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Applying event related potentials to evaluate user preferences toward smartphone form design

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Product forms can affect user preference and play an important role in user's purchasing decisions. Neuroimaging methods can provide an improved understanding of the mechanisms of decision making, which enhance the ability of enterprises to effectively design their products. Hence event related potentials (ERPs) were applied to explore the brain activity evoked by variety of product forms when users made preference among them. Smartphone product forms were displayed with equiprobability randomly. Participants were asked to click the left mouse button when they preferred one product form, else the right button for nonpreferred. The brain signals of each participant were recorded by Curry 7.0. Finally, brain signals were processed by using Curry 7.0 SBA and SPSS 18.0 software. The results showed that preferred product forms evoked enhanced N2, P2 and P3. Moreover, there were significant correlation between ERPs and behavioural data, participants devoted more attention and had faster responding time to preferred products than to nonpreferred. These results indicate that the differences of ERPs can be used to evaluate user preference.

Relevance to industry: The integration of customer preferences is nowadays a challenge in new product development. Hence a thorough research on the inherent mechanism of preference formation can provide an accurate measurement method of user's perception. The differences of brain signals evoked by product forms can also provide technical support for product designers, which in turn can meet with user experience. Moreover, the results can be taken as evaluating indicators of product design.

1. Introduction

User's decision to use a product is motivated not only by its functional competence, but also positive experience by its physical appearance (Yadav et al., 2013; Wu et al., 2014). The product appearance plays an important role in users' preference and purchase (Chuang et al., 2001; Lin et al., 2007; Ming et al., 2001). This is largely because that “what the product looks like” before purchasing is more important than product price in policy-making (Ho and Lu, 2014; Borsci et al., 2016). As Norman (2004) pointed out that, only if a product catch user's first sight or attention will “what is it?” and then “how much is it” happen. Moreover, sales platforms such as the Internet cannot provide users real interaction but visual perception of product appearance alone (Diego-Mas and Alcaide-Marzal, 2016). It is reasonable to assume that consumer preference for a product is mainly based on the form features (Shieh and Yang, 2008; Ming et al., 2001). Hence, it is crucial for designers and marketers to capture and characterize user preference of product form. And user preference measurement has received much attention in both academia and industry.

The affective aspects, potential and intuitive feelings contained in user preference bring challenges for evaluation. Traditionally, subjective methods are mostly used for user preference measurement, such as emotional questionnaire (Agost and Vergara, 2014), fuzzy decision support system (Alptekin, 2012; Hsiao and Ko, 2013), semantic differential and Kano's model in Kansei engineering (Llinares and Page, 2011) and so on. However, these methods have limitations for the assumption that people are actually able to describe their cognitive process without considering users' affective and intuitional responses (Ariely and Berns, 2010; Calvert and Brammer, 2012; Ding et al., 2016). These methods are underpowered to measure user preference accurately. With the characters of subjective, involving emotion, dynamic and often formed intuitively without explicit reasoning (Chuang et al., 2001; Bhushan et al., 2012; Agost and Vergara, 2014), more accurate methods are

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needed to measure user preference.

Based on this motivation, several studies measured preferences for products using physiological and neural responses (Ohira and Hirao, 2015; Khushaba et al., 2013; Javor et al., 2013). Wang and Minor (2008) summarized the validity, reliability and applicability of physiological techniques in marketing research, including eye movement, heart rate, blood pressure, facial muscle activity, voice pitch analysis and brain imaging. These methods collecting data from physiological aspects can give consecutive and real-time information produced by organs and accompanied by emotions (Bailenson et al., 2008; Ding et al., 2016). Among those indexes, brain responses can provide information not obtainable via conventional marketing research methods (e.g., interviews, questionnaires, focus groups) (Ariely and Berns, 2010). For evaluation of product preference, physiological indexes such as neuroimaging methods should have potential for measuring affective factors. In such cases, the effectiveness of product form design may be evaluated by monitoring people's brain activity resulting from observing different products. However, there is a substantial lack of research studying the neural mechanism of preference aroused by product forms (Céline, 2013).

In this challenging context, brain imaging has offered promising methodological alternative. There are several techniques for collecting brain activity data, in which event related potentials (ERPs) and functional magnetic resonance imaging (fMRI) are the most used methods (Sylcott et al., 2013; Daliri, 2013). In fMRI, hemodynamic responses reflect the perception and cognition of object presented, and are used to predict user preference (Kenning and Plassmann, 2008; Van der Laan et al., 2012). The previous studies revealed that the signals related to user preference of a single object from different brain areas have overlaps (McClure et al., 2004; Sylcott et al. (2013); Hampton et al., 2007; Van der Laan et al., 2012). These fMRI studies on preference tended researchers to use ERPs for user preference.

Compared to fMRI, ERPs is more appropriate for brain data collection for lower cost of experiment design and at very high temporal resolution (even to 10,000 times per second) (Plassmann et al., 2007; Morin, 2011; Daliri, 2013). In the experiment, electrodes are placed on the scalp of a participant by using an electroencephalograph (EEG) cap. Then ERPs can be obtained through subsequent processing which can reflect people's psychological activities (Luck, 2014). An ERP waveform is labelled by the polarity (Positive or Negative), latency and distribution over the scalp (Daliri, 2013). “ERPs reflect brain activity from synchronously active populations of neurons that occurs in preparation for or in response to discrete events, be they internal or external to the subject.”(Fabiani et al., 2000).

With the development of ERPs, they are regarded as neural manifestations of specific psychological functions (Fabiani et al., 2000; Treleaven-Hassard et al., 2010; Luck, 2014). Handy et al. (2010) pointed out that earlier P2 (peaking around 200 ms poststimulus) and the late positive potential (beginning around 400 ms poststimulus) are sensitive to emotional stimulus and can reflect whether participants like a logo. Herbert et al. (2006) pointed out that P2 and P3 potentials are larger for both positive and negative valence stimuli relative to a neutral valence baseline. While in the study of Wang et al. (2012), larger P2 amplitudes are evoked when participants browse beautiful pendants than ugly in frontal, central and parietal lobes. In the process of subjective evaluation, negative stimuli can elicit smaller P2 amplitudes (Yuan et al., 2007). Lindsen et al. (2010) found that larger late positive potentials are evoked by attractive faces compared to less attractive. Patel and Azzam (2005) reviewed studies about N2 and P3, which appear to be closely associated with the cognitive process of perception and selective attention.

From the above studies, the explanations of neuroimaging data are varied with the differences of stimuli, experimental paradigm or subjects (Solnais et al., 2013). And this method might infringe personal privacy to a totally unacceptable degree (Lee et al., 2007). But a lot of researches investigated the changes in brain activity while participants observe brand, products or TV advertising (Ma et al., 2010; Khushaba et al., 2013; Handy et al., 2010; Treleaven-Hassard et al., 2010). However, previous studies of affective evaluations have predominately relied on using stimuli (e.g. faces, pictures and words) which were deliberately selected for having strong emotional valence (Handy et al., 2010). Hence, what about daily products, what kind of visual products can engender a sense of good feeling or user preference? How product forms affect people's neural responses is still unclear (Céline, 2013).

With the narrow differences between smartphone forms, users cannot totally describe why they prefer one than others. Hence, based on previous studies in neuroscience and preference, ERPs was applied to investigate user's brain responses when they made preference among several product forms. In the experiment, smartphones forms were designed according to popular products mainly different with each other in screen size, colour and edges and corners. Then six smartphone forms were screen out preliminarily according to the whole visual experience. And these six smartphones were selected as stimuli in the ERPs experiment to analyse the neural activities during assessing user preference. And hypothesis was made that product form judged as preference could yield different neural activity for several ERPs components compared to nonpreferred as well as behavioural level.

2. Research method

2.1. Participants

Fourteen healthy right-handed students (7 males, range 24–32 years, mean age 25.4 years, SD = 2.13) from Northeastern University majoring in management science and engineering with a background of ergonomic were recruited as participants. They were all with normal or corrected-to-normal vision and without history of neurological or psychiatric disorders. They all signed written consent forms to participate before the experiment and received a gift worth about 5 $ as compensation.

2.2. Stimuli

By analysing the form features affected user's visual experience of smartphone, screen size, colour and edges and corners are the key indexes (Yun et al., 2003; Tsai and Ho, 2013). According to these features, several stimuli were designed by Pro/ENGINEER Wildfire 5.0 (PTC) software. Finally six smart phone pictures with difference in the whole feeling were selected, the subjective evaluation is based on the method of Guo et al. (2016). The size of pictures is set to 700 × 460 pixel, which made the smart phones more realistic-looking. The pictures are browsed with the same angle. Fig. 1 gives the details of each stimulus and all of the stimuli have the same thickness (8.7 mm).

2.3. Procedure

Participants sat in front of a computer screen comfortably in a quiet room with soft light and they were asked to focus on the central of the screen. The participants viewed the stimuli from a distance of 70 cm and had a visual angel of 11.4° × 5.9°. The task was programmed and presented by using E-Prime professional (vision2.0, Psychology Software Tools). Stimuli were displayed randomly, and manual responses to the target were made by