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Can pupil size be measured to assess design products?

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ABSTRACT

Some studies assessed aesthetic appreciation by pupillary measurement. While design judgments are also a kind of aesthetic appreciation, design products might be suitable for assessment in pupillary measurement as well. Hence, this study explores the relationship between pupil size and user subjective opinion using forty-eight International Affective Picture System (IAPS) images and forty-eight product images as stimuli. The stimuli are composed of positive, negative, and neutral images. For each trial, participants viewed scrambled versions of image and then viewed unscrambled versions (target image). The pupil sizes of participants were measured while viewing target image. After viewing target image, participants rated immediately their emotional response to the target on a 7-point scale.

The results indicated that the two classes of stimuli, IAPS and opener images, caused different variations in pupil sizes. The result of IAPS herein concerning the effect of emotion on pupil size is similar to that identified in prior research. However, product pictures yielded different results from IAPS pictures. The measurement of pupil size cannot distinguish between positive and neutral emotional responses. Negative emotional responses to products were reflected weaker than the other emotional responses. The pupillary responses were not similar viewing negative images of IAPS that pupillary variation was larger than neutral pictures. Taken together, the findings of this study support the claim that pupil size can be measured to assess products.

Relevance to industry: Since pupil size can be used to distinguish products that would elicit negative emotion, thus, on-line shopping service provider can measure customer's pupil size through laptop's camera to determine whether they dislike the product.

1. Introduction

Better-designed products attract more customers and communicate more effectively with them than products that do not satisfy user's need. Their value is increased by improving their quality and the experience of their users (Bloch, 1995). Accordingly, the fabrication of products that induce affective user reactions is an important issue in current design research. For example, since products can elicit strong emotional responses (Girard and Johnson, 2009), an increasing number of designers, engineers and marketing researchers have noted that products should be designed to satisfy various requirements and the extreme psychological needs of the users (Siu, 2005). Thus, satisfying the affective needs of customers is crucial to a company's success (Hsiao and Liu, 2002). Furthermore, a consumer's psychological responses to a product are affected by the product's appearance (including, size, shape, and color), and the emotional elements of the design. The response to the latter is related to the complex brain structure that is involved emotional processing (Crozier, 1994; Norman, 2004). Therefore, recent investigations have explored affective responses to product shapes. These studies have addressed how emotional responses may be evoked through the design of semantic applications to products (Demirbilek and Sener, 2003) as well as the fundamental dimensions of affective responses to product shapes (Hsiao and Chen, 2006). They have emphasized the way in which designers communicate with, and evoke responses from, consumers. Accordingly, understanding the emotional responses that are elicited by products and the effects of emotion on product usability is essential to product design.

Schifferstein and Desmet (2007) suggested that vision receives the largest amount of information about a product and it does so most quickly. Therefore, most of the feelings that are elicited by a product are mediated by initial visual perception. Additionally, researchers also found that vision is the most important sense in the product-buying experience (Fenko et al., 2010). As Norman (2004) argues that at first sight, people may say, "I want it"; they may then

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ask, “What is it?”; then, they may ask, “How much is it?” In this context, a customer’s subjective feelings are more important than their objective decisions about goods price in policy-making.

Kansei Engineering or Kansei ergonomics recognizes the consumer’s feelings and needs, and translates their feeling and demands into the product design domain (Nagamachi, 2002). In Kansei Engineering, “Kansei” refers to a customer’s psychological responses to a product (including security, luxury, confidence, satisfaction and others) (Nagamachi, 2002). Recently, Kansei Engineering has been primarily concerned with relationships between affective images and product shapes. It has been successfully applied in various design domains, such as the design of vehicles (Jindo and Hirasago, 1997), office chairs (Jindo et al., 1995), booth show (Huang et al., 2011), and to investigate differences between designers’ and users’ perceptions of semantic differential products (Hsu et al., 2000).

Kansei Engineering utilizes questionnaires to extract users’ subjective opinions or data about products in the form of adjectives. Designers can transform an adjective (Kansei) into a corresponding shape. However, in some cases, participants may have difficulty in verbalizing emotions that are elicited by products. Some investigations have attempted to avoid this problem by adopting cartoon patterns (a non-verbal instrument) instead of adjectives to emotional responses (Desmet et al., 2001; Desmet et al., 2007). In spite of this fact, questionnaires are the most frequently used research tool in this field. However, data using this tool are easily affected by the respondent’s surroundings and voluntary participation. Some participants may not be able clearly and completely to explain the differences among products (Laparra-Hernandez et al., 2009). Others may provide a false opinion if they do not want to express their true feelings or they feel inhibited (Czerwinski et al., 2001; Nielsen and Levy, 1994). Yet others may substantially change their stated opinions if they answer questionnaires under an implicit stress process (Regueiro and León, 2003). Hence, the results of such a study will not convey the truth, and then mislead the direction of design.

To identify the original feelings of participants, research on physiological measurements has focused on a user’s perceptual responses to stimuli, since user perception is strongly related to user emotion. People cannot easily control their physiological signals voluntarily. Thus, some studies have veered away from the traditional use of questionnaires to gauge user emotions and have instead made physiological measurements of subconscious signals to gauge user preferences. Current research on physiological measurement involves electromyography (EMG), galvanic skin response (GSR), electroencephalography (EEG), heart rate (HR), blood pressure (BP), temperature, and respiration rate (Berntson et al., 1993; Laparra-Hernandez et al., 2009).

Hess (1965) found that the variation in a user’s pupil size can reveal interest in an object. Some psychological investigations have attempted to exploit pupil response by measuring variation in pupil size to evaluate emotional responses that are evoked by visual stimuli (Bradley et al., 2008; Hess and Polt, 1960; Partala and Surakka, 2003). Much of the previous research on the relationship between affective stimuli and pupil size has been controversial. Early research suggested that dilating pupils indicate a positive stimulus, and contracted pupils indicate a negative stimulus (Hess, 1965; Hess and Polt, 1960; Janisse, 1974; Mudd et al., 1990). Other more recent investigations have indicated otherwise. Changes in pupil size were larger than neutral when emotionally arousing stimuli were viewed, regardless of whether the associated emotion was positive or negative (Bradley et al., 2008; Janisse, 1974; Partala et al., 2000; Partala and Surakka, 2003; Steinhauer et al., 1983). As these studies have established, if stimuli are emotional objects, then they will cause a pupillary response; however, whether such a response is caused by positive or negative emotions cannot yet be determined from the response alone.

In summary, pupillary responses have been reliably investigated (Kuchinke et al., 2007), and the performance of tasks that evoke pupillary responses has been shown to be sensitive to cognitive processes (Beatty and Kahneman, 1966; Granholm et al., 1996; Nuthmann and Van Der Meer, 2005). Accordingly, pupillary response can be regarded as an index of the strength of the relationship between processing load and emotion (Beatty, 1982). There are also aesthetic appreciation studies used pupillary measurements to assess aesthetic preferences. For example, recent research into the appreciation of art has indicated that pupillary responses are affected by aesthetic emotions (Kuchinke et al., 2009). Furthermore, an investigation that involved Mondrian’s paintings found that aesthetic preferences correlate with pupil size (Nagai and Georgiev, 2011). These studies of aesthetic judgment supported the viewpoint of Hess (1965) – people will have large pupillary variations when they appreciate the art works that they are looking at. Although relatively little research has been done on the assessment of design products, design judgment is also a kind of aesthetic preferences. Hence, using pupillary measurement to assess aesthetic appreciation might also be suitable for design judgment. However, previous research suggested that the intensity of affect evoked by product is weaker than image involving people (Bradley and Lang, 2007), and the most research of affect and perception focused on the objects evoking strong intensity of emotion (e.g., guns or roses) but not everyday products that are micro-valence stimuli (Lebrecht et al., 2012). It is not sure whether the intensity of affect evoked by everyday product is suitable for assessments on pupillary responses. Hence, the main purpose of the work presented in this paper was to check the capacity of pupil size variation as an index of physiological signals to evaluate an everyday product, i.e. opener.

2. Materials and methods

2.1. Participants

Thirty-two students with two years of design experience were recruited as volunteers from a university industrial design department. Data from some participants had to be discarded because of equipment malfunctions during the recording of information about the pupil. Therefore, the results of IAPS are based on data that were collected from 28 participants (16 females and 12 males, mean age 25.75 years, range 20–35 years). The results about products are based on data that were collected from 31 participants (17 females and 14 males, mean age 25.8 years, range 20–35 years). The participants gave informed consent and received NT$ 150 NT (approximately 5 USD) for their participation. The participants had not smoked cigarettes or drunk caffeinated beverages for two hours before the testing session. Additionally, none of them reported any injuries, diseases, or previous eye surgery. All reported normal or corrected-to-normal vision. Participants had to have a design background because they had to be sensitive to changes in product image and characteristics of products.

2.2. Stimulus materials

Stimuli fell into two categories. Since many previous studies of affect utilized images from the International Affective Picture System (IAPS) database as stimuli (e.g. Bianchin and Angrilli, 2012; Lithari et al., 2009; Purkis et al., 2009), this study also use images from the same database. Moreover, basing on the Lang et al. (2008) who selected 96 pictures from the IAPS images, this study selected the same pictures but remove culture-sensitive stimuli (e.g. sexual