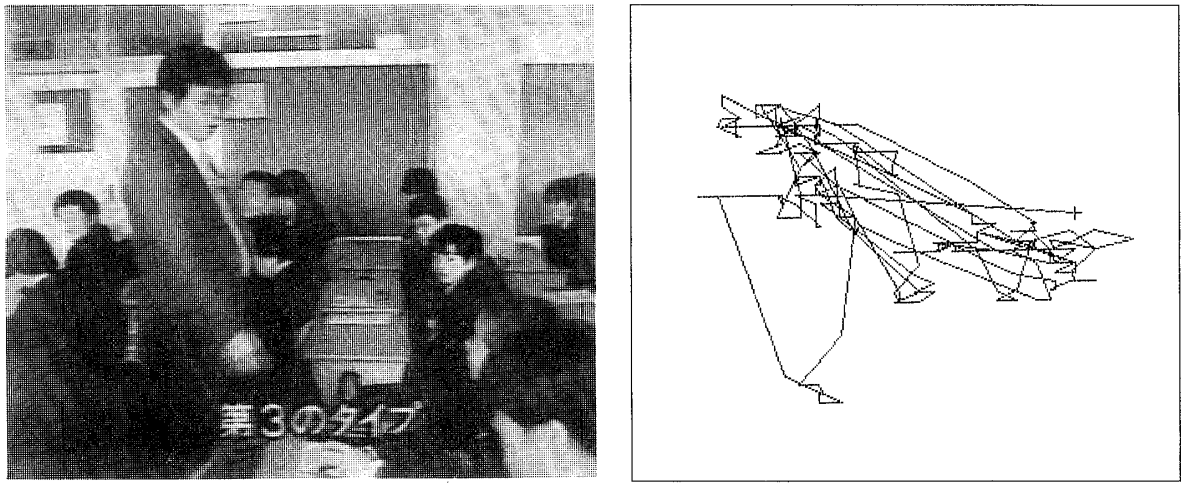
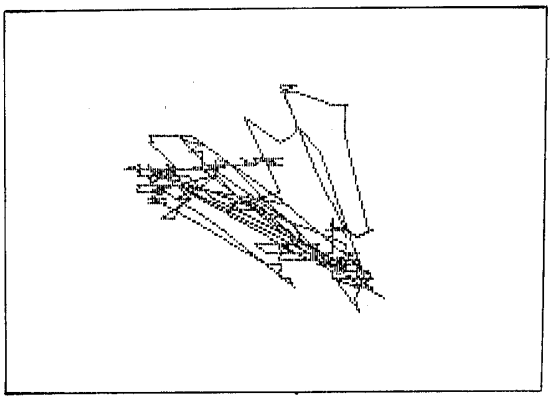


Figure 6 Scenes and scanpaths for a) shot 3 and b) shot 5, Program 1.

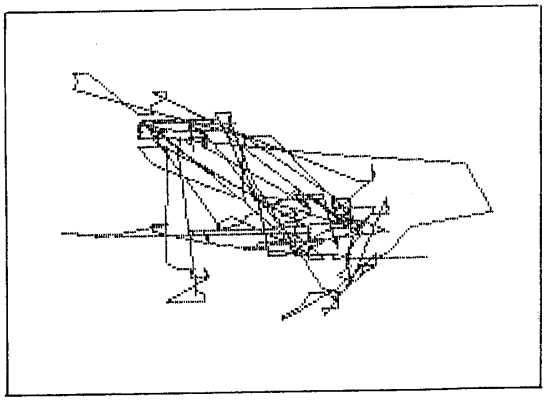
Comparison of Eye Movements under Conditions AV_1, V-AV_2, and A-AV_2

To examine the effects of pictures and sound on learning, eye movements under Conditions AV_1, V-AV_2, and A-AV_2 were compared. Figure 7 indicates examples of a) scanpaths and b) three-dimensional distributions of fixation time for shot 5, Program 1 (See Figure 6-b) under the three conditions. Generally, patterns of eye movements were similar in Conditions AV_1, V, and AV_2, as shown in Figure 7. In Condition A there were remarkable individual differences in eye movement patterns.

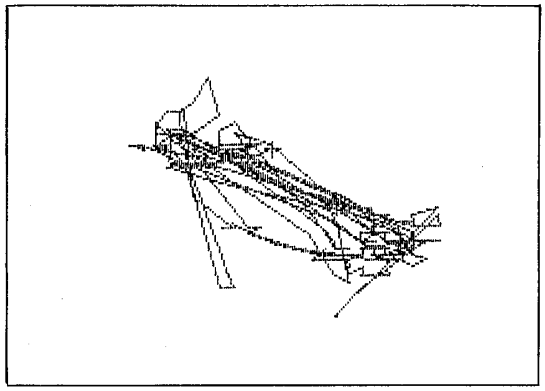
S12, Condition AV_1



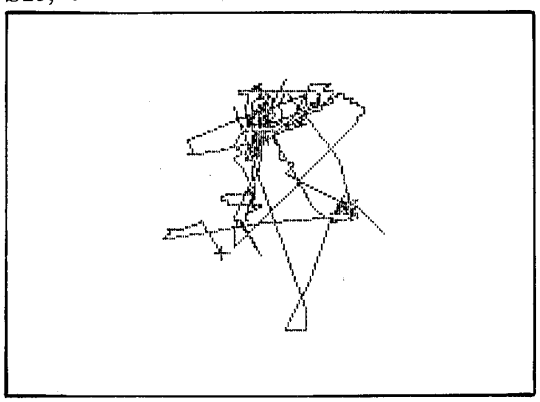
S14, Condition V



S14, Condition AV_2



S15, Condition A



S15, Condition AV_2

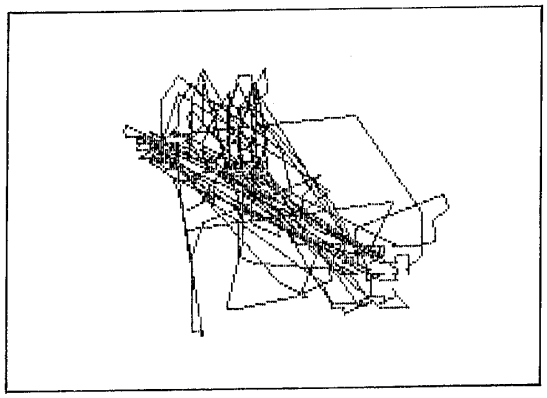
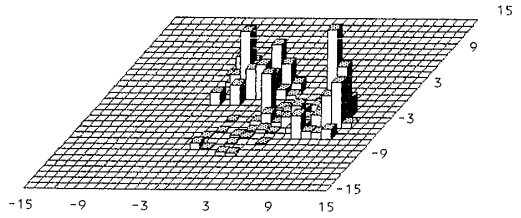
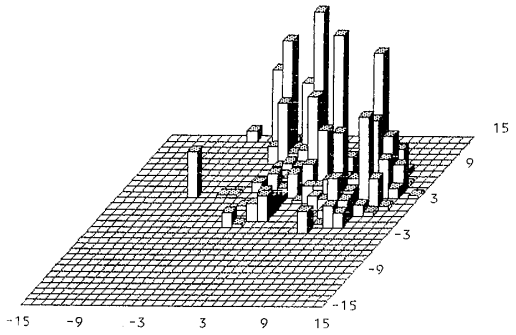


Figure 7-a Scanpaths for shot 5, Program 1 under Conditions AV_1, V-AV_2, and A-AV_2.

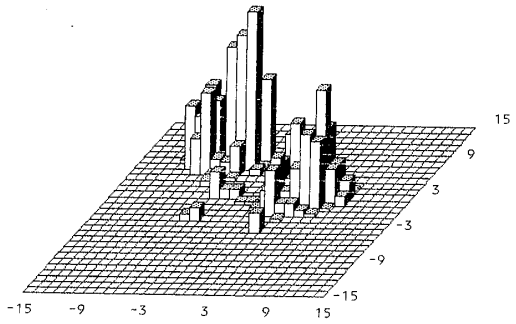
S12, Condition AV_1



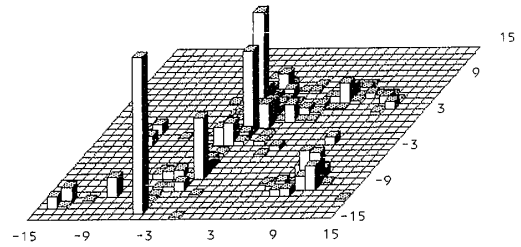
S14, Condition V



S14, Condition AV_2



S15, Condition A



S15, Condition AV_2

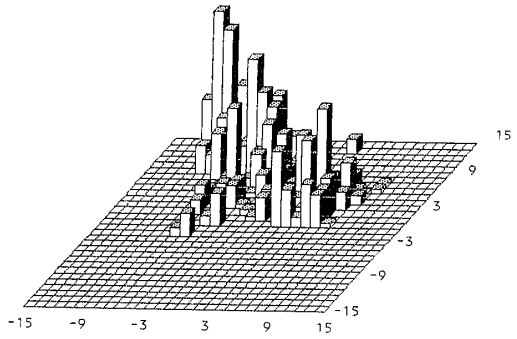
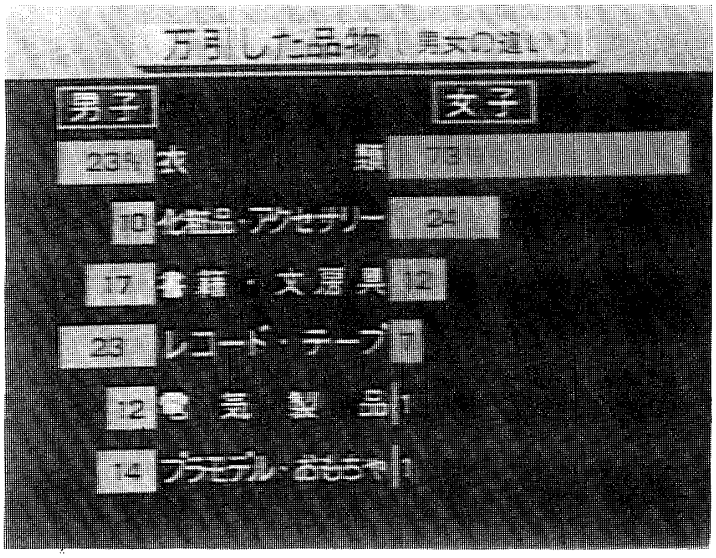


Figure 7-b Three-dimensional distributions of fixation time for shot 5, Program 1 under Conditions AV_1, V-AV_2, and A-AV_2.

Eye Movements and Recall

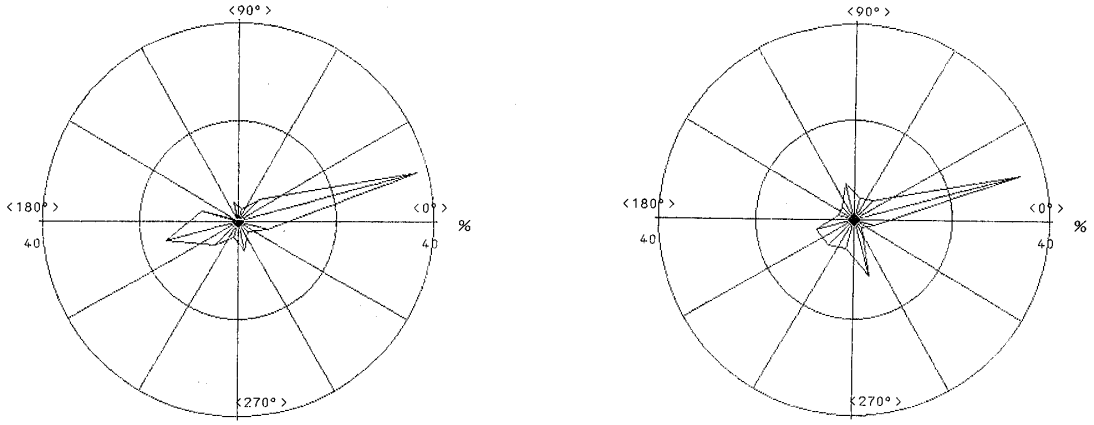
Differences in eye movements, similarities in recall

Figure 8 shows distributions of vectors on shot 2, Program 2. In S24, there are more vetrical movements in Condition AV_2 than Condition V, whereas in S25, the tendency is reversed. Analyses of free recall tests given after watching the program revealed that both subjects correctly answered the important points, such as, difference between boys and girls in tendencies for shoplifting.



a. S24 **b. S25**

Condition V



Condition AV_2

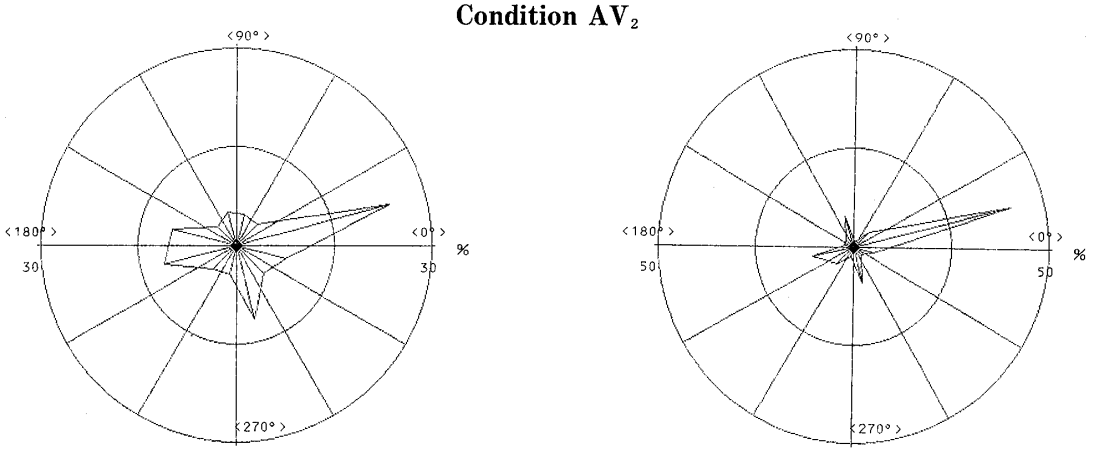
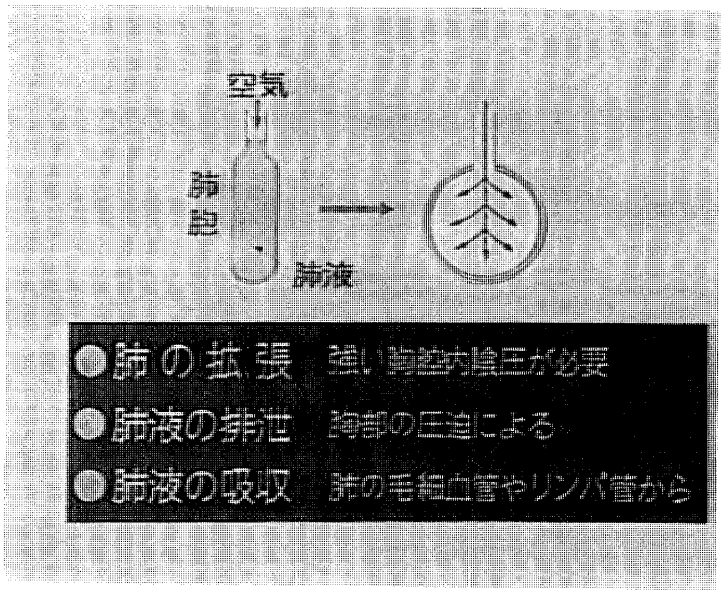


Figure 8 Two types of the distributions of vectors on shot 2, Program 2.

Similarities in eye movements, differences in recall

Figure 9 indicates a) a scene of shot 14, Program 3, and b) examples of scanpaths under Conditions AV_1 and V. Patterns of eye movements are similar in both cases. Analyses of recall tests revealed that S35 did not recall details of written information on the panel, even if the eye marks fixated on the scripts. In general, subjects under Conditions AV and A tended to show exact recall of auditory information. Subjects under Condition V tended to describe what they saw in more summarized ways. There were also individual differences in description both qualitatively and quantitatively.

a.



b.

S33, Condition AV_1 **S35, Condition V**

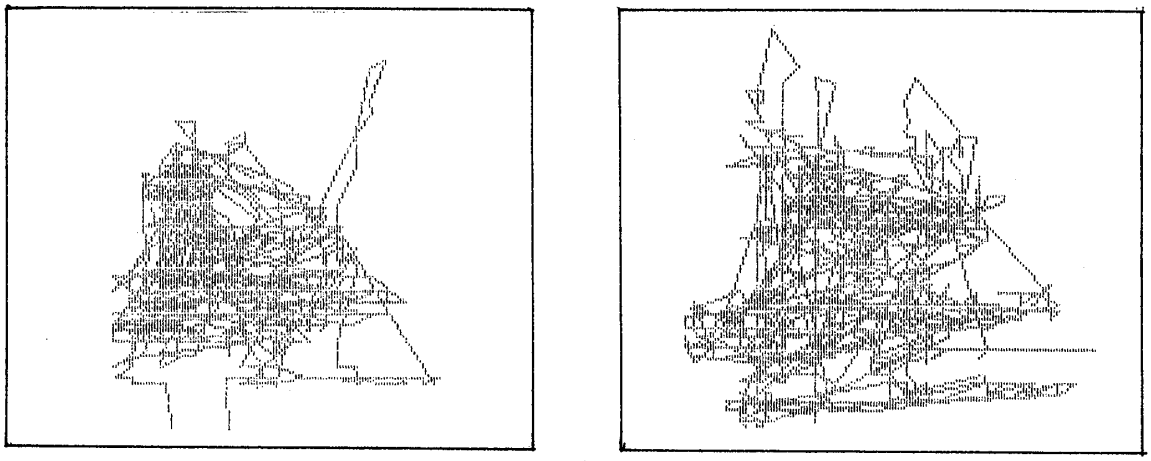


Figure 9 a) A scene of shot 14, Program 3 and b) scanpaths under Conditions AV_1 and V.

DISCUSSION

Various patterns of eye movements corresponding to various scenes of the programs were revealed by the analytical method, and those findings enabled us to characterize individual scanning behaviors during the observation of educational TV programs.

Analyses of scanpaths and distributions of fixation times indicated that most viewers paid attention to the human face, the caption, and moving objects in the pictures. All of these are important sources of information.

Attention to the human face starts at an early stage of development. Fantz (1961) found that 2-3 month old infants preferred a face pattern to black-and-white patterns and colored ones. Employing corneal photography, Salapatek (1975) found that 1-month-olds tended to inspect the external contour of the face, e.g., hairline, chin, ear. Two-month-olds, on the other hand, invariably inspected internal features of the face, e.g., eyes, mouth. Yarbus (1967) showed that, on the exploration of a picture, the eye seeks the region of semantically rich information, such as, the human face, especially eyes, mouth, and nose.

These findings suggest that a lecturer's face plays an important role in learning from educational TV programs. A learner may get information on the contents of a program from a lecturer's talk. Moreover they may get information about a lecturer's affection, personality, attitude, etc. by paying attention to his/ or her face. Eye contact between a lecturer and a learner might be especially important in a TV lecture where no direct interaction between them can occur. Thus, a lecturer may have both informative and motivating functions for the learner.

Captions give important information in the lecture in summarized forms. Fujita & Itoh (1989) found that the average percentage of correct recall was higher when the narration is presented with captions than when it is presented without them. Moreover, presenting narration with captions and pictures showed the highest recall. It was difficult to correctly learn key words such as technical terms and names only through auditory presentation. The finding implies that presenting pictures and/ or verbal explanations with summarized written information may facilitate a learner's understanding of the program.

Moving objects guide viewers' eye movements. As shown in Figure 6, eye marks corresponded to the movements of the teacher and the student. Itoh and Fujita (1983) showed that viewers acquired more information about movements in pictorial presentations than in auditory presentations. The present results correspond to the earlier ones.

Analyses of eye movements also revealed ways of information presentation which result in converging and diverging eye movements.

As shown in Figures 7 and 9, eye movement patterns were similar in Conditions AV and V, which means subjects under both conditions scanned the pictures in the same way. The eye movements during graphic presentations indicated greater individual differences (Figure 8). The finding is similar to the earlier results by Itoh (1990). Comparison of eye movements on computer graphics and still pictures of the same figures revealed that computer graphics guide viewer's eye movements, whereas there were greater individual differences in scanpaths on still pictures.

There were two types of relationships between eye movements and recall. Although their ways of viewing were different (Figure 8), the subjects correctly responded to the questionnaires concerning the important points in Program 2. It should be noted that they had already learned the key concepts under Condition V where pictures were presented without sound. These findings imply that *pictures are as eloquent as the sound*. Presenting pictures with minimum explanation stimulates the viewers to learn by themselves through the media, a finding which can be applied to improve production procedures for educational programs. In this case, however, pictures contain verbal symbols, such as, letters and figures. Further examination using pictures without verbal symbols is necessary for application of the technique.

On the other hand, similar patterns of scanpaths do not always mean similar recall. Similarities in eye movements suggest that information was registered at least at sensory level. A fixated point, however, was not always recalled. Results of free recall tests, as used in the present study, were greatly influenced by a learner's ability of verbal expression.

A further study should combine analyses of information presentation, eye movements, and recall tests to examine and characterize cognitive processes while learning from audiovisual media.

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