Apply Web-based Analytic Tool and Eye Tracking to Study The Consumer Preferences of DSLR Cameras

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Abstract

Consumer's preferences and purchase motivation of products often lie in the purchasing behaviors generated by the synthetic evaluation of form features, color, function, and price of products. If an enterprise can bring these criteria under control, they can grasp the opportunities in the market place. In this study, the product form, brand, and prices of five DSLR digital cameras of Nikon, Lumix, Pentax, Sony, and Olympus were investigated from the image evaluation and eye tracking. The web-based 2-dimensional analytical tool was used to present information on three layers. Layer A provided information of product form and brand name; Layer B for product form, brand name, and product price for the evaluation of purchase intention (X axis) and product form attraction (Y axis). On Layer C, Nikon J1 image samples of five color series were presented for the evaluation of attraction and purchase intention. The study results revealed that, among five Japanese brands of digital cameras, LUMIX GF3 is most preferred and serves as the major competitive product, with a product price of US$630. Through the visual focus of eye-tracking, the lens, curvatured handle bar, the curve part and shuttle button above the lens as well as the flexible flash of LUMIX GF3 are the parts that attract the consumer's eyes. From the verbal descriptions, it is found that consumers emphasize the functions of 3D support lens, continuous focusing in shooting video, iA intelligent scene mode, and all manual control support. In the color preference of Nikon J1, the red and white colors are most preferred while pink is least favored. These findings can serve as references for designers and marketing personnel in new product design and development.

Keywords: Website Technique, Consumer Preference, Eye Tracking.

1. INTRODUCTION

With the technological advance, cameras have been developed from the previous conventional film-type into digital ones. The prevalence of digital cameras also makes it possible for more and more people to share their photographs instantly through the Internet platform. Therefore, digital cameras have become an indispensable necessity everyone or every family cannot do without. In designing and developing new products, if designers can bring consumer's opinions regarding product purchase such as preferences of product form and color, acceptable range of product price, functional conditions to meet their needs, it will be critical for the product's success in the market place.

In the past, designers often process the product design thinking from their own points of view and define consumer preferences by their subjective way of assessment. Such kind of thinking method, however, does not truly reflect consumer's preferences and needs for products. In this study, therefore, the web-based 2-dimensional analytical tool and eye tracking experiment are combined to explore subject's opinions regarding the product form and prices of five Japanese DSLR cameras (Nikon, Lumix, Pentax, Sony, Olympus) as well as color preferences for Nikon J1 series. Moreover, verbal descriptions regarding the functional preferences of DSLR cameras are integrated to offer references for the design and development of DSLR cameras in the future.

2. LITERATURE REVIEW

In this study, consumer's behaviors regarding DSLR camera purchase are explored. Moreover, views from scholars of related studies on the application of web-based 2-dimensional analytical tool, eye tracking, and product price acceptability are collected and synthesized for further experiments in the study.

2.1 The Web-based 2-dimensional Analytical Tool

In this study, the context of commercial center was simulated where product samples were placed on the same plane for consumers to conduct their preference comparison. Lin and Huang developed the web-based 2-dimensional analytical tool based upon the gravitation theory. Through the coordinates of product samples from each subject in the survey, objective analysis of the products tested in the four quadrants can be conducted for market segmentation and positioning [1]. More importantly, the result of market segmentation can be effectively applied for the policy making of essential competition strategies [2]. For enterprises, market segmentation is an important strategic commercial domain [3, 4]. Through web techniques, Lin, Chang and Huang further extended the functions of web-based 2-dimensional analytical system. Their system is able to (1) collect subject's personal data and coordinates of the product samples tested in the survey; (2) collect and calculate the gravitation centers of product samples from the database; (3) present visualized diagrams for market segmentation based on the coordinates of gravitation centers of product samples; (4) specify preferences for special target user groups (gender, vocation, living area and the like demographic variables) by the presentation of specific single product sample [5]. For product form, Chuang and Kao claim that product image is composed of such elements as colors, lines, textures, and structure, which form certain types of feelings. Together with visual and perceptual experiences, such feelings can help people recognize products and perceptual functions [6]. Chen and Owen proposed a style description framework for the analysis of product style, in which six attributes are included: (1) form elements, (2) joining relationships, (3) detail treatments, (4) materials, (5) color treatments, (6) textures. For affective domain, design elements of product form play a key role in user's image perception [7]. Through web techniques, Huang and Lin further extended the functions of web-based 2-dimensional analytical tool. The output systematic diagrams and tables could help researchers process market segmentation, select competition products, potential target user groups, and morphological analysis for product form elements. With digital data and graphic output, the web-based design decision tool could help designers and marketing managers set up proper policies for product form design and marketing of new products, in which a certain number of product samples are needed for morphological analysis [8]. In this study, the variables along axes of the 2-dimensional analytical tool were based on the preference and purchase intention proposed by Wind and Green to investigate the differences among different user groups for market segmentation [9, 10].

2.2 Consumer Behavior

Consumer behavior is an integral discipline whose structure consists of social science, psychological science, economics and marketing. Many scholars define consumer behavior from different perspectives. For instance, Peter and Olson define it as thinking, cognition, and interaction procedure people respond to the purchasing conditions and environment [11]. Engel, Kollat, and Blackwell consider it a kind of behavior people use money or substitute of money for commodity or service. There exist a series of strategies during the exchange, including before and after the action of purchase [12]. Schiffman and Kanuk define it as the behavior people

search for products, services or ideas, acquire, evaluate and propose information to satisfy their needs [13]. Zikmund refers it a psychological and contextual procedure and physical activity where people select, purchase, and use products to satisfy their needs and desires [14]. Zaltman thinks it the way people acquire, purchase, and dispose products, services, and ideas. The more we understand consumer behavior, the more we can find the rules in such kind of behavior [15]. Engel, Blackwell, and Miniard refers it the activities involved in the way people acquire, consume, and dispose products or services, which is a dynamic strategic procedure including the specification of needs, search of information, information processing, evaluation prior to and after purchase, purchase action, and disposal [16].

From the above studies, it is clear that the scale of a market is formed by consumer's behaviors. Different target user groups vary in their behaviors. It will be helpful for the design and development of new products if enterprises can take the preferences of different user groups and develop suitable strategies for them. In this study, college students are selected as target user group for DSLR cameras for the exploration of major competing products, price acceptability and color preferences so as to offer references for the design and marketing strategy of related products in enterprises.

2.3 Eye Tracking

Human vision is the most important information channel to help people deal with the majority of incoming messages. The physical structure of the eye determines only what we feel, and the information stored in the human brain is used to interpret the signals seen, and to guide the eye to collect new information. Therefore, from the eye movement, we can explore the intention of an observer [17]. Meanwhile, he also points out that when people look at artistic works, they will first pay attention to some things interesting; then move their eyes; stay there for a short while; and repeat the process again and again. People comprehend the outer stimulus during the gaze period; the duration of eye fixation is about 300 milliseconds (ms). The eye movement of people's visual perceptions toward a product form can be precisely tracked by infrared reflection of cornea and relative positions of pupils [18, 19]. In visual scanning, subjects will move their eyes to the area attracting them and stay there for more than 100 milliseconds (ms) so that the brain can receive the visual information. Such kind of procedure is defined as eye fixation. Henderson and Hollingsworth and Tatler, Baddeley and Gilchrist claim that in earlier period of scanning, subjects will have similar fixation durations, but in later scanning, the fixation is more dispersed, mostly because of the scene and meaning of different areas in the content [20, 21]. In this study, the 2-dimensional analytical tool was integrated with the Mangold eye tracking system (VisionV3.2.3 in Figure 1). The fixation is determined by the gazes in specific areas of product sample images. The conditions of a gaze are set up to be 30Hz, so it takes 33.333 ms to form 1 Gaze. Through the detection of eye fixations, we can understand the visual responses consumers have toward product forms of different features. More importantly, the fixations subjects scan specific areas of product sample images are compared with the verbal descriptions subjects have in considering the product form elements of DSLR cameras they prefer. The results obtained from the study can serve as references for product designers.
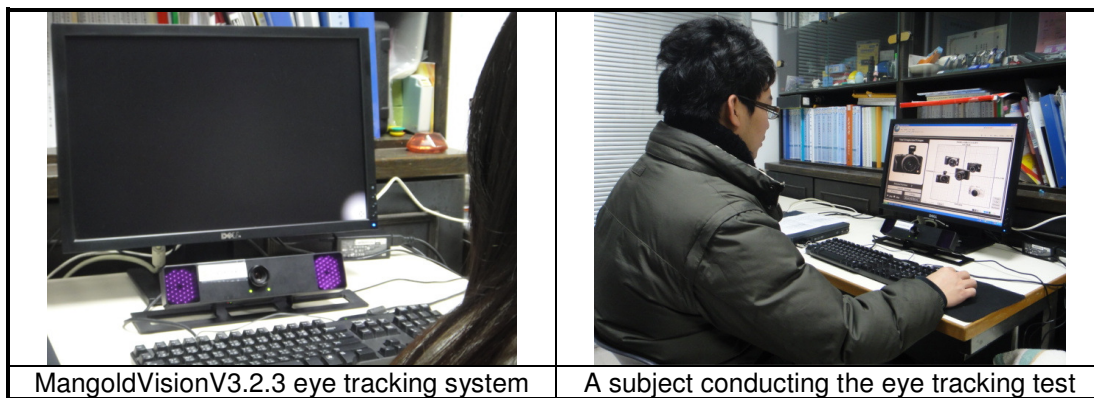
| MangoldVisionV3.2.3 eye tracking system | A subject conducting the eye tracking test |

FIGURE 1: MangoldVisionV3.2.3 eye tracking system (Courtesy of PITOTECH Co.,Ltd, Taiwan).

In the experiment, the implicit factors consumer consider about the purchase of DSLR cameras are visualized by the eye tracking system. To visualize such a complicated and dark-box type of cognition, the web-based 2-dimensional analytical tool is combined with the eye tracking system to record quantitative data and verbal descriptions from think aloud so as to build up the visual responses subjects use in looking at product sample images. Such kind of visual perceptual data will be compared and contrasted with the voice of subjects in terms of their preferences towards product form. Through a comparative analysis of qualitative (psychological feelings) and quantitative data (eye fixations), it is expected to have an in-depth understanding of the consumer's preferences towards product form design.

2.4 Acceptability in Product Prices
Dodds et al. found that the impact of product prices on the perceived quality decreases with the increase of other clues, but compared to other external cues such as brand or product image, product price is still an important indicator of consumer's purchasing decisions [22]. Anderson and Vincze pointed out that product price is the amount of money consumers pay for goods or services, the monetary sum a buyer is willing to pay to obtain a product or service [23]. Therefore, product price can be divided into the objective price specified by the vendor and the identified price perceived by the consumers. The perceived price of a product combines the actual price of the product with the non-monetary price, such as time costs, search costs, mental costs, and the like. The perceived price of a product is different from the actual objective price because consumers are not able to know the real costs, causing it difficult to judge the rationality of the objective product price. As a result, the objective price of a product is often transformed into cheap-lower price or expensive-higher price, an easy way to feel the perceived price. From the above, product price is one of the important factors that will affect consumer's purchase intention of a product. Therefore, in terms of the product information, a layer without product price is used to examine the subject's perceived price (subjective judgment) while the other layer with product price is used for the objective price (rational judgment) to explore the product price strategy. Through the manipulation of product price information, Lin and Huang found that there exist significant differences in terms of subject's purchase intention for the same product. Three product price strategies for product price setting: type I: reasonable price; type II: too expensive and should be lowered; type III: a good bargain for the product price strategy of DSLR cameras [24].

3. METHODS
To explore consumer's preferences toward product form and price acceptability, five Japanese brands of DSLR cameras, including Nikon, Lumix, Pentax, Sony, and Olympus were used for the 2-dimensional marketing survey. With data from the eye tracking experiment and think aloud experiment, consumer's preferences to product form features of DSLR cameras were clarified.

Moreover, five color series of Nikon J1 were used for the color preference test. The results could serve as references for designers in product form design and color scheme.

3.1 Select Product Samples
Through websites, images of five Japanese brands of DSLR cameras were collected, including their logo and product prices (Table 1).

Product image					
Product title	Nikon1 J1	Lumix GF3	Pentax Q	Sony α	Olympus
Price in US dollars	$ 830	$ 630	$ 840	$ 899	$ 699

TABLE 1: DSLR camera images of Nikon, Lumix, Pentax, Sony, and Olympus.

3.2 Setup Web-based 2-dimensional Analytical Tool
The web-based 2-dimensional analytical tool was adopted to present information on three layers. A layer provides information of product form and brand name but without product price; B layer for product form, brand name, and product price for the evaluation of purchase intention (X axis) and product form attraction (Y axis). On C layers, Nikon J1 image samples of five color series were presented for the evaluation of attraction and purchase intention.

On the scale, as can be seen in Figure 2, X axis indicates the purchase intention and Y axis means the product form attraction. From product without price (Layer A) and eye tracking system as well as verbal descriptions in think aloud, subject's preferences in product functions are specified. From product with price (Layer B), major competition products are identified. From Layers A and B, product price acceptability is explored. At last, color preference test is conducted from Layer C. The results can work for references in design and marketing strategy.
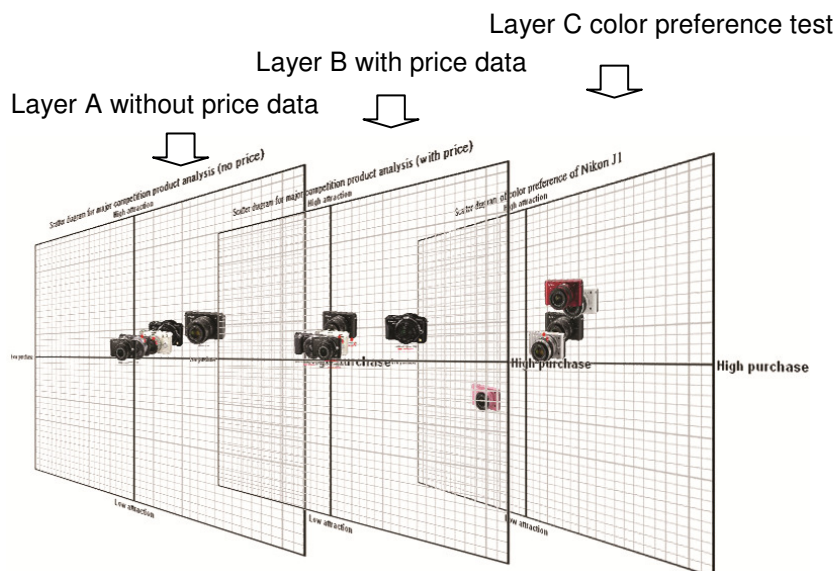

FIGURE 2: Three layers in the web-based 2-dimensional analytical tool.

3.3 Eye Tracking Setup and Product Information
Experimental facility: MangoldVisionV3.2.3 eye tracking system. Monitor resolution is set to be 1024 x 768. Screen capture setting: the desktop eye focus unit is connected to the test host.

Hardware calibration: adjust the angle of desktop eye focus unit according to the distance between subject's seat height and monitor. Instead of being fixed and stiff, the subject can slightly turn his or her head. The accuracy percentage of focus is set to 70%. If a subject's accuracy is lower than 70%, then a recalibration is needed. In the eye tracking test, it is hoped that the subject will not be influenced by the price information when he or she evaluates the product form. Therefore, Layer A (without product price information) is used for the eye tracking test. When product samples are played in different viewing angles, the fixations and number of gazes of detailed areas of product form are collected. Meanwhile, the think aloud test is also conducted to explore the subject's preferences to product form features and functions. In this study, areas of product form details and functions were previously set. Scores of 0 and 1 were assigned for specific areas of interest and functions. For the objectivity of research, a weighting of 1 is assigned to every subject in terms of the areas of interest and functions. The presentation details of DSLR cameras, taking Nikon J1 as an example, are (8/900/37.5), meaning 8 pictures, 900 frames, 24 frames per second (fps), and 37.5 seconds in total presentation. Details for other brands are Lumix GF3 (8/1045/43.5), Pentax Q (9/1125/46.9), Sony α (9/1245/51.8), Olympus (7/930/38.7), (Table 2). Because of different numbers of pictures and presentation time periods, only eye tracking data of major competition products are selected for preferences of product form feature and function. No comparisons are conducted among products of different brands.

Brands	Pictures played	Frames	Total presentation time (sec.)
Nikon	8	900	37.5
LUMIX	8	1045	43.5
PENTAX	9	1125	46.9
SONY	9	1245	51.8
Olympus	7	930	38.7

TABLE 2: Presentation Details of Five DSLR Cameras.

3.4 Purchase Behavior Evaluation and Eye Tracking Experiment

60 college students were invited for the eye tracking experiment. Features of product forms of five DSLR cameras were played to collect the fixations subjects gazed at the product form images. Experimental procedure:

(1) For each subject, focus calibrations of the eye tracking system and LCD monitor were first conducted.
(2) Through homepage of the web-based 2-dimensional analytical tool, a briefing for the purposes of the experiment was introduced.
(3) Images of five DSLR cameras were imported to the system. Subjects were asked to place product images on the 2-dimensional scale according to their perceptions of product form attraction and their subjective purchase intention.
(4) During the eye tracking test, subjects were asked to speak out their preferences in product form features and functions, from which the product form features and functions of major competition products were identified.

4. RESULTS AND ANALYSIS

4.1 Major Competition Product Analysis

60 college students (30 males and 30 females) took part in the eye tracking test in which product form, logo, and price information are presented in different layers. With the coordinates of product samples in the test, the scatter diagram of five DSLR cameras was exported (Figure 3). The major competition product analysis reflects that along Y axis (attraction of product form), Nikon and Lumix were more attractive than the other three brands while Lumix was most competitive along X axis (purchase intention). Through such kind of scatter diagram, the major competition products can be prompted in real time for designers and marketing personnel.
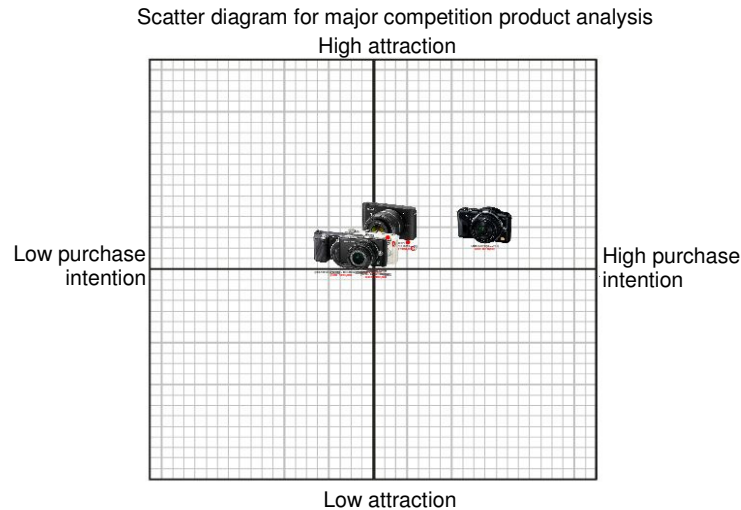
Scatter diagram for major competition product analysis

FIGURE 3: Major competition product analysis (layer with product price information).

With the coordinates of gravitation centers, and brands data of DSLR cameras, one-way MANOVAs were conducted. The result of MANOVA indicates that Wilks' Lambda F=16.604; p value=.000 (<0.05), meaning that there existed significant differences among 5 DSLR samples. Moreover, through marginal tests, it was found that these five samples were significantly different along X axis (marginal test F=29.363, P value =0.000<0.05) and Y axis (marginal test F=2.550, P value =0.039<0.05), meaning that there were significant differences among five brands of DSLR cameras in terms of product form attraction and purchase intention. In terms of product form attraction and purchase intentions, the average values are Nikon (1.39, 4.79), LUMIX (9.89, 4.03), PENTAX (-0.28, 2.14), SONY (-2.39, 1.97), Olympus (-0.95, 1.76). Furthermore, the Duncan post hoc test reflected that these five competitive samples could be divided into three clusters in purchase intention. Among them, Lumix (9.89, US$630) was of the relatively lower price and had the highest degree of purchase intention. In terms of product form attraction, Nikon and Lumix were of the cluster of highly attractive. From the results, it is clear that student user group will give a higher priority to buy Lumix whose price is much lower.

As far as price acceptability is concerned, the coordinates of Lumix were (4.73, 3.30) on Layer A where no price information was offered and (9.89, 4.03) on Layer B where price data was offered. The coordinate of Lumix image with price data fell to the right side of that of Lumix image without price data (Figure 4) means that consumers are more likely to buy this product. Furthermore, a pairwise t test was conducted for the comparison of purchase intentions (X axis). The result of t test (t= -5.38, P value=0.00<0.05) indicated that subjects thought Lumix was much more valuable. For subjects' preferences to Lumix's product form feature and functions, fixations and verbal descriptions subjects had for Lumix image on Layer A were further examined.
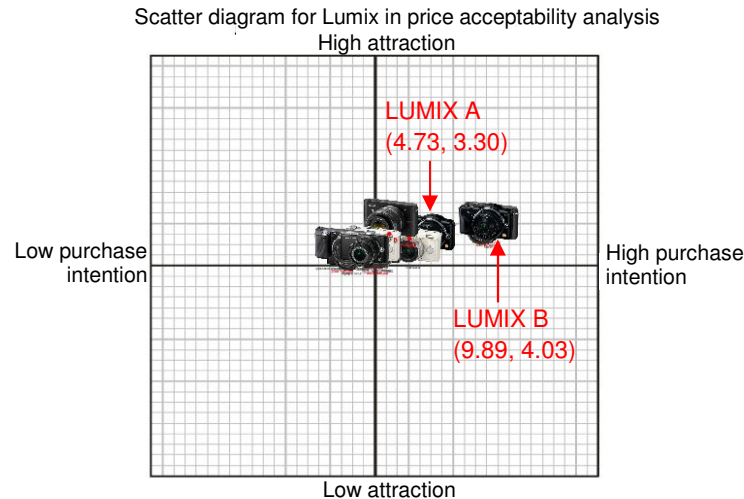
Scatter diagram for Lumix in price acceptability analysis

FIGURE 4: Scatter diagram for Lumix in price acceptability on Layers A and B.

4.2 Eye Tracking Data for Major Competition Products

Through the product form without price information in Layer A and the frequency of visual focus in eye tracking system and verbal descriptions from think aloud, which product form features and functions in major competition product Lumix attracted the subjects were explored.

In this study, areas of interest in product form of Lumix DSLR camera were defined. As illustrated in Table 3, the lens are denoted as pn1; curvatured handle pn2; lens switch button pn3; screen pn4; multiple circle shuttle dial pn5; curve above the lens pn6; pull up flash pn7, shutter button pn8; recording key pn9; iA key pn10.
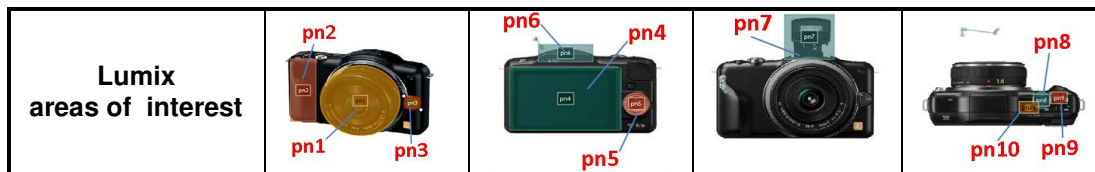

TABLE 3: Area of interest in product form of Lumix DSLR camera.

In this study, MV Analyzer in MangoldVision was used to analyze fixations of visual focus in areas of interest of Lumix product form. Through one-way ANOVA, there existed significant differences among ten different areas of interest in Lumix product form, F =42.7, P value =0.00<0.05. Further analysis was therefore conducted.

From post hoc of Duncan MRT, ten areas of interest in Lumix product form can be classified into two clusters. The first cluster includes the lens (pn1) (5414 ms, 32.8%), curvatured handle (pn2) (3570 ms, 21.6%), and curve above the lens (pn6) (2440 ms, 14.8%). The average fixation and percentage of frequency in these areas are significantly higher than those in other areas. Among these areas of interest, the lens (pn1) includes the following special functions: M4/3 system; 2X Focal length conversion ratio; support continuous focus in recording; autofocus speed can reach 0.18 seconds; support 3D camera and other users' needs. In addition, the curvatured handle (pn2) meets ergonomics design. Moreover, the design of front curve of the handle and the curve above the lens (pn6) are visually attractive. The accumulated fixations of these areas of interest (pn1, pn2, and pn6) reach 69.2% of the total fixations. To demonstrate the remarkable differences between these three areas and other seven areas of interest, pair-wise comparisons were conducted. The contrast coefficients of the pair-wise comparisons are 7, 7, -3, -3, -3, -3, 7, -3, -3, -3, and t=17.07, P value =0.00＜0.05, indicating that the areas of the lens (pn1), curvatured

handle (pn2), and curve above the lens (pn6) are significantly different from the other areas. They can be looked upon as the appealing items consumers pay more attention to.

Besides, twelve functions are offered for subjects' references in think aloud test while the Lumix images are played. These functions include (1) 2.1 MP Live MOS sensor; (2) M4 / 3 system, lens of 2X focal length conversion ratio; (3) recording supports continuous auto focus; (4) autofocus speed can reach 0.18 seconds; (5) 3D lens support; (6) fast 23-point contrast-detect auto focus; (7) iA intelligent scene mode; (8) fully manual control support; (9) RAW file supports; (1) 320 shots / per charge; (11) compact dimensions: 107.5 x 67.1 x 32.0mm; (12) light-weighted: 222g.

In this study, a score of 1 is assigned to the function item that is considered important by the subject and 0 for the function considered not important. The relative weight of each subject is set to 1 for variance verification. The result of one-way ANOVA indicates significant differences among twelve functions, F=18.47, P value =0.00<0.05. From post hoc of Duncan MRT, four clusters can be found. Among them, "3D lens support" (0.276) belongs to first cluster; "recording supports continuous auto focus" (0.177), and "iA intelligent scene mode" (0.172) belong to second cluster. These three functions are considered much more important than other nine functions. The function "iA intelligent scene mode" is a functional setting property of the software while the other two are related to characteristics of lens. This result confirms the finding in eye tracking system where subjects fix their eyes on lens (pn1) for the longest period of time. In other words, the lens is an important feature of product form and function of Lumix DSLR camera. Furthermore, pair-wise comparisons demonstrate that these two clusters are considered significantly more important than other two clusters (contrast coefficients are -3, -3, 9, -3, 9, -3, 9, -3, -3, -3, -3, -3; t=13.26; P value =0.00<0.05). Accordingly, from the opinions of consumers, "3D lens support", "recording supports continuous auto focus", and "iA intelligent scene mode" are the most important functions in Lumix DSLR camera.

4.3 Subject's Color Preferences Toward Nikon J1

To understand consumer's preferences of colors of DSLR cameras and to avoid too many choices of colors in a single series that may result in future inventory problems, five major colors of Nikon J1 are used for the test. 80 subjects were invited for this preference evaluation. The result indicated that the pink series of Nikon J1 (-6.44, -4.93) falling in third quadrant was least preferred. All of the other four color series fell in first quadrant, Red (5.05, 8.37), Whit (6.78, 7.27), Black (5.13, 4.42), and Silvery (2.90, 2.22). As can be seen in Figure 5, they are much more preferred.
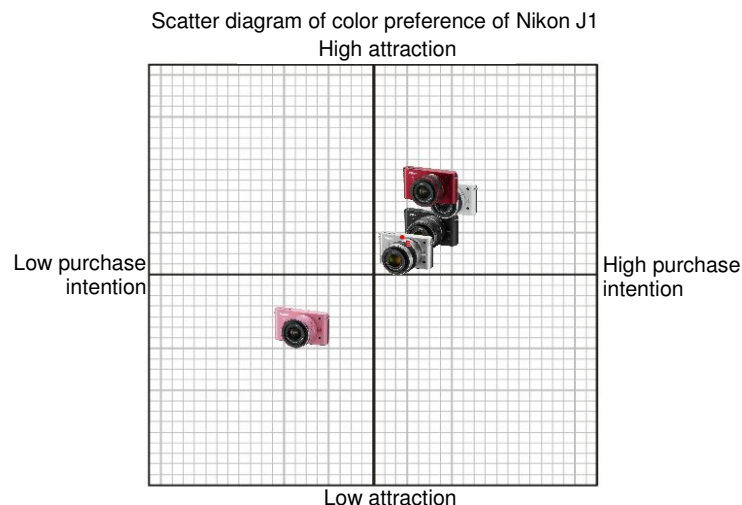

FIGURE 5: Scatter Diagram of Color Preference of Nikon J1.

To check whether there exist significant differences among five color series of Nikon J1, coordinates of 80 subjects in 2-dimensional analytical tool were used for the variable in MANOVA. The result demonstrated significant differences along X axis (purchase intention) (marginal test F=21.781, P value =0.000<0.05) and along Y axis (product form attraction) (marginal test F=34.728, P value =0.000<0.05). Furthermore, post hoc Duncan MRT reflected three clusters in purchase intention, the white, black, and red series are most preferred; silvery series the second; pink series the least preferred. In terms of product form attraction, three clusters can also be found: the red and white series are most attractive; black and silvery series the second; the pink series the least. From the above, it is clear that among five color series, red series (5.05, 8.37), and white series (6.78, 7.27) will be most favored; black and silvery series the second; the pink series (-6.44, -4.93) do not catch consumer's eyes. This result coincides with the cancelation of the pink series in recent media advertising.

5. CONCLUSIONS AND SUGGESTIONS

DSLR camera images of NIKON, LUMIX, PENTAX, SONY, and OLYMPUS were used for a 2-dimensional analytical tool to explore major competing products and product price acceptability of users. In this study, the evaluation tests were combined with an eye tracking system to take down the visual focus of subjects in viewing the product sample images to investigate the form features that attracted the subjects' eyes. In addition, subjects were asked to speak out why they preferred certain DSLR cameras in terms of the characteristics in their product forms and functions. At last, five color series of NIKON J1 were used for the color preferences of users for the color scheme of DSLR cameras in the future. Through the interactive interface in the web-based 2-dimensional analytical tool, images of five DSLR cameras were played with an aim to enable subjects fully understand the details of product form and to enhance the precision of measurement. Some major findings are listed below:

1. From the web-based 2-dimensional analytical tool and eye-tracking equipment, different areas of interest can be analyzed from a specific or few product samples. The form features in different AOIs can offer a different model for consumer preference analysis.
2. In major competition DSLR cameras, Lumix GF3 (US$630) had the highest degree of purchase intention. This indicates that product price is a top priority for college students. In terms of product form attraction, Nikon and Lumix are more attractive; their product form design features are worthy of designer's references.
3. According to the fixations in eye tracking test, different areas of interest in DSLR cameras will play different roles. In the case of Lumix GF3, the lens (pn1), the curvatured handle (pn2) and curve above the lens (pn6) are the product form features that will catch the consumer's eyes. Their gaze durations accounted for 69.2% of the total fixations.
4. From the verbal descriptions of think aloud, some functions are significantly favored by the consumers. For twelve functions of Lumix, one of the major competition products, "3D lens support", "recording supports continuous auto focus", and "iA intelligent scene mode" are the most important functions in Lumix DSLR camera.
5. In the color preference evaluation of Nikon J1, the red and white series are most attractive; black and silvery series the second; the pink series the least.

Because of the calibration process of eye focus on LCD screen, subjects are suggested not to move their heads as much as possible so as not to affect the accuracy of measurement. Therefore, it is suggested to control the eye tracking test during the range of 15~20 minutes.

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