Gaze-Based Metrics for Consumers' Viewings of Printed Advertisements

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Abstract

This paper develops gaze-based metrics for consumers' attentional processes during reading of printed advertisements. The proposed gaze-based metrics are coverage rate, rate of cognition for superficial contents and rate of cognition for explanatory contents, all of which represent three different aspects of consumers' attention allocation. A series of experiments in which we recorded 20 female participants' eye movement data during looking at two types of insurance advertisements were conducted. The proposed metrics were preliminary applied to obtained data. Based on the metrics calculated, we conducted comparative analysis of each participant's tendency of attention allocation processes quantitatively. By comparative analyses of the metrics between participants as well as advertisements, we infer possible influential factors to consumers' attention. Considering all the analysis results, we discuss potentials of our metrics and some implications for effective advertising design.

Keywords
Eye movement, printed advertisement, human factors approach to advertising issue

1. Introduction
Eye tracking approach is recognized as a powerful tool in cognitive task analysis since it involves a promising ability of temporal and spatial recording of processing activities (Rayner 1995). One of notable strengths of eye tracking approach is that it is the only method to record very rapid attentional processes (Pieters and Wedel 2008). Such attentional processes recordings cannot be performed by conventional retrospective techniques like verbal protocols and interview. In advertising researches, however, eye tracking approach is still recognized to be in its infancy compared to other academic domains such as fundamental psychological research in reading, scene perception, and so forth due to the limited number of researches (Higgins et al. 2014. The following two facts may be the major reasons for the relatively a small number of studies. First, the analysis of eye tracking data is extremely time-consuming (e.g., Segall et al. 2007), mainly caused by that transcription of eye movement data necessitates frame-by-frame investigation from great amount of eye tracking data. This seems to prevent advertising researchers from adopting eye tracking approach. To eliminate this obstacle, development of some efficient data analysis procedure seems to be a key factor. Second, it is very difficult to give appropriate interpretations to eye movement data (e.g., Aoki et al. 2013). There are no standardized interpretation principles that can be used in advertising research context to uncover what attentional processes are performed from eye tracking data. This indicates that some eye tracking data-based metrics representing characteristics of in human attentional processes are strongly required. With all the background issues mentioned above, the objective of this paper is to develop eye tracking data-based metrics for the analysis of consumers' attention allocations during viewing of print advertisements.

2. Calculation Procedure of Gaze-Based Metrics
2.1 Identification of Information Areas in Advertisements
To capture characteristics of attention allocation processes, the first step is to identify information areas in printed advertisements. An information area in this paper means a component which can be considered as a single resource of information from both of pictorial and textual points of view. The identification of information area enables us to count the number of information shown/fixated in a specific advertisement.

Figure 1 shows an example insurance advertisement used in our experiment. By recognizing a small amount of background (e.g., white space), we can identify 23 pictorial areas like figures, arrows and illustrations(highlighted by dot-line rectangles), and 31 textual areas (highlighted by solid-line rectangles) as shown in Figure 2.

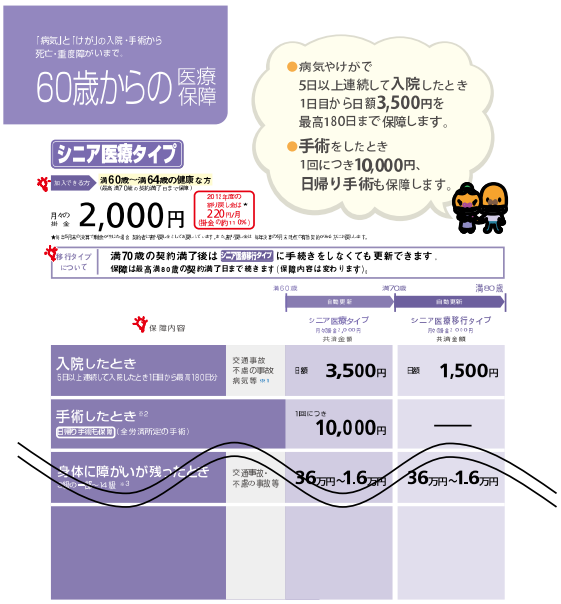

Figure 1: Example insurance ad

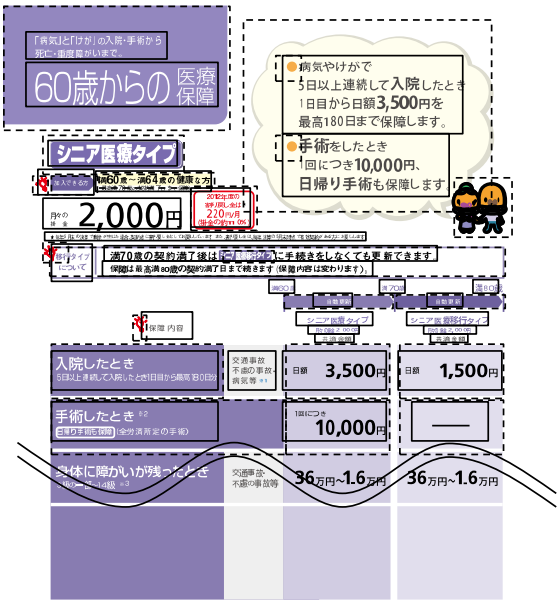

Figure 2: Information areas identified

2.2 Gaze-Based Metrics Proposed

The following three metrics are developed. These measures can be calculated by matching fixations elicited from eye tracking data with the information areas identified.

Coverage rate (Cov). This is a very simple metric representing the general tendency of how much information areas are gazed at by a consumer. The definition of this metric is the total number of information areas fixated divided by the total number of information areas displayed. As understood from the definition, this metric ranges from 0 to 100%, reflecting the percentage of information areas which were fixated at least once.

Rate of cognition for superficial contents (RS). This metric represents how frequently fixations are given to information areas involving superficial contents. The superficial contents indicates information areas having only pictorial elements or very short phrases/single word involving emotional feelings such as catch copy. This is calculated as the total number of fixations to information areas involving superficial contents divided by total number of fixations. This metric also ranges from 0 to 100%, meaning the percentage of the fixations that are oriented to superficial contents.

Rate of cognition for explanatory contents (RE). This metric reflects a different aspect from *RS*. This metric represents how frequently fixations are given to information areas involving explanatory contents. The explanatory contents mean information areas claiming concrete messages regarding the advertised product such as texts explaining benefits. The metric is calculated as the total number of fixations to information areas involving explanatory contents divided by total number of fixations

3. Eye Tracking Experiment

3.1 Participant

A series of eye tracking experiments were conducted in collaboration with National Federation of Workers and Consumers Insurance Cooperatives using its advertising materials. The author's university's research ethics board approved all research procedures. We recruited 20 female participants living in Tokyo area through an announcement by a marketing research company. They were key persons responsible for their decisions on daily expenses of their family. Their families were very much likely to earn medium to high annual income compared to average in urban Tokyo area. The participants' ages ranged from 27 to 39 years old. Upon completion of the experiment, a participant received JPY 7,000 as compensation for her time from the marketing research company.

3.2 Advertisements and Materials

Two versions of a full color print advertisement (Ad1 and Ad2) were exposed to participants. Table 2 summarizes physical and creative variables of the advertisements. Ad1 having 18 pages advertised four types of insurances (insurances A, B, C and D), whilst Ad2 having 34 pages did all nineteen types including the aforementioned four types. Ad1 focused on the four types which the insurer pushed in public at the moment. Ad2, on the other hand, covered all nineteen types of insurance that were available when the experiment was held. In Ad1, the explanations of insurances were very simplified compared to those in Ad2. All of the articles in both advertisements covered two facing pages.

Eye movement recordings were conducted using a remote sensing eye tracking system (Tobii eye tracking system), which did not require any head-mounted equipment. The system was determined to have a spatial accuracy of 0.5-1.0°, and the sampling frequency was 60 Hz. It had a 17-inch TFT monitor on which visual stimulus were displayed.

Participants looked at both advertisements in the experiment. Because of constraints of time and perceived fatigue caused by eye movement recordings, we were allowed to carry out eye movement recording during looking at one out of two versions of print advertisements for each participant. Considering this, we divided 20 participants into groups 1 and 2 (10 participants for each group), and allocated an eye movement recording session during looking at Ad1 to the group 1, and that during looking at Ad2 to the group 2. For an advertisement used for eye movement recordings, we converted the advertisement into pdf format, and displayed it on a monitor (every two facing pages at a time)of the eye tracking system.

While looking at the advertisement in pdf format, participants could go forward/back to the next/previous pages by pressing arrow keys (right or left) in a keyboard. In the sessions without eye movement recordings, participants looked at an advertisement in a booklet style.

Table 1: Two versions of ad

	Ad1	Ad2
Insurance types advertised	4 types of A, B, C and D A: general, B: health-oriented, C: for kid, and D: for elderly	19 types including A, B, C and D
Size	A4 size (210 mm * 297 mm)	A4 size (210 mm * 297 mm)
Page	18 pages	34 pages
Content	Cover page, back cover, overall explanation of the 4 types of insurance (2 pages), detailed explanation of each insurance type (8 pages in total), explanation of contract procedure(1 page), detailed explanation of conditions of contract (5 pages in total), introduction of the insurance company (2pages)	Cover page, back cover, overall explanation of the 19 types of insurance (3 pages), detailed explanation of each insurance type (14 pages in total), detailed explanation of conditions of contract (7 pages in total), explanation of the appropriate premium/indemnity for individual customers (4 pages), introduction of related other insurances (6 pages in total)

3.3 Procedure

The experiment was performed for each one of participants. Upon entering the laboratory, a participant was seated and told that she would look at two versions of print advertisements like those found in ordinary banks. She was also told that she would participate in two experimental sessions. First one was an eye movement recording session, and the second one was a session without eye movement recordings. In both of sessions, she was asked to consider a possibility that she would be an insurance policy holder of advertised insurance types while looking at the advertisements. She was told that our experimenter would give the following question just after looking at the advertisement: “Tell me the insurance types that you would consider becoming an insurance policy holder.” Additionally, she was informed that an eye tracking system would record her eye movement while she looked at one of the two advertisements in the eye movement recording session, including the explanation of calibration procedure. Then the eye movement recording session began.

The participant was asked to sit in front of the monitor of the eye tracking system, and performed calibrations. After calibration, Ad1 in pdf format was shown to the group 1's participants, whilst Ad2 in pdf format to the group 2's participants. She was told to let the experimenter know that she finished looking. Just after the eye movement data collection, we asked her to fill out a questionnaire to obtain data relating to preferred insurance, memory test as well as subjective evaluation of understandability of the advertisement.

After a short break, the second session (w/o eye movement recordings) began. Ad2 in a booklet style was shown to the group 1's participant, whilst Ad1 in a booklet style to the group 2's participant. Except eye movement recordings, the identical procedure was taken in this session.

4. Result

4.1 Coverage Rate (*Cov*)

To perform comparison between advertisements (Ad1 and Ad2), *Cov* were calculated for pages in which insurance types A-D were advertised (eight pages for both advertisements). The identical calculation procedure was also applied to other metrics. From coverage rates, the effectiveness of advertising information conveyance can be compared between the advertisements. The grand mean of *Cov* was 44.6%. A 2-way analysis of variance (ANOVA) of the advertisement types (Ad1 and Ad2) and insurance types (corresponding with insurance types A-D) was conducted, as shown in Table 3. As found in this table, only a significant effect of advertisement types could be observed. Figure 3 depicts the mean coverage rate for each condition. As Figure 3 indicates, mean *Cov* in Ad1 (50.8%) is significantly higher than that in Ad2 (38.4%). No significant difference could be found between insurance types A-D. It may be possible to say that simplified version (Ad1) successfully direct participants' attention widely compared to Ad2 (standard version). From practical view, this can be considered as an evidence supporting the superiority of Ad1's design. At least, we can say that the simplified version is preferable for our participants because it could capture wide attention to its pages.

Table 2: ANOVA result for *Cov*

Factor	*s. s.*	*d. f.*	*V*	F_0
Ad type	0.307	1	0.307	9.666 **
Insurance type	0.135	3	0.045	1.422
Ad type*Insurance type	0.115	3	0.038	1.209
Error	2.285	72	0.032	
Total	2.843	79		

**: $p<0.01$, *: $p<0.05$

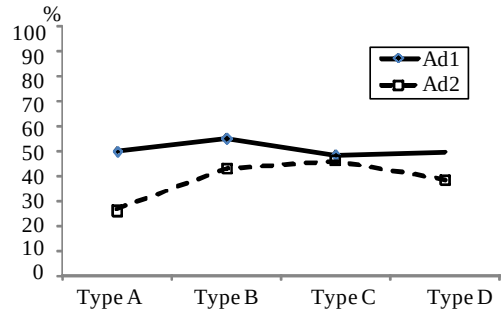

Figure 3: Mean *Cov* for each condition

4.2 Rate of cognition for superficial contents (*RS*)

The extent to which attention is paid to the superficial contents can be evaluated based on *RS*. The grand mean of *RS* was 17.2%. The result of ANOVA is shown in Table 4. As found in the table, main effects of advertisement types and insurance types as well as their interaction effect could be observed. From Figure 4 which depicts the mean values for each condition, interestingly, the notable difference between advertisements can be found in the insurance type D. Only in the insurance type D, our participants tended to show superficial cognition while reading Ad2 (Mean value of *RS* was 34.4%). From practical view, we can say that the page advertising the insurance type D in Ad2 is problematic since too many fixations were directed to superficial contents. Comparing this problematic pages with those for other insurance types in Ad2, though, we could not find any conspicuous differences in its design. This may indicate that the relatively high *RS* in Ad2's insurance type D cannot be attributed to design of advertisements, but to participants' individual factors such as individual tastes and preferences. To find some possible reasons, further examination to uncover participants' individual factors is needed (e.g., depth interview, laddering and so on). We are now performing such detailed examination.

Table 3: ANOVA result for *RS*

Factor	*s. s.*	*d. f.*	*V*	F_0
Ad type	0.117	1	0.117	15.063 **
Insurance type	0.099	3	0.033	4.252 **
Ad type*Insurance type	0.254	3	0.085	10.867 **
Error	0.561	72	0.008	
Total		79		

**: $p<0.01$, *: $p<0.05$

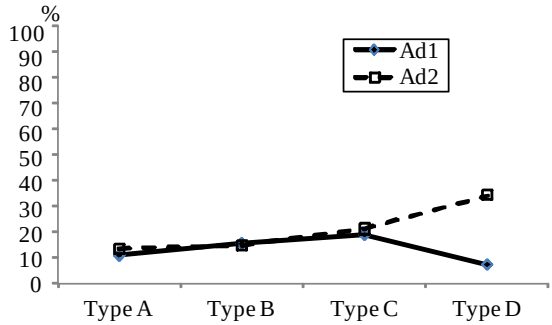

Figure 3: Mean *RS* for each condition

4.3 Rate of cognition for explanatory contents (*RE*)

The extent to which attention is paid to the explanatory contents can be analyzed based on *RE*. The grand mean of *RE* was 65.4%. ANOVA revealed a significant main effect of insurance type and an interaction (see Table 5). Figure 5 depicts the tendency found in mean *RE* for each condition. From Figure 5, we may say that the mean *RE* is relatively stable over insurance types in Ad1, but not in Ad2. In Ad2, mean *RE* in the insurance type A is high (78.3%), but that in the insurance type D is low(53.2%) compared to grand mean (65.4%). From practical view, the pages for the insurance type A in Ad1 is preferable, but those for the insurance type D may be problematic. Considering the fact that the design in Ad2 are almost identical over insurance types, we may say that the observed difference in *RE* cannot also be attributed to design factors (see Section 4.2). As shown in Section 4.2, further investigation based on retrospective technique is strongly required to find the possible reasons.

Table 5: ANOVA result for *RE*

Factor	*s. s.*	*d. f.*	*V*	F_0
Ad type	0.003	1	0.003	0.163
Insurance type	0.202	3	0.067	3.384 *
Ad type*Insurance type	0.171	3	0.057	2.865 *
Error	1.430	72	0.020	
Total	1.806	79		

**: $p<0.01$, *: $p<0.05$

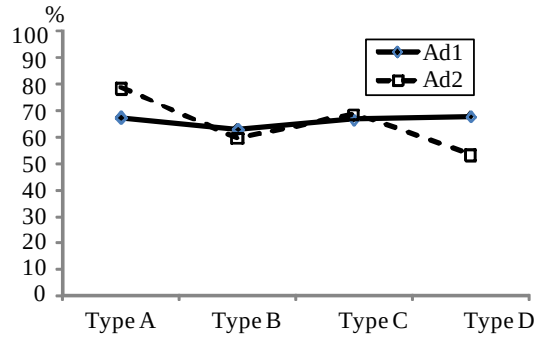

Figure 5: Mean *RE* for each condition

4.4 Relations of the metrics with understandability

In our experiment, each participant was asked to rate the degree to which how easily she could understand the whole of the advertised messages for each advertisement. The answers were on a five-point Likert scale ranging from "strongly easy to understand (5)" to "strongly difficult to understand (1)." The mean rating scores for Ad1 and Ad2 were 4.1 and 2.8, respectively($t_0(38)=4.41$, $p<0.01$), meaning that Ad2 cannot be easily understood. Considering the fact that only the *Cov* showed a constant gap between Ad1 and Ad2 (see Figure 3), it may be conjectured that the *Cov* is a promising metric that predicts subsequent consumers' understandings of advertised messages.

5. Conclusion

In this study, we presented three gaze-based metrics for printed advertisement viewer's attention allocation processes, employing the eye-tracking technique combined with characteristics of information contents. In particular, these metrics allows us to trace consumers' tendency while viewing of printed advertisements quantitatively. From a preliminary application of the metrics to the analysis of insurance advertisements, it is found that the metrics is useful in analyzing the 20 participants' viewing styles (i.e. tendencies of how they direct their attention to information contents). In our data analysis, some possible implications/hints about potential influences of advertisement design as well as participants' individual factors could be obtained. As mentioned in the body text, however, such implications/hints are just possible conjectures at this moment. To obtain more sound implications, we are now conducting more detailed analysis in which eye tracking data are thoroughly investigated in consideration of participants' individual factors (such as preferences and intentions to hold the advertised insurances) as well as heir subjective evaluation of the advertisements/insurances.

Acknowledgements

This research was partly supported by the Grant-in-Aid for Scientific Research (C) (No. 15K01182), The Japan Society for the Promotion of Science. We would like to acknowledge Takuya Yoshida and Mai Osaka, National Federation of Workers and Consumers Insurance Cooperatives for their great support for our study.

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Biography

Hirotaka Aoki is an Associate Professor in the Department of Industrial Engineering and Management at Tokyo Institute of Technology. He received B.S., M.S. and PhD in Industrial Engineering and Management from Tokyo Institute of Technology. He has a special interest in cognitive task analysis in various domains such as marketing and medicine, and has developed eye tracking-based task analysis methodologies.