P300 and categorization in brand extension

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Abstract

Brand extension is the behavior of applying an established brand to enter new product categories. Its success depends on the perception of attribute similarity between the original brand and the extension product. In this study, 16 participants were required to decide the suitability of extending the brand in stimulus 1 to the product category in stimulus 2 during a S1–S2 paradigm. S1 consists of 15 well-known beverage brands. S2 consists of products in two categories: beverage and non-beverage. P300—an important component of ERP—was elicited in all probes. The P300 amplitude was larger and distributed over almost all parietal and occipital regions when S2 is a beverage product. The P300 amplitude, however, was smaller and presented predominantly over the right regions when S2 is a non-beverage product. We speculate that the participants’ decision process is a categorization process: they tried to classify the product in S2 into brand category in S1. In this process, the brand name in prime evoked the memory of specific products, and the neurons in corresponding cortex areas were activated. The higher similarity and coherence between the brand name in prime and the product name in probe produced an overlap of the similar stimuli in prime and probe, which resulted in larger P300. Otherwise, there is no overlap, resulting in smaller P300. Hence, the P300 may potentially be used in marketing research as an endogenous neural indicator of measuring consumers’ attitude towards an intended brand extension.

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Brand extension is the use of established brand names to enter new product categories or classes [15]. Categorization theory has explained the transfer of affection between an existing brand and an extension product which results in the positive evaluation by consumers [10,9]. According to this theory, individuals classify objects into different categories for a better understanding and processing (see [23], for a review). A person can transfer the attitude towards a category to a new object, if the object can be classified as a member of that category [7]. Many different objects belong to a common category [3], e.g. black tea and juice belong to “beverage”, while bread and cake belong to “bakery”. An existing brand concept (functional, symbolic or experiential) can constitute a mental category [4]. In categorization theory, Fiske and Pavelchak (1987) found that there is a dual process mechanism for attitude formation for brand extension [10]: (i) category-based processing which depends on the general similarity; (ii) piecemeal integration processing which depends on similarity of inferred scattered attributes. If consumers perceive an overall similarity of attributes between the original and extension product classes, the category-based processing will help them transfer quality perceptions of original brand to the new product (extension product) quickly; if not, the piecemeal integration processing will try to find the nonfigurative common ground in some aspect (see [15], for a review).

There are several explicit evaluation techniques to test consumers’ reactions to brand extensions, such as focus groups and surveys, and similarity judgments by category membership. Few implicit indicators, however, were used to measure the perceiving fit or similarity between the existing brand and extending products except reaction times [6] and eye movements [24] (see [5,11], for a review). In particular, no endogenous neural indicator has been used to measure the similarity between original brand and extending products.

Many components of ERPs are endogenous, which can be used as signals for both the conscious and unconscious components of the human attention and memory systems. Given that the categorization theory is based on the associative memory model...
The associative memory model describes memory for the experiences we have for a brand or a product as being stored in a series of nodes. An individual node may be linked to one other node or to a whole group of nodes. For instance, a node that contains information concerning soda pop might be more connected to nodes concerning the Coca-Cola brand than bread does. With the prime of a brand, the target stimulus of extension product will evoke the associated nodes’ pathways between the product and brand category. Closer perceived fit or similarity between original brand category and extension will overlay more associated nodes [19] and lead to higher evaluations of the extension. Recent studies with fMRI in neuromarketing suggested that the hippocampus and dorsolateral prefrontal cortex might be crucial for the emotional association of culturally familiar brand information [18,1]. But few neuroimaging literatures studied the categorization mechanism, which is much different from brand emotion mechanism in prefrontal cortex, between the brand and the extension products.

P300 is a positive potential with peak latency between 300 and 1000 ms providing a great deal of information about the neural activity of fundamental cognitive operations, especially the activity of updating of working memory [8] and orienting response [21]. Its amplitude reflects the allocation of attention resources [13], and its peak latency reflects the stimulus classification time [16,17]. In an experiment of modified Sternberg paradigm by Zhang et al. (2003), the prominent P300 was elicited when the picture in probe set and its presentation order were congruency with that in memory set [27]. In the experiment of multi-stimulus Oddball paradigm, the “typical” non-target stimuli (and also non-novel stimuli) can still elicit a P300 component, but its amplitude is smaller than that of the target stimuli, whereas its latencies and morphologies are similar to those of the target stimuli [14,20]. For example, in a multi-stimulus Oddball experiment about pictures and corresponding words by Watson et al. (2005), all of the target and non-target stimuli elicited P300 and the target stimulus evoked prominent P300 when the target stimuli were pictures and the non-target stimuli were corresponding words, or vice versa [25]. In another multi-stimulus Oddball experiment of schematic human face by Azizian et al. (2006), the larger P300-like neurophysiological responses were produced when the non-target stimuli were perceptually similar to the targets than did other non-target stimuli [2]. Therefore, we speculate that the P300 can be elicited by categorization processing for sequentially displayed objects. In addition, the higher attribute similarity between the sequentially displayed objects, the larger the P300 amplitude.

In this study, the participants were asked to judge whether a brand extension suitable or not with the prime-probe paradigm (S1–S2 paradigm), i.e., whether it is suitable to use the brand name that appears in the prime stimuli to market a product that appears in probe stimuli. We hypothesize that there will be a categorization processing for products in probe stimuli to make the evaluation of brand extension, in which case, P300, a component of ERP, will be recorded.

Sixteen right-handed healthy undergraduates aged 22–35 (mean = 26.5) were included in this study (nine male). All had normal or corrected-to-normal visual acuity, and did not have any history of neurological or mental diseases.

Fifteen beverage brands with Chinese characters were chosen from the “Well-known Trademark List” determined by the China Trademark Bureau as the prime stimuli (S1). These brands, such as Pepsi®, Coke®, Wahaha® (Chinese local brand), Nongfu Spring® (Chinese local brand), were all regarded culturally familiar to the participants who were screened in advance by a special brand familiarity test. None of these brands has been extended to other industrial areas in Chinese market. Twenty product names were chosen in total from the familiar product categories as the target stimuli (S2). Among them, five products belong to the beverage category. Each brand name and product name was limited to no more than four Chinese characters.

The stimuli consisted of 300 of brand name (S1) – product name (S2) pairs, i.e. 15 brand names × 20 product names. These visual stimuli (white on a black background) were presented to each participant in the center of a computer-controlled video monitor (Stim2, Neurosoft Labs, Inc. Sterling, USA). The stimulus word (S1 or S2) was always presented at fixation for 1000 ms each, with a visual angle of 2.58 × 2.4° in each trial for a varied interstimulus interval (ISI) of 300–700 ms (average ISI was 500 ms). The interval between the end of the previous S2 and the onset of the following S1 was 2 s. The stimulus pairs (S1–S2) were randomly presented in sequence and had the equal probability.

Table 1 shows the experiment stimuli and its conditions.

Electroencephalogram (EEG) was continuously recorded (band pass 0.05–100 Hz, sampling rate 500 Hz) with Neuroscan Synamp2 Amplifier (Scan 4.3.1, Neurosoft Labs, Inc. Sterling, USA), using an electrode cap with 64 Ag/AgCl electrodes mounted according to the extended international 10–20 system and referenced to linked mastoids. Vertical and horizontal electrooculograms were recorded with two pairs of electrodes, one placed above and below the right eye, and another 10 mm from the lateral canthi. Electrode impedance was maintained below 5 kΩ throughout the experiment. Following electrode application, participants sat on a comfortable sofa located in a shielded

<table>
<thead>
<tr>
<th>$S_1$ brand name</th>
<th>$S_2$ product name</th>
<th>$S_2$’s product category</th>
<th>Experiment condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fifteen well-known beverage brands, e.g. Coke, Pepsi</td>
<td>Cola, soda pop, milk, black tea, juice</td>
<td>Beverage</td>
<td>Condition 1: congruity</td>
</tr>
<tr>
<td></td>
<td>Biscuit, bread, cake, jelly, candy, trousers, skirt, shirt, T-shirt, shoes, air-conditioner, fan, television, telephone, refrigerator</td>
<td>Non-beverage</td>
<td>Condition 2: incongruity</td>
</tr>
</tbody>
</table>

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room and were asked to fix a point in the center of the computer display located 1 m away from his/her eyes. Participants were asked “Whether or not you accept the products in the second stimulus with the brand name in the first stimulus”. They were instructed to evaluate the stimuli and press the left button of a push pad as fast as possible if they give a positive evaluation, meaning that the brand extension will be accepted by the consumer, otherwise to press the right button. Each participant was instructed to use the left hand for half of the trials and the right hand for the other half. Following 20 practice trials, the 300 stimulus trials were presented.

Electroencephalogram recordings were segmented for the epoch from 200 ms before onset of each word appearing on the video monitor to 1000 ms after this onset with the first 200 ms pre-stimulus as a baseline. Electrooculogram artifacts were corrected using the method proposed by Semlitsch et al. [22]. Trials contaminated by amplifier clipping, bursts of electromyographic activity, or peak-to-peak deflection exceeding ±80 μV were excluded from averaging. The remaining trials were corrected by using baseline. The EEG epochs were averaged separately for different product categories of beverage and non-beverage, and the averaged ERPs were digitally filtered with a lowpass filter at 30 Hz (24 dB/Octave). To investigate the neurophysiologic correlates of the processing of different product names, we compared the amplitudes of the four ERPs using a within-subjects repeated-measure of ANOVA.

Behavioral data are given in Fig. 1. The repeated-measures ANOVA in two categories of beverage and non-beverage in S2 indicated that product category had a highly significant main effect on affirmative rate $[F(1,15)=524.641, p=0.000]$ and Reaction times (RTs) $[F(1,15)=8.099, p=0.012]$. More affirmative answers and shorter RTs were made in condition 1.

Following the onset of the probe word, the positive wave P300 was recorded no matter whether the category of the product in probe stimulus was beverage or non-beverage. The latency of the P300 was 320–440 ms. In the non-beverage condition, a negative component of ERP, the N400, was observed following the P300. Fig. 2 shows the grand-averaged ERP waveforms in each condition at the parietal and occipital sites P3, PZ, P4, CP3, CPZ, CP4, PO3, POZ, PO4. Table 2 shows the mean amplitudes of ERP in this time window and the results of ANOVA in two conditions at these sites.

It was clear in Fig. 2 that there was no obvious difference of positive components being documented between beverage and non-beverage categories in S2 before the appearance of the P300. To examine the effect of the P300 evoked by brand extension categorization processing, the mean amplitudes for the window of 320–440 ms in two conditions were compared with a 2 (extension product categories: beverage vs. non-beverage) × 9 (nine scalp sites: P3, PZ, P4, CP3, CPZ, CP4, PO3, POZ, PO4) within-subjects repeated measure ANOVA. For the P300 time window, this ANOVA showed the significant differences of positive components with respect to product categories $[F(1,15)=40.179, p=0.000]$ and electrode factors $[F(8,8)=4.423, p=0.025]$, and also showed the significant interaction between product-categories and electrodes $[F(8,8)=3.437, p=0.050]$. Post hoc comparisons showed that the P300 was more positive in the beverage category in S2 than the non-beverage category over all these electrodes and it was identified as right lateralized positivity at the parietal sites (P4, CP4 and PO4).

The topographic plots (top down view; nose up) of maximal amplitudes of the P300 (330 ms) were consistent with the outcomes from ANOVA analysis, where the peak potential of the P300 was distributed over the right occipital scalp regions in two extension product categories (Fig. 3). However, the higher potentials of P300 were clearly observed in the parietal and left occipital region as well in condition 1 (beverage product in S2).

Previous studies found that P300, one of the most salient and robust endogenous ERP components, can be evoked by category similarity. Higher similarity elicits the larger amplitude of the P300 [27,25,2]. Our study reveals that P300 was elicited in both extensions: extending the beverage brand into other beverage product category (condition 1) and extending it into the non-beverage product category (condition 2), whereas the amplitude of the P300 in the first extension was much larger than the second extension. There was significant difference of amplitude distribution

<table>
<thead>
<tr>
<th>Site</th>
<th>Condition 1</th>
<th>Condition 2</th>
<th>F value</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>P3</td>
<td>6.74 (3.16)</td>
<td>3.91 (2.49)</td>
<td>30.88</td>
<td>.000</td>
</tr>
<tr>
<td>PZ</td>
<td>5.65 (4.40)</td>
<td>2.76 (3.76)</td>
<td>31.44</td>
<td>.000</td>
</tr>
<tr>
<td>P4</td>
<td>6.49 (3.28)</td>
<td>4.54 (2.70)</td>
<td>12.32</td>
<td>.003</td>
</tr>
<tr>
<td>CP3</td>
<td>4.88 (3.69)</td>
<td>1.26 (3.67)</td>
<td>54.05</td>
<td>.000</td>
</tr>
<tr>
<td>CPZ</td>
<td>4.41 (4.01)</td>
<td>1.34 (4.07)</td>
<td>44.76</td>
<td>.000</td>
</tr>
<tr>
<td>CP4</td>
<td>4.48 (3.41)</td>
<td>2.00 (2.79)</td>
<td>21.49</td>
<td>.000</td>
</tr>
<tr>
<td>PO3</td>
<td>6.28 (3.15)</td>
<td>3.79 (3.35)</td>
<td>29.67</td>
<td>.000</td>
</tr>
<tr>
<td>POZ</td>
<td>5.23 (3.81)</td>
<td>3.21 (3.62)</td>
<td>21.88</td>
<td>.000</td>
</tr>
<tr>
<td>PO4</td>
<td>5.18 (2.81)</td>
<td>3.68 (2.47)</td>
<td>14.97</td>
<td>.002</td>
</tr>
</tbody>
</table>

Table 2 The mean amplitudes of ERP and S.D. in parentheses in the time window of 320–440 ms and the results of ANOVA in two conditions at different sites.
Fig. 2. The grand averaged ERPs evoked by the product names with the prime effect of brand name. The P300 could be recorded in two categories. The amplitude of the beverage was much more positive than the non-beverage.

Fig. 3. Topographic maps of the maximal amplitudes of P300 (330 ms) from two different probe categories. The P300 in the beverage category was more remarkable than in the non-beverage, almost all parietal and occipital areas had been covered by higher positive potential, while in the non-beverage category a right predominant occipital distribution was clear and much more remarkable over other areas. In the non-beverage category, the N400 could be observed in the frontal area.
probe, which resulted in larger P300. In contrast, no overlap is produced when the perceived similarity and coherence is low, leading to smaller P300.

The data of our study suggests that P300 should be a physiological marker of how the brain processes the categorization of extension products in accordance with the attributes of original brand. This categorization processing may be one of two processes: Consumers transfer their perception of original brand attributes to extension product if they feel the categorical similarity between them; Consumers look for abstract and scattered similarity of attributes to integrate the beliefs to extension product if they do not feel the categorical similarity.

In our study, the P300 showed a right hemispheric dominance in condition 2 (extension product mismatching to brand name in S1), while it showed a bilateral dominance in condition 1 (extension product fitting brand name in S1). In other words, there were not only higher potentials of the P300, but also larger activate area of brain cortex when the product names in target stimuli matched brand name names in prime stimuli. This indicated that if the brand extension is suitable, the product will attract more neural resources to retrieve the attributes from the memory system. Without doubt, it can promote the consumer to build more associations between the new product and the existing brand which will facilitate the purchase of that product.

Taken together, the results of this study suggest that P300 can be elicited by categorization processing for brand extension. The higher perceived similarity of their attributes is, the larger the amplitude of the P300. In other words, more suitable the brand extension is, the larger the P300 amplitude. The P300, as an endogenous neural signal, could play an important role in the amplitude of the P300. In other words, more suitable the brand extension is, the larger the P300 amplitude. The P300, as an endogenous neural signal, could play an important role in the categorization of brand extension: Toward a reconsideration of the Concept of Attitude, Advances in Consumer Research, vol. 9, M; Association for Consumer Research, 1982, pp. 94–100.


Our study shows that if the brand extension is suitable, the product will be elicited by event-related potential (ERP) measures, Biol. Psychol. 47 (1998) 121–135.

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Conflict of interest

None.

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References