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Gazing behavior, choice and color of food: Does gazing behavior predict choice?

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ABSTRACT

This study investigated the effect of food color on gazing behavior using eye-tracking technology and the correlation between gazing behavior and choice decision. Tobii T60 eye-tracker was used for analyzing the gazing behavior of consumers. Images of three different food products with three different colors each (yellow, green, pink) were used as stimuli. Seventy-three subjects were recruited; color blind individuals were excluded from the test. After the eye tracking procedure, the test persons had to decide which sample they preferred. Results show that the colors of the used food products significantly affected the gazing behavior and the choice. Fixation count and visit duration correlated significantly in a positive way with choice rate. This insight highlights the importance of visual attraction for the choosing behavior and it might open the chance to predict choice behavior measuring gazing behavior.

1. Introduction

Colors of food products have a high impact on visual preferences (Kildegaard, Olsen, Gabrielsen, Moller, & Thybo, 2011). The "first taste" in human is created based on the visual cues when gazing at food items (Clydesdale, 1991; de Wijk, Polet, Engelen, Vandoorn, & Prinz, 2004; Imram, 1999; Jaros, Rohm, & Strobl, 2000). Food color might influence the choosing behavior by eliciting certain expectations and feelings of appropriateness, but it also might modulate the gazing behavior, which itself might have an impact on decision making. Armel, Beaumel, and Rangel (2008) found that the relative amount of time that subjects fixated an item during a decision-making process increases the probability that the item will be chosen. The gazing behavior individuals pay to items like food products can be investigated using eye tracking technology (Gofman, Moskowitz, Fyrbjork, Moskowitz, & Mets, 2009). This method studied gazing behavior by inspecting eye movement and monitoring the focus of gazing behavior, based on defined areas of interest (AOI) within a visual stimulus (Salvucci & Goldberg, 2000). Important aspects of monitoring eye activities during respondents' viewing are where people's attention is attracted, how long the fixation position is captured within a defined region but also how often the AOI is revisited, and the time to first fixation (Henderson & Hollingworth, 1998).

Visual tracking technology can possibly be useful for receiving vital information about non-verbal and implicit reactions of consumers towards food objects. Gofman et al. (2009) used the so called "hot spot" technique to analyze the effect of several dimensions of packages such as font size, colors and locations of images on capturing the gazing behavior of the viewing individual. Moreover, Bialkova and van Trijp (2011) used to assess attention to information cues displayed front-of-pack. The attention bias of the eye movement and reaction time of overweight and normal-weight subjects to food and non-food images was studied by Castellanos et al. (2009). They found that both groups of subjects increased gaze duration for food compared to non-food images. Duerrschmid, Wallner, and Kneifel (2009) and Graham, Hoover, Ceballos, and Komogortsev (2011) studied the impact of low and high-calorie food images on gaze responses of normal weight and overweight women. Both groups did not differ in the average amount of time spent gazing at the different regions of the presented visual food stimuli. Haindl and Duerrschmid (2010) presented an U- or inverted U-model for the relations between eye tracking parameters and food quality status. Results revealed that spoiled products even attracted more attention than fresh food products.

To our knowledge of literature on consumers' eye movement pattern using eye tracking technology, there are few publication involving the effects of food coloration on gazing and choice behavior of consumers. Our experiment investigated the effects of color on consumers' gazing behavior and their choice decision. Images of food objects (desserts with three different colors each) were used as stimuli. A focus was laid on the relationship between gazing and choosing behavior. Therefore, three research questions had to be answered: (1) Does the

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color of food samples have an impact on gazing parameters? (2) Does the color of samples have a significant impact on the choosing behavior? (3) Is there a relation between gazing behavior parameters and choosing behavior?

2. Materials and methods

2.1. Subjects

Sixty males and fifty-eight females (students or staff at the University of Natural Resources and Life Sciences in Vienna) participated in this study. Subjects suffering from any kind of color blindness or subjects failing in the eye tracking calibration procedure were excluded. Detecting color blindness the method of Velhagen and Broschmann (2003) was used. For calibration procedure, subjects had to follow a red dot on the screen with their eyes. The dot was moving from the screen center to the corners. This procedure allows the eye tracker to adjust the analysis algorithm to the specific eye configuration of the tested individual. The final number of subjects was 37 males and 36 females; they passed calibration and their data showed eye tracker recording quality over 75%. Their age ranged from 18 to 50 with a mean age of 26.3 ± 5.6 years.

The study was performed in appliance with the ethical guidelines for scientific research of University of Natural Resources and Life Sciences, Vienna. The subjects were informed about the testing procedure before the test and about the aims of the experiment after the test with the option to delete the data, if the test person would not agree to participate in a test with these aims; all test persons gave a written informed consent.

2.2. Stimuli

Three kinds of Thai desserts were prepared freshly for taking the eye tracking pictures (product 1–3). The main ingredients of each dessert are listed in Table 1. Colors and their concentrations used in the formulas were selected based on traditions of preparation. Artificial colorants (Winner brand, Thailand) used in all samples were green, pink and yellow. Colorant concentrations used for yellow and green were 0.1% (w/v) and that for pink was 0.05%. Images of each sample were taken with a Canon EOS 400D digital camera after preparation. Images were placed on a white plate in front of a black background; the samples were adjusted for scale, contrast and color using Adobe Photoshop CS5.

2.3. Color measurement

Colors of all samples were measured by using a LMG051 Micro Color (Dr. Lange, Düsseldorf, Germany). In the CIELAB system, L^* indicates degree of lightness or darkness ($L^* = 0$ indication perfect black and $L^* = 100$ indicating perfect white); a^* and b^* indicate degree of redness or greenness and yellowness or blueness, respectively and chroma (C^*) indicates degree of color saturation and is equal to zero at the center of the color space and increases based on the distance from the center (Lawless & Heymann, 2010).

2.4. Testing procedure

The Tobii T60 eye tracking device and Tobii Studio software (version 3.0.5, Tobii Technology AB, Sweden) were used for recording and analyzing the gazing behavior of consumers. The stimulus images of the dessert products were shown on the eye tracking monitor (17 in., 1280×1024 pixel resolution). Subjects took a seat in front of the eye tracker screen with their face at a distance of approximately 70 cm. They were instructed to look at the pictures at the monitor in a relaxed way and not to move too much. Each test started with an instruction text on the screen. In order to define the starting point of gazing, a central fixation cross was displayed between the instruction texts and also between the following food images for two seconds. Pictures of the three color variants of one product were shown separately with a display time for eight seconds to highlight visual appearance. Then, an image containing all three color variants of this product on three different positions (left, right and bottom) were displayed for 15 s (see Fig. 1 for an example). The position of the color variants was randomized for subjects. This was repeated for all three products.

After completing the eye-tracking procedure, subjects were asked to look at food images on the monitor showing the three differently colored products (green, pink, and yellow) and to choose the most preferred color variant for each product.

2.5. Data analysis

All statistical analyses were performed using SPSS version 21 for Windows (IBM Corporation, Armonk, USA). Five parameters of gazing behavior were collected: 1) *time to first fixation* (TFF, the time from the start of the media display until the test participant fixated on the area of interest (AOI) [seconds]), 2) *first fixation duration* (FFD, duration

Table 1
Thai desserts used in this study.

	Sample	Characteristics	Ingredient	Cooking method
	Product 1 (*Pui-fai*)	This is a muffin-style dessert with 3 to 4 cracks on the surface. Taste is sweet and texture is very soft.	Wheat flour (34%), condenser milk (12%), baking powder (1%), water (19%), emulsifier (3%), egg (3%) and sugar (30%)	Steam at 95 °C, 25 min
	Product 2 (*Khao-naeow-gaow*)	Sticky rice, which is sweet and has a coconut flavor.	Glutinous rice (62%), coconut milk (17.50%), salt (0.5%) and sugar (20%)	Heated stir at 50 °C, 20 min
	Product 3 (*Kha-nom-shun*)	It is usually made of nine layers, white ones alternating with layers of another color. Taste is sweet, texture is smooth and sticky.	Tapioca flour (12.50%), corn flour (3.75%), rice flour (3.75%), coconut milk (37.50%), water (13.75%) and sugar (28.75%)	Steam at 95 °-C, 15 min a layer