Event-related potential N270 correlates of brand extension

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The aim of this study is to investigate the neural mechanism of extending a brand in a specific product category to other product categories. Facing two sequential stimuli in pairs consisting of beverage brand names (stimulus 1) and product names (stimulus 2) in other categories, 16 participants were asked to indicate the suitability of extending the brand in stimulus 1 to the product category in stimulus 2. These stimulus pairs were divided into four conditions depending on the product category in stimulus 2: beverage, snack, clothing, and household appliance. A negative component, N270, was recorded for each condition on the participants' scalps, whereas the maximum amplitude was observed at the frontal area. Greater N270 amplitude was observed when participants were presented with stronger conflict between the brand product category (stimulus 1) and the extension category (stimulus 2). It suggests that N270 can be evoked not only by a conflict of physical attributes (different shapes of words of brand and product names) but also by that of lexical content. From the marketing perspective, N270 can be potentially used as a reference measure in brand-extension attempts. *NeuroReport* 18:1031–1034 © 2007 Lippincott Williams & Wilkins.

Keywords: brand extension, conflict, event-related potential, mismatch, N270, neuromarketing, product category

Introduction

Brand names can be defined as cultural symbols that may be based on real people, places, animals, objects, or something fictitious. A culturally familiar brand name promises certain advantages of the product because it has rich brand equity, including brand awareness, perceived brand quality and brand association. Recent functional MRI studies suggest that the prefrontal cortex may be crucial for the processing of brand knowledge [1,2].

Brand extension is the use of established brand names to enter new product categories or classes [3]. Evaluation of brand extension is often assumed to be determined by categorization processes [4]. Laboratory research suggests that the influence of a famous brand name on brand extension depends on the perception of how well the extension products match the original brand category in customers' brand-cognitive process [5,6]. It means that when consumers encounter a new extension product, they will assess this product by the original brand category not only in physical similarity but also in functional similarity or the context in which it is used [5,7]. Studies also show that consumers attempt to maintain a certain level of coherence in their perception of a brand when encountering new information about a product under this brand [8]. This finding suggests that 'match' is a key factor in successful brand extension [4,5,9]. In practice, however, it is very difficult to observe such matching in consumers' mind before their purchase decision [10]. To avoid potential failure of marketing a new product under the existing famous brand name, identifying the 'mismatch' is very important for the manufacturers to keep away from huge losses.

In earlier event-related potential (ERP) studies, a negative component with a peak latency around 270 ms (N270) was elicited when the physical attribute of the second stimulus showed mismatching with that of the first one, such as color [11], shape [12], position [13], digit value [14] or face picture [15]. N270 is the electric signal of cerebral cortex for processing conflict information [11,12,14,16], which shows some similar features to other negative components including error-related negativity (ERN), mismatch negativity (MMN), the physical mismatch-N2, and semantic N400 [17].

In this study, participants were asked to judge a brand extension as suitable or unsuitable, that is, it is suitable or not to use a famous brand name that appears first on the video monitor to market a product that appears second. We hypothesize that there will be a complex conflict if the product does not belong to the category of the famous brand that appears first, in which case a component of large N270 will be recorded. This experiment is designed to test this hypothesis. In other words, we want to look for the neuronal mechanism of brand extension, especially the time course of mismatch between the brand and the extension product.

Materials and methods

Study participants

Sixteen right-handed healthy undergraduates aged between 22 and 35 years (mean = 26.5) were included in this study (nine men). All had normal or corrected-to-normal visual

acuity. They did not have any history of neurological or mental diseases.

Material

Fifteen brands (Chinese characters) of beverages were chosen from Chinese 'Well-known Trademark List' of CTMO (Trademark Office under the State Administration for Industry and Commerce, China) as the prime stimuli (S1). These brands, such as Coca, Pepsi, Wahaha, Nongfu Spring, were all regarded as being culturally familiar to the participants who were screened in advance by a special Brand Familiarity Test. These beverage brands have not been extended to other industrial areas in the Chinese market. Every word pair of brand products was limited to no more than four Chinese characters.

Twenty product names were chosen in total from four product categories (five products per category) as the target stimuli. These product categories include the following: (i) beverage category: cola, soda pop, milk, black tea, and juice; (ii) snack category: biscuit, bread, cake, jelly, and candy; (iii) clothing category: trousers, shirt, T-shirt, shoes, and skirt; and (iv) household appliance category: television, refrigerator, air-condition, fanner, and telephone set. All the names were made up of two Chinese characters.

Stimulus presentation and timing

The stimuli consisted of 300 pairs of brand name (S1)–product name (S2), that is, 15 brand names $\times$ 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, Virginia, USA). The stimulus word (S1 or S2) was always presented at fixation for 1000 ms each, with a visual angle of $2.58^\circ \times 2.4^\circ$ in each trial for a varied interstimulus interval from 300 to 700 ms (average interstimulus interval 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 were divided into four conditions depending on different product category in S2: it is called 'low-conflict' if the product is from beverage and snack categories, 'high-conflict' if the product is from the categories of clothing and household appliances (see Table 1). The stimulus pairs (S1–S2) were randomly presented in sequence and had the equal probability.

Electroencephalogram recording

Electroencephalogram was continuously recorded (band pass 0.05–100 Hz, sampling rate 500 Hz) with Neuroscan Synamp2 Amplifier (Scan 4.3.1, Neurosoft Labs, Inc.), 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 in a comfortable sofa located in a shielded 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 'Do you or not accept the products in the second stimulus with the brand name in the first stimulus?' They were instructed to evaluate the stimuli as accurately as possible and to press the left button of a push pad as fast as possible if they thought the probe word matched the prime word (meaning that this brand could be extended to this product category); otherwise they had 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.

Table 1 Four conditions of low-conflict and high-conflict

Condition	1	2	3	4
S1: Brand names of	Beverage	Beverage	Beverage	Beverage
S2: Product names of	Beverage	Snack	Clothing	Household appliance
Conflict	Low	Low	High	High

Electroencephalogram analysis

Electroencephalogram recordings were segmented for a time period from 200 ms before onset of each word appearing on the video monitor to 1000 ms after this onset with the first 200 ms prestimulus as a baseline. Electrooculogram artifacts were corrected using the method proposed by Semlitsch *et al.* [18]. Trials contaminated by amplifier clipping, bursts of electromyographic activity, or peak-to-peak deflection exceeding ± 80 v were excluded from averaging. The remaining trials were baseline corrected. The electroencephalogram segments were averaged separately for different product categories of beverage, snack, clothing and household appliances, and the averaged ERPs were digitally filtered with a low-pass filter at 30 Hz (24 dB/Octave). ERPs for each of the four conditions were averaged. To investigate the neurophysiologic correlates of the processing of different product names, we compared the amplitudes of the four ERPs using a within-participant repeated measures of analysis of variance (ANOVA).

Results

Behavioral data

Behavioral data are showed in Fig. 1. The repeated-measures ANOVA in four conditions indicated that product category had a highly significant main effect for the answer and reaction time (RT). More affirmative answers were made in the beverage and snack than in the clothing and household appliance condition [$F(3,45) = 80.724$, $P = 0.000$]. These four conditions prolonged the RT independently [$F(3,45) = 5.629$, $P = 0.002$]. RT was shortest in the beverage condition and was shorter in the clothing than in the household appliances. Especially, the RT in the snack condition was the longest one among all conditions.

Event-related potential data

Following the onset of the probe word, remarkable negative-wave N2 was recorded from widespread scalp areas in all four product conditions. The N270 was most prominent at the frontal sites and was analyzed at F3, FZ, F4, FC3, FCZ and FC4 (Fig. 2). After that, a late positive component (LPC) and N400 were recorded in widespread areas in all conditions.

To examine the effect of the brand-extension conflict processes on the principal negative components, we conducted a repeated-measure ANOVA of mean amplitudes for the time window of 240–330 ms in both four product

conditions and six selected electrodes (F3, FZ, F4, FC3, FC and FC4), respectively. Figure 2 shows grand average ERP waveforms at six selected scalp sites. The ANOVA results show that the mean amplitudes in the time window from 240 to 330 ms have significant differences among four conditions [$F(3,45) = 7.328$, $P = 0.000$] and among six electrodes [$F(5,75) = 10.226$, $P = 0.000$]. No significant interaction between condition and electrode [$F(15,225) = 1.525$, $P = 0.098$] was found. Post hoc tests revealed that the order of the N270 amplitude was similar to the behavioral results, household appliances > clothing > snack > beverage. Relative-low-significant difference was found between snack and clothing and insignificant difference was found between clothing and household appliances [beverage–snack: $F(1,15) = 11$, $P = 0.005$; snack–clothing: $F(1,15) = 1.987$, $P = 0.179$; clothing–household appliances: $F(1,15) = 0.045$, $P = 0.835$].

Consistent with the outcomes from ANOVA analysis, the peak potential of N270 was distributed on the prefrontal and posterior scalp areas in conditions of clothing and household appliance; such distribution style was not observed in beverage condition (Fig. 3).

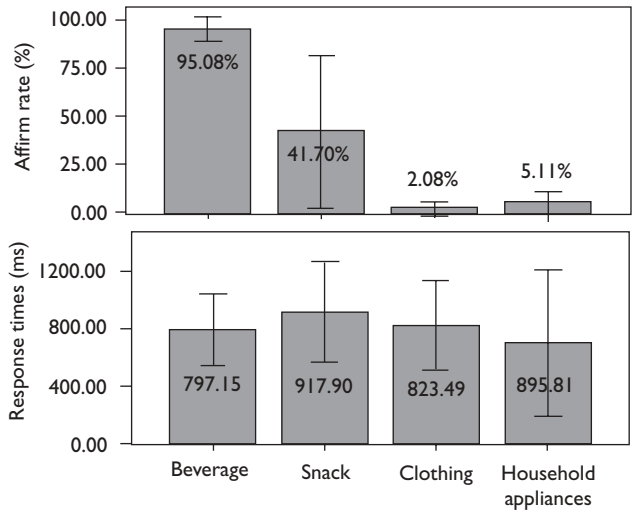

Fig. 1 Mean percentage of affirm answer and response times, as a function of product categories.

Discussion

Our study reveals that N270 was elicited in each of the four conditions, and that the order of amplitudes of N270 in four conditions from small to large was beverage-snack-clothing-household appliance, and that significant difference of mean amplitudes was seen between low-conflict and high-conflict conditions, and the high potentials of N270 were distributed at the frontal and bilateral posterior regions, and also at the central region in the conditions of high conflict.

This distribution of conflict effect is consistent with previous studies of PET and functional MRI in neuromarketing, which found the activated prefrontal cortex and posterior brain regions during brand-memory performance [2,19]. The active neuron regions reflecting the mechanism of brand extension conflict should, however, be studied further.

In the previous S1–S2 paradigm of experiment, there was always an N270 component recorded when S2 was different from S1 in physical attribute, such as shape, color, position, or in the frequency at which S2 appeared on the video monitor [11,16,17]. Of course, the S1 and S2 always have different shapes in our experiment because they are different words, so N270 is always recorded in every condition. Moreover, our study revealed that amplitudes of N270 in four conditions were larger and larger following the order from condition 1 to 4 (meaning the order of S2 was product category of beverage, snack, clothing and household appliance, respectively). If N270 had been evoked only by the conflict of word shape, the amplitudes of N270 in the four conditions would have been similar because the shape differences between words of brand names and product names were small. (No one can measure the degree of difference between words of brand name and product name.) The result of our experiment, however, shows that the amplitudes of N270 in the four conditions are affected by the visual differences. Especially, there is a significant difference of mean amplitudes of N270 between low-conflict and high-conflict conditions. So there must be other stronger and stronger conflicts in the sequence of conditions from 1 to 4 to enlarge the amplitudes of N270. This result suggests that N270 is not evoked just by simple and single conflict. This result is different from those of previous studies [16,17].

An earlier study [20] assumed that brand names are stored in memory as associative general knowledge structures. In general, consumers may not actively evaluate

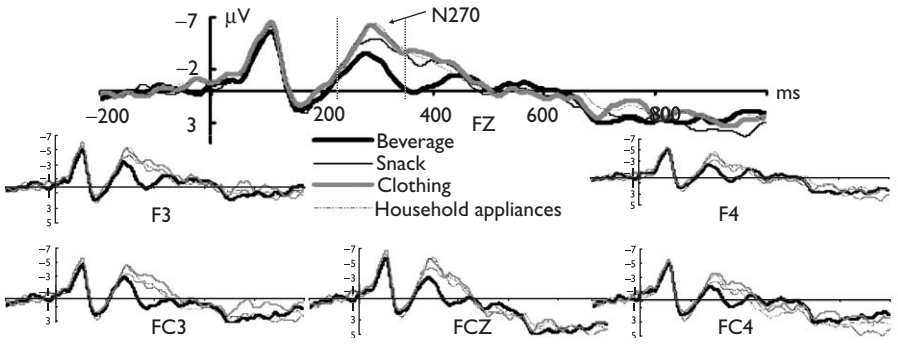

Fig. 2 Grand-averaged ERPs of 16 participants at six selected electrodes to different stimulus conditions. N270 could be recorded in the four brand–product mismatch conditions. The amplitude increased in ascending order of magnitude from the low-conflict condition to the high-conflict condition. The amplitude of N270 elicited in conditions 3 (beverage brand vs. product of clothing) and 4 (beverage brand vs. product of household appliances) showed no significant difference in the time window of 240–330 ms, whereas, the mean amplitude of N270 elicited in condition 2 (beverage brand vs. product of snack) was higher than in condition 1 (beverage brand vs. product of beverage). Another negative wave, N400, also appeared in these conditions in the time window of 380–450 ms. ERP, event-related potential.

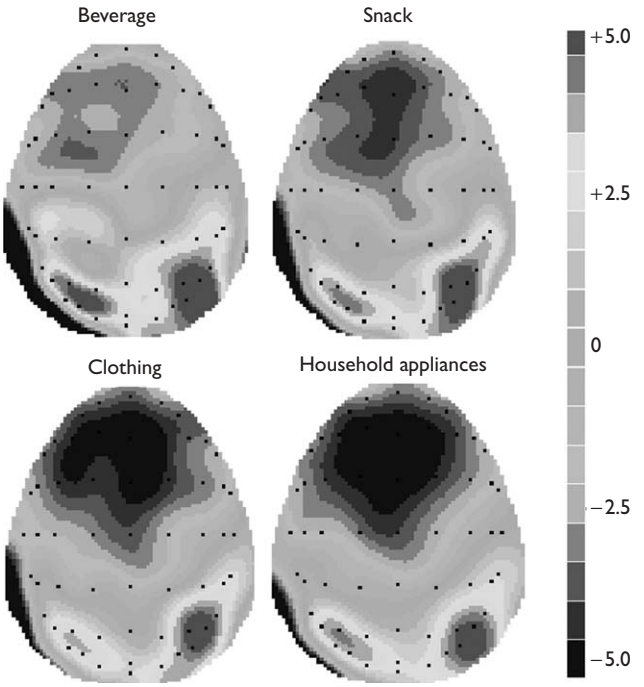

Fig. 3 Topographic maps of maximal amplitudes of N270 (270 ms) from different probe-identification conditions. The N270 for clothing and household appliances was more remarkable than for snacks and beverages in the frontal area.

brand's attribute extensively, but appear to use the brand name as a heuristic, or as a retrieval cue for evaluating brand–product performance [21]. When needing to evaluate brand–product performance, brand name is generally the main source of information [22].

So we speculate that the brand extension conflict effect (such as the amplitude of N270) might have resulted from the comparison of the product (S2) attribute to the corresponding brand's (S1's) product attribute in brand memory. The conflict effect will be larger if the product attribute is conflicted more strongly with the encoded item of the brand's product attribute in brand memory.

In our study, N270 showed a left-hemispheric dominance in low-conflict condition, whereas it showed a bilateral dominance in high-conflict condition. This indicated that low-conflict can be processed without full recruitment of the neural resources of the conflict-processing system.

N400 was originally discovered in a semantic experiment in which sentences had incongruent endings [23]. When a participant responds to the incongruous semantic context of sentence stimuli, N400 appears. And after N400, there was no LPC. Another study [17] suggested that N400 can be elicited by multiple dimension conflicts, such as conjunction of shape and color conflicts. In our study, we also observed the component of N400 following LPC, which follows N270 in four conditions. This component of N400 in our study might, therefore, be evoked by multiple dimension conflicts of brand extension, as well as by the semantic context in memory, because the brand name and the product name often appear in the same sentence of an advertisement.

Conclusion

N270 can be evoked by both physical conflicts of different Chinese characters and by lexical content conflicts, as this study reveals. The stronger the content-information conflicts, the larger the amplitude of N270 will be. Companies could potentially use N270 as a reference measure in brand-extension attempts in marketing research.

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