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Using event related potentials to identify a user's behavioural intention aroused by product form design

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ABSTRACT

The capacity of product form to arouse user's behavioural intention plays a decisive role in further user experience, even in purchase decision, while traditional methods rarely give a fully understanding of user experience evoked by product form, especially the feeling of anticipated use of product. Behavioural intention aroused by product form designs has not yet been investigated electrophysiologically. Hence event related potentials (ERPs) were applied to explore the process of behavioural intention when users browsed different smart phone form designs with brand and price not taken into account for mainly studying the brain activity evoked by variety of product forms. Smart phone pictures with different anticipated user experience were displayed with equiprobability randomly. Participants were asked to click the left mouse button when certain picture gave them a feeling of behavioural intention to interact with. The brain signal of each participant was recorded by Curry 7.0. The results show that pictures with an ability to arouse participants' behavioural intention for further experience can evoke enhanced N300 and LPPs (late positive potentials) in central-parietal, parietal and occipital regions. The scalp topography shows that central-parietal, parietal and occipital regions are more activated. The results indicate that the discrepancy of ERPs can reflect the neural activities of behavioural intention formed or not. Moreover, amplitude of ERPs occurred in corresponding brain areas can be used to measure user experience. The exploring of neural correlated with behavioural intention provide an accurate measurement method of user's perception and help marketers to know which product can arouse users' behavioural intention, maybe taken as an evaluating indicator of product design.

1. Introduction

Industry never stops research on new and improved products from user's aspects. Users face a vast number of diverse products which are similar in forms or even interactions. Products that sell well in the market implicate a consideration of user experience (e.g. emotion, meanings, and positive actions) into product design (Seva et al., 2007; María-Jesús and Margarita, 2014). Product design should not only satisfy user's needs from usability (Kuijk et al., 2015) but the ability to grasp user's attention at the first sight, and finally trigger the feeling of anticipated use of product (i.e. behavioural intention). As Norman (2004) pointed out that only if a product arousal user's intention or positive feelings will "what is it?" and then "how much is it" happen. Recently, user's needs of experiential aspects such as emotion, aesthetic experience, desire to use, positive feelings and so on has been a focus in product design (Seva et al., 2011; Hassenzahl and Tractinsky, 2006; Law et al., 2014; María-Jesús and Margarita, 2014).

The process of user experience can be divided into using and anticipated use processes based on the definition of "perceptions and responses resulting from the anticipated use and/or use of a product" (ISO 9241-210, 2010). While most of the researches focused on the using process, the anticipated use process has received limited attention. If a product cannot arouse a user's behavioural intention, further interaction with product would not go ahead. Behavioural intention is the sole determinant of actual behaviours occurring (Davis, 1989), namely earlier perception of product attributes will colour later evaluations of other characteristics (Mugge and Schoormans, 2012).

Behavioural intention has been researched for decades. TRA (theory of reasoned action) (Fishbein and Ajzen, 1975) and TAM (technology acceptance model) (Davis, 1989) are best-known

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researches of behavioural intention. Lots of researchers investigated the factors effecting behavioural intention. Venkatesh and Davis (2000) studied the processes of before using, first introduced and three months after using of product. Questionnaires were used to obtain user's perception and feeling, they found that social influence processes and cognitive instrumental processes significantly influenced user's behavioural intention. Venkatesh et al. (2012) promoted a united theory of acceptance and use of technology according to TAM, and found factors affecting user's behavioural attention by questionnaires such as price, habit, hedonic, etc. These studies explored the relationships between behavioural intention and evaluation of products. However, there is a substantial lack of researches studying the neural mechanism of behavioural intention aroused by product forms (Céline, 2013). Moreover the subjective methods and survey cannot completely reflect a user's real feeling, in addition, numerous factors motivate participants to distort the reporting of their feelings (e.g. time pressure, memory ability and incentive) (Morin, 2011). Unfortunately, there exists bias in the results for the assumption that people are actually able to describe their cognitive process. The results totally depend on users' willingness and competency to describe how they feel when they are exposed to a product (Ariely and Berns, 2010; Calvert and Brammer, 2012; Guo et al., 2015). Generally, behavioural intention is a potential and intuitive feeling, or even without rational reasoning and hard to describe with words. Hence, more accurate methods are needed to measure user's inner intention even unconsciously formed.

In this challenging context, brain imaging has offered promising methodological alternatives. There are several techniques for collecting brain activity data, in which electroencephalography (EEG) and functional magnetic resonance imaging (fMRI) are the most used methods (Sylcott et al., 2013; Daliri et al., 2013). As one of the well established non-invasive methods for measuring and mapping brain activity, EEG is more appropriate for brain data collection for lower cost of experiment design and at very high temporal resolution (Daliri et al., 2013; Daliri, 2013; Morin, 2011). In the experiment, electrodes are placed on the scalp of a participant by using an EEG cap. Then event related potentials (ERPs) can be obtained through subsequent processing which can reflect people's psychological activities (Luck, 2014), are the sum of electrical responses of EEGs in response to some cognitive events with three key parameters: Amplitude, latency, and distribution over the scalp (Daliri et al., 2013). Studies pointed out that visual attention-related brain activities evoked by stimulus could reflect user's cognition even with a low level of attention (Kawasaki and Yamaguchi, 2012) and can be regarded as the signature of detection and identification of objects (Daliri et al., 2013; Behroozi et al., 2015; Taghizadeh-Sarabi et al., 2015).

And with the development of neurophysiology and mature of measurement techniques, there are more researches to investigate consumer's behaviours and decisions from brain cognition in product design (Morin, 2011). For example, Handy et al. (2008) explored the human neurocognitive systems of commercial branding images evaluation by ERPs. They found that hedonic evaluations of everyday images are rapid and implicit, and the images disliked appear to stand out. Sylcott et al. (2013) used fMRI to determine what parts of the brain are primarily involved with a given trade-off between form and function. In the past, ERPs has been used to investigate how product characteristics such as brand, price and packaging affect consumer decision (Sylcott et al., 2013). Whereas these studies focus on the judgment process of users, in the current study we focus on whether product form designs can arouse user's behavioural intention or not.

This research seeks to investigate the neural responses in the perception of product form design, namely features can give users good first impression (Lin et al., 2007) or arouse their behavioural intention (Davis, 1989), on which users choose a product mostly depend. In this study, ERPs and behavioural data were combined to inform designers the forming process of user's behavioural intention. Participants were asked to pick out the smart phone pictures that could arouse their behavioural intention and click the left mouse button. At the same time, the EEG signal of each participant was collected. Finally, ERPs obtained in two conditions (intended and no response) were compared. This study did not consider the influence of price and brand because the objective is to investigate the brain activity evoked by product form designs.

2. Research method

2.1. Participants

The understanding of sex differences in processing of visual information (Kret and De Gelder, 2012) is beyond our aim and is a topic for future study, so eleven healthy right-handed males (aging from 21 to 26 years, mean age of 23.8, SD = 2.14) 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 as compensation.

2.2. Stimuli

The stimuli were designed by Pro/ENGINEER Wildfire 5.0 (PTC). Finally four smart phone pictures with differences in the whole feeling were selected and another five were picked from websites. The Adobe Photoshop® 7.0 was used to eliminate the brand loyalty. The resolutions of pictures were set to 700 × 460 pixel, which made the smart phones more realistic-looking. The pictures were browsed with the same angle.

2.3. Procedure

Participants sat in front of a computer screen comfortably in a quiet and soft light room 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 using E-Prime professional (vision2.0, Psychology Software Tools). Stimuli were displayed randomly, and manual responses to the target were made by pressing the left mouse button when a smart phone picture can give him a behavioural intention for further user experience. Each picture was repeated 40 times, and the task paradigm of experiment was shown as Fig. 1. The representation time of smart phone pictures was 800 ms, and 1000–1200 ms for blank screen. There were four times of rest. The entire experiment lasted about 35 min, including electrode placement and instructions.

2.4. Electrophysiological recording and analysis

The EEG signals were continuously recorded using Neuroscan EEG system (Neurosoft Labs Inc) with 21 Ag/AgCl electrodes (Fig. 2). The electrodes location was based on an expanded version of the international 10–20 electrode placement system. A reference electrode was placed on the left mastoid with the midpoint of FPZ and FZ location as the ground. Vertical and horizontal electro-oculographic activity (EOG) was recorded with additional electrodes located 1.5 cm above and below the left eye and 1.5 cm outside the outer canthi of both eyes. All EEG electrode impedances