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N400 as an index of uncontrolled categorization processing in brand extension

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HIGHLIGHTS

- ► Examined the ERP correlates of processing of categorization in brand extension with irrelative task.
- ► When S2 was atypical to S1, N400 was recorded.
- ► N400 was relative to unconscious mental categorization but not to the task difficulty and the conscious evaluation.

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ABSTRACT

This study examined the ERP (event-related potential) correlates of categorization processing in brand extension with irrelative task. Participants faced two sequential stimuli in a pair consisting of a soft drink brand name (S1) and a product name (S2) which comprised two categories: beverage (typical product of the brand, e.g. Coke branded soda water) and clothing (atypical product of the brand, even though sometimes it was seen in the real market, e.g. Coke branded sport wear). The N400 was recorded and more largely distributed in frontal, frontal–central and central areas when S2 was clothing compared with beverage. The study did not require the participants to evaluate that the brand extension was appropriate or not, the N400 recorded here was, therefore, irrelative to the task difficulty and the conscious categorization process. We speculated that it reflected an integration processing related with the mental category. The brand performed the role of prime which aroused the participants' association of the brand-related typical products and attributes retrieving from their long term memory. The product name activated an unconscious processing of comparison between the brand and the product. In this process, the participant treated the brand as a mental category and classified the product as a member of it. There would be a large cognitive reaction which elicited the N400 if the product's attributes were atypical to the category of the brand. These findings might help us understand the N400 component in unconscious mental categorization and supported the categorization hypotheses in brand extension theory which was crucial in consumer psychology.

1. Introduction

Brand, an important concept in consumer behavior theories, is supposed as a mental category of products [1,3,4]. Facing the mass products in the marketplace, consumers have to use construct categorical representations to classify and understand them with the attributes from their brands. Brand extension is the use of an existed brand name to sell a new kind of products [1]. The brand extension evaluation is regarded as a typical mental categorization process which is somewhat similar to object classification [2].

Brands appear to have graded structure with products that are more or less 'brand like'. At the far end of the graded structure are products that are considered to be outside of the brand category. The previous literatures supposed that the category typicality of the products was the crucial factor which had great influence on the evaluation of brand extension [4]. That is, the more elements of a brand category an extension possesses, the more typical it is considered of the category. However, there has not been direct neurological evidence supporting this hypothesize.

A recent study has examined the event related potential (ERP) correlates of the processing of brand extension with a prime-probe paradigm and found a P300-like component elicited by category [20]. A drawback of this previous study was that it was difficult to distinguish the effects of decision difficulty and perceptual similarity between a brand and a product stimulus. Conscious task to answer whether a brand extension suitable or not was difficult and might elicit the P300. For instance, while the target stimulus (e.g.

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clothing) and the prime stimulus (e.g. Coke) belong in a different classification, it is also difficult for participants to give a certain answer because Coke has been producing clothing which is not popular in real market.

N400 is a negative brainwave at roughly 400 ms post-stimulus, which is larger to incongruent (contextually inappropriate) than congruent sentence endings, to unrelated than to related words, and to weakly associated than strongly associated words [16–18]. The amplitude of the N400 is inversely proportional to the extent to which the stimulus fits semantic expectancies [15], and when the processes are more difficult, its amplitudes are large [10]. Kutas et al. demonstrated that in both affirmative and negative statements, the N400 amplitudes were reduced when the exemplar was a member of the category by using sentence verification paradigm (such as 'A carrot is a vegetable') [13]. In category priming paradigms, for example, "Pear"–"Pear" (exact match), "Pear"–"Apple" (in-category), and "Pear"–"Curtain" (out-of-category), words that are out of category yield a more negative N400 than the others [21]. Many studies suggested that the semantic typicality of an exemplar modulated the N400 amplitude, and both atypical member and non-member would elicit the N400 [7,9]. Similar effect was also found although no required attention to the semantic relationship between words [22]. In all these types of studies, participants directed their attention to the stimuli, and that seems to be important for the N400 elicitation. What is more, most of them were orthogonal to task performance and not evidenced in overt behaviors. Thus, Kutas and Federmeier summarized that the N400 could not be neatly mapped into the automatic or controlled category (being importantly modulated by attention and thus not fully automatic, but not requiring the kind of awareness important for controlled processing) [14].

The purpose of this study was to examine the effect of categorization process between typical and atypical stimuli on atypical N400 amplitude. We used brand extensions as atypical targets but removed the participants' decision task from the experimental paradigm used by Ma et al. [20]. We speculated that the new paradigm would neatly elicit categorization-related N400 (associated with attention but not with task).

2. Materials and methods

2.1. Participants

Eighteen non-business major undergraduates (8 females, all right-handed) aged from 19 to 26 years (mean age, 22.5 years) from Zhejiang University participated in this experiment as paid volunteers. One participants' data were excluded since the number of valid trials was insufficient. They were all native Chinese speakers and had normal or corrected to normal vision with no history of neurological or psychiatric abnormalities.

2.2. Experimental stimuli

The prime stimuli (S1) consisted of twenty soft drink brands selected from the "Well-known Trademark List" published by the State Trademark Administration, China. Participants were all familiar with these brands, such as Coca and Pepsi, because they were screened in advance by using a special Brand Familiarity Test. To emphasize that the priming was a brand name, we added the word of "Brand" to each prime stimulus. Because most brand names had their additional meanings in the non-commercial context, e.g. Coke without "brand" means "tasty" in Chinese. The probe stimuli (S2) comprised eight product names chosen from two product categories: beverage and clothing (four product names per category). That is, the beverage (e.g. soda water) was a typical exemplar of the soft drink brands but the clothing was not even though these brands had clothing products in real market (e.g. Coke branded sport wear and Pepsi branded shorts are well-known in youth). In other words, there were two categories: typical and atypical. Each picture is digitized at 150 × 200 pixels.

2.3. ERP paradigm

The stimuli consisted of 160 pairs of brand names (S1)–product names (S2), i.e. 20 beverage brand names × 2 categories × 4 product names. They were presented in the center of a screen with black word on gray background. A stimulus system (Stim2, Neurosoft Labs, Inc., Sterling, VA, USA) was employed to control the presentation of the stimuli. The stimulus words were presented for 500 ms followed by a random interstimulus interval between S1 and S2, ranging from 200 ms to 300 ms. The interval between the end of S2 and the onset of the following S1 was 1500 ms (see Fig. 1). Participants were instructed to focus on the stimuli and to bear S1 and S2 in mind. After experiment, the participants were required to fill a questionnaire to identify which name pairs ever emerged in the experiment. The questionnaire contained 20 words (10 product names and 10 brand names), 5 of which were chose from prime stimuli, 5 from probe stimuli, 5 from new brand names and 5 from new product names. They were paid 30 Chinese Yuan (about $4) as basic payment, with an additional monetary reward paid depending on their performance in filling the questionnaire. The performance was also one of criteria to decide whether or not to exclude the participant from analysis. The stimulus pairs (S1–S2) were randomly presented in the screen and had equal probability.

2.4. Electroencephalogram recording and analysis

The experiment was performed in an electrically shielded and sound-attenuated cabin. Participants sat in a comfortable chair and computer display was located 1 m away from his/her eyes. The Electroencephalography (EEG) was recorded (band pass 0.05–100 Hz, sampling rate 500 Hz) with Neuroscan synamp2 Amplifier (Scan 4.3.1, Neurosoft Labs, Inc.), using Ag/AgCl electrodes placed at 64 scalp sites according to the extended international 10–20 system and referenced to left mastoid with a cephalic (forehead) location as ground. Vertical electrooculograms (EOG) were recorded with one pairs of electrodes placed above and below the left eye, horizontal electrooculograms with another pairs 10 mm from the lateral canthi. Electrode impedances were maintained below 5 kΩ throughout the experiment. Before the formal experiment, Participants were tested their familiarity of the twenty beverage brands. And then following 20 practice trials, the blocks were presented.

Electroencephalogram recordings were extracted from −200 to 800 ms time-locked to the onset of stimulus 2 (S2), with the pre-stimulus period as baseline. Electrooculogram artifacts were corrected using the method proposed by Semlitsch et al. [24]. Trials containing electrooculography activity or other artifacts (bursts of electromyographic activity, or peak-to-peak deflection exceeding ±100 μV) were excluded from averaging. For the data sets in the analysis, the mean for beverage category was 73.88, and 74.29 for clothing category. The remaining trials were corrected to baseline. ERPs were averaged for every participant in both conditions (extension product categories of beverage, and clothing). The averaged ERPs were digitally filtered with a low pass filter at 30 Hz (24 dB/Octave).

To study the neurophysiologic features of uncontrolled evaluation process on brand extension, a 2 (product category) × 5 (coronal) × 3 (sagittal) within-subjects repeated measure ANOVA for N400 was conducted. The Greenhouse–Geisser [8] correction was applied when necessary (uncorrected *df* were reported with the ε and corrected *p*-values), and the Bonferroni correction was

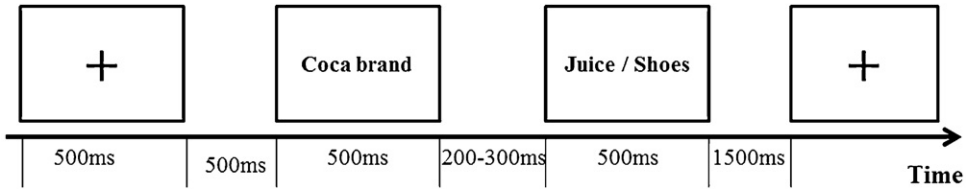

Fig. 1. Schematic illustration of the procedure.

used for multiple paired comparisons. Fifteen electrodes which composed the coronal and sagittal factors were F3, Fz, F4, FC3, FCz, FC4, C3, Cz, C4, CP3, CPz, CP4, P3, Pz, and P4 in frontal, fronto-central, central, centro-parietal, and parietal areas for N400.

3. Results

3.1. Behavioral data

Because participants had no response task in this experiment, there were no behavioral data recorded. The average accurate rate of recognition for participants was 93.14% with standard deviation 0.089. Only two participants identified one pair that never appeared in the experiment as the appeared one. We did not exclude participants according to this criterion.

3.2. EEG data

The grand average ERPs for product categories of beverage and clothing were displayed in Fig. 2. Fig. 3 depicts the scalp distributions of effects engendered by both categories (beverage category and clothing category) at four time windows.

The average amplitudes around the N400 peak (390 ± 60 ms) were taken as the N400 measures to clothing and beverage products. The ANOVA for the mean amplitude of N400 in the 330–450 ms time window revealed significant effects for product category [$F(1, 16) = 8.225$, $p = 0.011$], coronal factor [$F(4, 64) = 9.163$, $\varepsilon = 0.309$, $p = 0.005$], and sagittal factor [$F(2, 32) = 11.974$, $p = 0.000$], respectively. Although the pairwise comparison test for sagittal factor showed the mean amplitude of N400 across the electrodes at midline (Fz, FCz, Cz, CPz and Pz) was significantly different from the mean N400 amplitude across the left hemisphere (F3, FC3, C3, CP3 and P3) ($p = 0.002$), as well as differed from that across the right hemisphere ($p = 0.001$). However, there was no significant hemisphere effect, i.e. the left hemisphere did not differ from the right in the mean amplitude of N400 ($p = 1$). The ANOVA revealed that the extension product category had no significant interaction with coronal [$F(4, 64) = 0.330$, $\varepsilon = 0.408$, $p = 0.678$], or sagittal [$F(2, 32) = 0.852$, $p = 0.436$], or coronal × sagittal [$F(8, 128) = 0.837$, $p = 0.571$] factors.

The mean voltages distributed from frontal to parietal regions showed a decline trend (negative-polarity): frontal electrodes F3, Fz and F4 ($M = -1.93$ μV, SE = 0.50), fronto-central electrodes FC3, FCz and FC4 ($M = -1.88$ μV, SE = 0.50), central electrodes C3, Cz and C4 ($M = -1.46$ μV, SE = 0.41), centro-parietal electrodes CP3, CPz and CP4 ($M = -0.57$ μV, SE = 0.39), and parietal electrodes P3, Pz and P4 ($M = 0.07$ μV, SE = 0.44). The Bonferroni-corrected pairwise comparisons test for coronal factor showed that the mean voltages among frontal, fronto-central and central electrodes did not significantly differ from each other, whereas the mean voltage across parietal electrodes was marginally significantly different from the mean voltages for frontal ($p = 0.066$), and significantly different from fronto-central ($p = 0.037$), central ($p = 0.012$), and centro-parietal electrodes ($p = 0.04$); there was also significant difference between central and central parietal electrodes ($p = 0.023$).

4. Discussion

In classic brand extension theory, the scholars assumed that there is a category-based processing for brand extension evaluation which depends on the general typicality or similarity between the original brand and the extension product [6]. As each brand–product pair in this experiment could be found in real marketplace, participants paid attention to the stimulus for remembering them but did not evaluate them consciously. With ERP recording and neuromarketing method, the large ERP component N400 observed in the atypical category should be related to the uncontrolled processing of categorization.

Previous studies found that N400 was closely related with semantic category [7,9,10,13,15,16,21,22]. For example, when the first word (S1) is animal and the second word (S2) is the name of an object, the N400 amplitude evoked by this non-exemplar target is large [10,15]. In this study, the soft drink brand name (S1) was a mental category and the N400 was elicited by clothing name (S2, atypical category) compared with beverage name (S2, typical category). The brand of S1 aroused the participants' memory of the brand-related typical products, and the product of S2 was compared with the memory. Participants deemed that the beverage product in S2 is a typical exemplar of soft drink brand in S1, whereas clothing product in S2 cannot be classified into the category of a given soft drink brand. The comparing typical attributes between S1 and S2 happened unconsciously and then the participants finished the brand extension evaluation by mental categorization process even though they were not required to do it consciously. The clothing product which had little attributes belonged to the soft drink category evoked large N400 component.

In a brand extension study with a response task [20], Ma et al. claimed that the P300 was the reflection of the brand extension evaluation based on categorization process. However, in comparison with that study, we found the N400, not the P300, could reflect the cognitive process in brand extension evaluation. The current study did not require the participants to evaluate that the brand extension was appropriate or not, the N400 recorded here was, therefore, irrelative to the task difficulty and the conscious categorization process. We considered the different results were mainly caused by different paradigms. There were two aspects which were different from Ma et al. [20] in paradigm: one was the task types, and the other is the SOA (stimulus-onset asynchronies).

For task types, participants had no response task, but had to pay attention to stimuli and remember them for a good performance in the post testing. But in the experiment of Ma et al., participants were asked to judge whether a brand extension suitable or not [20]. P300 was closely related with decision-making and the amount of attention paid to the stimulus [12]. The same stimuli that evoked a robust P300 under normal circumstances did not evoke a P300 when they were deliberately ignored or when participants' attention was occupied by another task [5]. Thus, we speculated that the P300 in the experiment of Ma et al. [20] reflected combined effect of categorization and evaluation to the task, especially which could not separate from the attention caused by decision task.

For SOA, it was relatively shorter in current study compared with Ma et al. [20]. The stimulus words of soft drink brand (S1) were

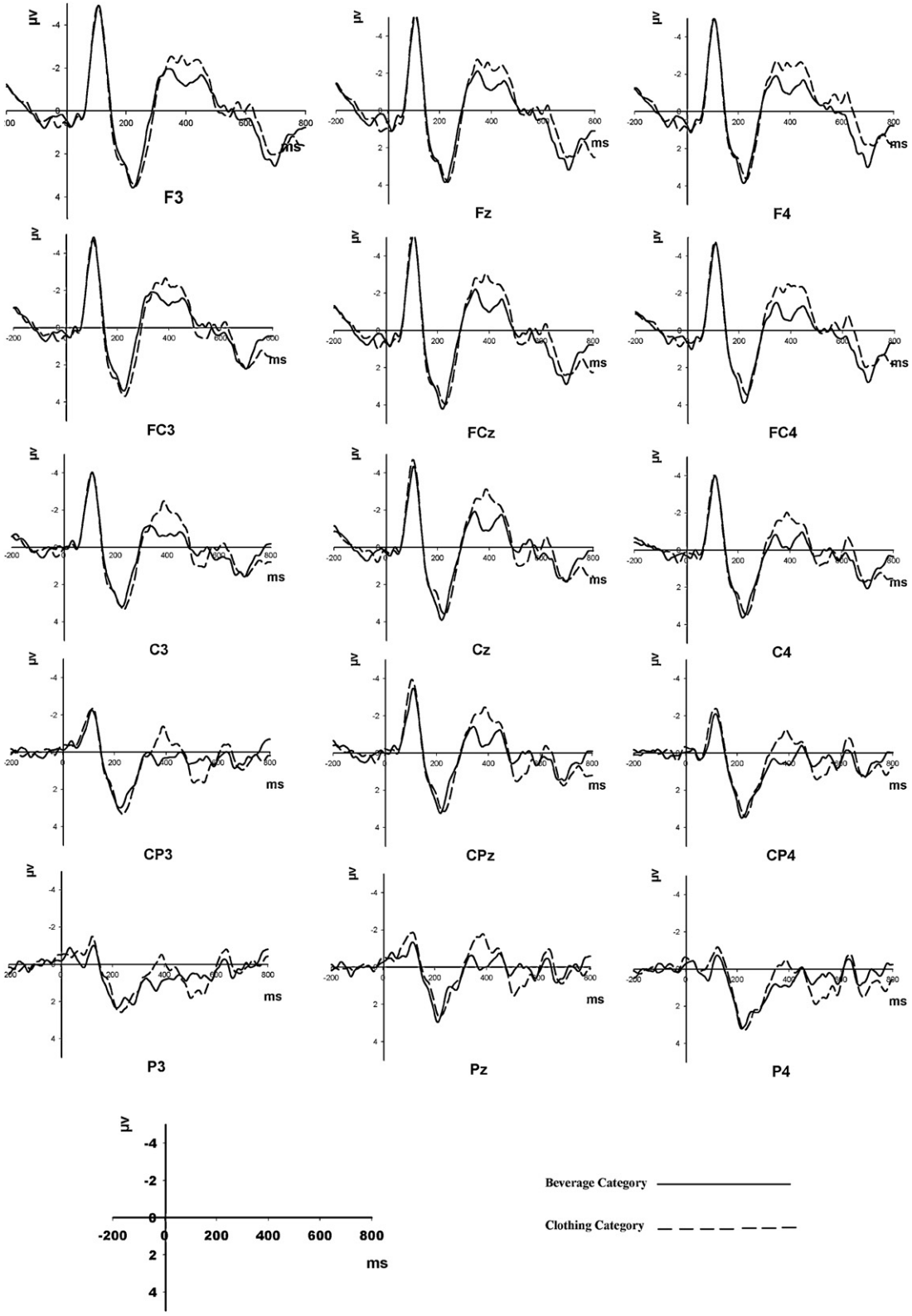

Fig. 2. Grand averaged ERPs elicited by the product names with the prime effect of the brand name at 15 electrodes in the frontal, central and parietal areas.

presented for 500 ms followed by a random interstimulus interval (ISI) between S1 and S2, ranging from 200 ms to 300 ms (average ISI was 250 ms) in our experiment. However, in the paradigm of Ma et al. [20], the stimulus word (S1 or S2) was always presented for 1000 ms, with a varied interstimulus interval (ISI) of 300–700 ms (average ISI was 500 ms). Kutas and Federmeier reported that N400 activity was contained when every word read one at a time (rapid serial visual presentation), and it revealed the inherently incremental nature of language processes [14]. The SOA was much shorter in current experiment, and we speculated N400 elicited by product (S2) with uncontrolled paradigm also revealed the nature of brand extension evaluation processes.

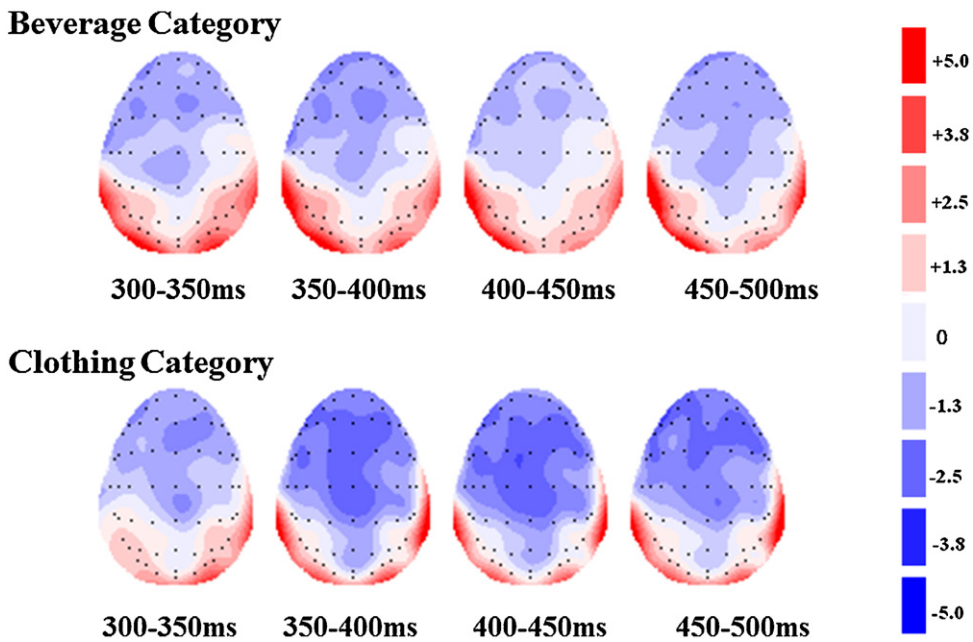

Fig. 3. Topographic distribution of two categories (beverage category and clothing category). The N400 was observed in the clothing category compared with beverage category in the frontal, fronto-central, central, centro-parietal, and parietal areas.

N400 was distributed over most brain areas from frontal to parietal–occipital area, and its amplitude was lager in frontal, frontal–central and central areas. Some previous studies suggested that the stronger N400 at frontal and fronto-central sides represented an integration and conceptual analysis process of the probe word into the prime context [11,19,25]. Thus, the N400 elicited in this study also reflected an integration and conceptual process related with the mental category. The soft drink brand in S1 and the product in S2 shared high level features such as semantic category not low-level perceptual features such as color and size. If the product was not the typicality of soft drink category, N400 component was elicited.

Most previous studies on categorization theory in consumer psychology used explicit tasks which required participants to make a classification judgment or a decision based on it [1,2,4,23]. This study used a task-irrelated paradigm and N400 reflected an important unconscious categorization processing in branded products choice. The brand performed the role of prime which aroused the participants' association of the brand-related typical products and attributes retrieving from their long term memory. The product name activated an unconscious processing of comparison between the brand and the product. In this process, the participant treated the brand as a mental category and classified the product as a member of it. There would be a large cognitive reaction if the product's attributes were atypical to the category of the brand. Taken together, our result seems to be a neurological hard evidence for categorization hypotheses in brand extension theory which is crucial in consumer psychology. This would also suggest that brand extension evaluation could happen unconsciously and companies should pay more attention to it.

Conflict of interest statement

There are no conflicts of interest.

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