An Application of Eye-tracking Technology to Fashion Design Education: A Pilot Study on How Women Gaze at Handbags

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Abstract: Questionnaire is a conventional approach for fashion designers and educators to survey consumers' general preferences of products' appearances; however the precision of survey results remains questionable. The authors proposed an alternative in this pilot study in which five eye trackers were used to record 10 female participants' eye movement data of gazing at 20 randomly displayed handbag pictures. Six types of Regions of Interest (ROI) of handbags were assigned to understand which regions were more attractive to the participants. The times and duration of fixations showed the degree of ROIs' attractiveness to the participants. The findings provide persuasive eye-movement evidence of predicting potential female consumers' gazing behaviors. Textbook editors of fashion design can also add eye-tracking approach to future books. And eye-tracking technology can also help fashion design educators to enhance teaching and students' learning. Moreover gazing behavior can be broadly considered a form of reading, and the findings of this study further extend the existing knowledge of human reading process.

Keywords: Fashion design education, eye tracking technology, women's handbags, gaze pattern

1. Introduction

Fashion design education aims to foster future designers, and understanding consumers' visual preferences is important to teaching and learning of this field. Still it is challenging for educators and designers to precisely predict consumers' visual preferences by using conventional questionnaire survey. Eye-tracking approach proposed in this paper can help them can develop better understanding of consumers' general gazing behaviors so that they can enhance their teaching, students' learning and designing.

Eye tracker is an instrument designed to record eye movement data to be used to analyze process of reading a written text or behavior of gazing at an object, for instance. Researchers can identify viewers' degrees of visual attractiveness to a material or the crux that causes readers reading difficulty based on their eye movement data such as frequency of gazing at particular Regions of Interest (ROIs) of certain materials and the duration of fixations on the regions. Eye-tracking technology has been applied to various fields such as language teaching and learning, neurosciences, psychology, engineering, marketing, computer sciences, and others [3], [6], [7], [8].

In literature survey, some researchers used eye trackers to study consumers' gazing behavior of fashion products [4], [5]. However, by far, no literature has specifically

documented how women gaze at women's handbags by taking an eye-tracking approach. This approach is applicable and time-efficient, and it is able to provide valuable references to both fashion design educators and designers.

This pilot study aims to look for women's general gaze patterns of handbags instead of studying the differences and correlations between various styles and degrees of attractiveness. In the experiment the authors recorded and analyzed 10 female participants' eye movement data of gazing at 20 randomly displayed pictures of women's handbags. The authors defined six types of ROIs of a handbag on the basis the structure of a handbag: handle (denoted as R_1), main body (R_2), hanging ornament (R_3), strap (R_4), featured area (e.g. a larger-sized metal part) (R_5), and textual information (e.g. brand's name, logo figure or trademark) (R_6). Figure 1 is an example of a handbag's ROIs.

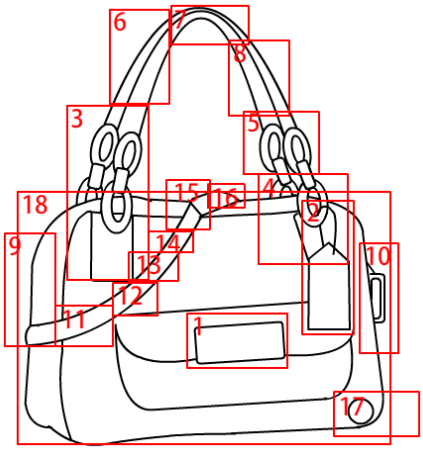

Figure 1. An example of a women's handbag with different ROIs

The research questions are list below.

Q_1: What is the gaze sequence when the participants gaze at the images of handbags?

Q_2: What is the sequence of the capacities of ROIs to adhere attention?

Q_3: What is the sequence of degrees of attention to ROIs?

Before this pilot study, the results of a preliminary experiment were used to propose the following hypotheses.

H_1: The gaze sequence is R_2, R_3, R_6, R_5, R_1, and R_4.

H_2: The sequence of the capacities of ROIs to adhere attention is R_5, R_1, R_4, R_3, R_2, and R_6.

H_3: The sequence of degrees of attraction to ROIs is R_5, R_2, R_3, R_1, R_6, and R_4.

2. Method

2.1 Participants and Procedure

The participants were 10 voluntary female undergraduate students of National Taiwan Normal University, Taipei, Taiwan (20.75 years old on average, SD=1.7 years, range 19-22 years), and they all signed consents of participating in this experiment. The participants were not informed the purpose of this research before the experiment in order to observe their natural gazing behaviors. Instead, they were told that the aim of this experiment was to measure the expansion of pupillary responses. A self-developed eye-tracking instrument named EyeNTNU-180 was used to collect the participants' eye movement data from their left eyes. When the experiment was completed, the authors told them the true purpose of this

experiment and asked them if they had ever questioned the purpose of the experiment. None of them questioned the purpose.

The 20 selected pictures had six types of ROIs. The distance from the participants' eyes to the screen was 60 centimeters. The authors used self-developed ROI Tool to define ROIs of the 20 pictures and another self-developed Fixation Calculator was used to process the participants' eye movement data.

2.2 Stimulus Material

The authors collected 80 pictures of women's handbags from online stores' webpages. Each picture only had one handbag without background colors or patterns. Some pictures had brands on it; some did not. To remove pictures that include any distracting elements, the authors carefully selected 20 pictures with good image quality (10 pictures with textual information, brands, or trademarks on the handbags). The pictures were placed in the same orientation and image sizes of the pictures were very similar.

The definitions of six types of ROIs are illustrated below. The bag's main body was defined as a common ROI of 20 pictures; 10 handbags' handles were defined as a ROI type; 10 handbags' textual information was defined as a ROI type; 10 handbags' hanging ornaments were defined as a ROI type; 10 handbags' straps were defined as a ROI type; and 10 handbags' featured areas were defined as a ROI type. The 20 pictures were randomly displayed and they were all centered on the computer screen. The participants were allowed to decide how much time they would like to spend on gazing at each picture. They were asked to start from the centers of the pictures. They were also asked to calibrate the eye trackers before they view every picture to ensure the accuracy of their eye movement data. Finally the authors asked them to fill out questionnaires in order to collect their basic background information, age or majors, for instance.

2.3 Eye Tracking: Recording and Quantification

Five EyeNTNU-180s were simultaneously used to record the participants' eye movement data. The sampling rate was 180 Hz. Two infrared LEDs provided lighting that reflected on dark pupil to measure the participants' eye movements. The outputting energy of the LEDs was 3.5 mW/cm^2 at a working distance of four centimeters. The participants were asked to do nine-point calibration by tracing nine white moving points on the screen (the background color was black) before the experiment. The participants' eye movement data was collected every 5.56ms from their left eyes as they gazed at the working area on the screen. No data would be recorded when the participants blinked.

The ROI Tool was used to define ROIs of every picture. Since the sizes of ROIs were not the same, the sizes of pictures were adjusted to 80%-100% in proportion to the height of the screen. When the participants gazed at certain spots for at least 80ms, one time of fixation would be counted into the total number of fixations. Fixation Calculator was used to calculate the following parameters of each participant's eye movement data:

(a) the dwell time: total contact time of all fixations of gazing at each ROI,
(b) the number of fixations on each ROI,
(c) the latency of first fixation on each ROI, and
(d) the duration of the first fixation on each ROI.

The authors considered ROI as a factor and used descriptive statistics for data analysis.

3. Results

3.1 Eye movement Data

The authors interpreted the eye movement data through three perspectives. First, the dwell time shows the participants' the degree of attention to each region. Second, latency of the first fixation shows that the attractive regions which participants can quickly position. And finally, the duration of the first fixation and the number of fixation shows the participants' adhere attention to the ROI.

3.2 Latency of the First Fixation and Duration of the First Fixation

The latency of first fixation (Table 1) indicates that the participants' gaze sequence is R_2, R_3, R_6, R_5, R_1, and R_4. It also shows that which ROIs can quickly attract the participants' attention. This result confirms H_1.

The duration of first fixation in Table 1 shows the sequence of the duration of the first fixation is R_5, R_1, R_4, R_3, R_2, and R_6. The longer duration shows that the capacity of attention of the ROI is stronger than the others; H_2 is confirmed.

3.3 Number of Fixations and Dwell Time

The number of fixations shows the participants' times of fixation on each ROI and the sequence is R_5, R_2, R_3, R_1, R_6, and R_4. The dwell time shows the total duration of fixations on each ROI, and the sequence is R_5, R_2, R_3, R_1, R_6, and R_4.

The number of fixations and dwell time show that the two sequences are the same; therefore H_3 is supported. A possible explanation is that when the participants have faster speed of saccade, the dwell time will be longer if the number of fixation times is larger.

Table 1 Eye movement data of each ROI

	Number of fixations		Dwell time (ms)		Latency of first fixation (ms)		Duration of first fixation (ms)	
ROI	Mean	SE	Mean	SE	Mean	SE	Mean	SE
R_1	3.01	.95	440.36	195.89	4567.45	2042.16	212.78	50.53
R_2	4.35	.95	648.30	205.64	1437.58	213.93	128.35	12.78
R_3	3.75	1.34	511.72	208.13	1805.79	418.13	143.96	17.97
R_4	2.79	.60	365.18	97.30	5702.36	2067.85	193.40	29.24
R_5	4.62	1.69	742.60	329.73	4515.88	1990.06	226.98	49.31
R_6	2.88	.56	397.21	106.49	1900.41	400.09	120.80	10.65

Note: Mean and standard error (SE)

4. Discussion and Conclusion

According to the results, R_2 can quickly attract the participants' visual attention, and it also has more times of fixations although its duration of fixation is shorter. A possible answer is that the area of R_2 is largest among the six types of ROIs. The participants' fixations do not immediately fall on R_5, but it has the longest duration at the first fixation, the largest number of fixations, and the longest duration of total fixations. In this regard, R_5 can be considered the most attractive region of a handbag, and it might easily arouses the participants' curiosity and a sense of novelty [1], [2], [9].

The concrete eye movement evidence demonstrates that eye-tracking approach is an effective and efficient approach of predicting potential female consumers' gazing behaviors

and visual attention as they look at images of fashion products. The findings of this research have practical contributions to fashion design education. For instance, if featured area (R_5) is the most attractive region to female consumers, educators can advise students to emphasize on the design of this region. The proposed approach can help educators to improve their teaching, and textbooks editors can also add eye-tracking approach to future textbooks. Moreover, gaze can be defined as a form of reading. The findings of this research also extend the existing knowledge of human reading process.

The insufficient participants and the number of handbag pictures, and few variety handbags' styles are the limitations of this pilot study. Nevertheless the eye-tracking approach can also be applied to other fields of education and researches that related to reading process.

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