Diffusive and Specific Searches on Eye Fixation in Subjective Selection with Paired Food Pictures

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Abstract Eye fixation time distribution was obtained from eye fixation data in subjective selection test with paired food pictures by three opinions; “Like”, “Slightly like”, and “Neither like nor dislike”. And the diffusive and specific searches were discussed. Results show the frequency of eye fixation in the diffusive search is higher than that in the specific search, and the frequency of eye fixation for ‘selected’ pictures is higher than that for ‘not selected’ pictures in the specific search.

Key words: eye movement, eye fixation time, subjective evaluation, opinion test, food picture

1. Introduction

Subjective evaluation is often performed in opinion tests for design and development of many products and food†. Human beings get much information from eyes, and it has been known empirically that eye movement is directed to visual information of the interest‡. Quantitative evaluation by biomedical signals, such as EEG (Electroencephalographic) and visual information, has potential. The authors have studied ERP (Event-Related Potential) in subjective evaluation of picture quality and food appearance§. In addition to this ERP study, investigations to use information of eye movements in the subjective evaluation would be important.

Human beings alternate saccades and eye fixations, and cognitive processing in the brain is performed by visual information obtained in the eye fixations‖. The eye fixation is defined as the condition in which eye movements in less than approximately 2° are kept for more than 150 ms‖. There are some studies on the relationship between eye movements and human preference¶. And there is a report about ‘diffusive search’ and ‘specific search’; the frequency of eye fixation with a duration of less than 300 ms is larger in the diffusive search which is to gaze a specific point including those‖. But the relationship between eye fixation time and subjective evaluation has not yet been clear.

As a fundamental study on quantifying subjective evaluation by eye movement information, eye fixation time in opinion test (subjective selection) with pairs of food pictures was measured, and the results shows the eye fixation time for a picture evaluated as the opinion “Like” or “Dislike” becomes longer than that for the other picture (not evaluated¶). In this paper, eye fixation time distribution is obtained from eye fixation data¶ in subjective selection with pairs of food pictures, and the diffusive and specific searches are discussed.

2. Method of Opinion Test

As a typical food, 10 pictures of Sushi, shown in Fig. 1, were prepared¶. Pairs of food pictures for the evaluation were parallelly displayed on a 20-inch LCD, as illustrated in Fig. 2. Two sets of 45 combinations were tested with random order.

The pictures were evaluated with three opinions; “Like”, “Slightly like”, and “Neither like nor dislike¶.”
In the cases of “Like” and “Slightly like”, a subject pushes buttons ‘1’ and ‘2’ for left side pictures, and buttons ‘5’ and ‘4’ for right side pictures, respectively. In the case of “Neither like nor dislike”, the subject pushes button ‘3’. Presentation time of each combination is the period from presentation of pictures to pushing buttons. And the interval by white picture with a central fixation point was set average 3 s (2–4 s).

Ten healthy, male subjects (21–25 years old) participated in this experiment. All subjects provided written informed consent.

3. Extraction of Eye Fixation Time

Eye movement measurement system developed by the authors was used. In the system, the pupil of subject’s right eye and looking landscape were captured by two CCD cameras (480×640 pixel²) with 30 Hz sampling frequency, respectively. And the view point on displayed picture was converted from the coordinates of center of the pupil by linear projection transform. A mean error of view point measurements at viewing distance of 650 mm was in 1°. Eye movements in the period of presentation time of evaluation pictures were analyzed. The eye fixation in the region of each food picture was detected when the change of the eye position in less than 2° was kept for more than 150 ms. Duration time \( t_f \) of eye fixation was defined as eye fixation time. Eye fixation time distribution is obtained by

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p(t_f) = \frac{m(t_f)}{M} \times 100, \tag{1}
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where \( p(t_f) \) is percentage of the frequency of eye fixation with the time \( t_f \) which is also the class of histogram 0.033×n s (n=5, 6, 7, ···), \( m(t_f) \) is the frequency of eye fixation with the time \( t_f \), and \( M \) is the total frequency of eye fixation for each picture.

4. Results and Discussions

Distributions of eye fixation time \( p(t_f) \) in the cases of “Like” and “Neither like nor dislike” are shown in Fig. 3. Average value and standard deviation are shown in the following figures, too. In the cases of “Like” and “Slightly like”, the percentage \( p(t_f) \) for ‘selected’ (evaluated) picture in the range from 167 to 267 ms is smaller than that for ‘not selected’ picture, and \( p(t_f) \) for both pictures is decreased as eye fixation time \( t_f \) becomes longer. On the other hand, in the case of “Neither like nor dislike”, the distributions of ‘Left’ and ‘Right’ side pictures are almost the same. As parameters to discuss the diffusive and specific searches, total percentage \( p_d \) of the percentage \( p(t_f) \) of eye fixation in the range from 167 to 300 ms, and total percentage \( p_s \) of \( p(t_f) \) in the range from 333 to 1033 ms were obtained by

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p_d = \sum_{n=5}^{9} p(0.033 \times n), \quad p_s = \sum_{n=10}^{31} p(0.033 \times n), \tag{2}
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where \( p_d \) and \( p_s \) correspond to the frequency of eye fixation in the diffusive and specific searches, respectively. Results are shown in Fig. 4. In the cases of “Like” and “Slightly like”, the results are almost the same, and the frequency of eye fixation in diffusive search is higher than that in specific search. The frequency of eye fixation for ‘selected’ pictures is higher than that for ‘not selected’ pictures in the specific search. In the case of “Neither like nor dislike”, the frequencies of eye fixation
Results show that the frequency of eye fixation in the diffusive search is higher than that in the specific search, and the frequency of eye fixation for ‘selected’ (evaluated) pictures is higher than that for ‘not selected’ pictures in the specific search. Investigation by opinion tests without ‘selecting’ and/or ‘pushing buttons’ is still in process.

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References