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AN ANALYSIS OF BRAND ASSOCIATION PERCEPTION USING N400 EVOKED POTENTIAL[7]

In this paper, a novel application of the event-related potential (ERP) method is proposed. The authors applied an N400 evoked potential for brand perception analysis, particularly for brand associations. Traditionally, N400 has been used as a marker of semantic incongruence of a word to a context. The N400 activity is manifested in a more negative deflection of ERP response to incongruent stimuli. We recorded N400 in response to congruent and incongruent sentence endings in marketing and non-marketing contexts, respectively. In the main experimental condition, congruent and incongruent brand associations (nouns) presented before brand names were selected from real marketing campaigns building brand communities. In the control semantic memory N400 condition, the incongruent sentence endings evoked significant fronto-centrally distributed N400 brain response at 300–500 ms. The N400 response in the brand association condition was delayed for 250 ms compared to incongruent words in the context of short sentences and appeared in the central brain area. In this study, we showed for the first time the possibility of applying the N400 method to identify the strength of brand associations using ecologically valid stimuli.

Keywords: event-related potential method, N400, electroencephalography, neuromarketing, brand associations

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INTRODUCTION

Social media has provided an opportunity to create new touchpoints with real and potential customers (Nambisan & Baron, 2007) and to co-create brand value with customers (Zwass, 2010), since a brand's target audience can influence brand image (McAlexander, Schouten, & Koenig, 2002). Previous studies of online communities have shown that engaging the target audience in social media communication generates additional value for the brand (Schau, Muñiz, & Arnould, 2009). Brands need to build the process of user engagement, since this strongly affects the sense of belonging to a certain brand (Yan, 2011).

One way to engage potential customers in communication is to formulate certain brand associations (BA) for a given target audience, therefore building BA is an essential part of brand management in social management (Korchia, 2003). Brand associations include information that consumers associate with the brand (Brown & Dacin, 1997). For example, such associations may include perceptions, certain inferences or emotions experienced by customers, and other perceived attributes (Brown & Dacin, 1997; Aaker, 1996). Unique brand associations may construct a mental image of the brand in consumer's mind (Aaker, 1996; Maclnnis and Nakamoto, 1991).

The data used for measuring the effectiveness of BA campaigns is gathered from traditional methods of research such as questionnaires, focus groups or in-depth interviews (Park & Srinivasa, 1994; Low, & Lamb Jr, 2000; Belén del Río et al., 2001; Gladden, & Funk, 2002; O'Cass, & Frost, 2002). However, there are internal and external factors which influence the accuracy of the data gathered. A lack of opportunity to check data reliability, and to know about latent brand associations can be cause of irrelevant information being collected. Therefore, a researcher gets an excess or lack of information, an interviewer affects a private part of respondent's life and may cause a negative reaction.

Researchers employed psychophysiological markers of valuation, perception, sensory processing in the search for objective correlates of the effectiveness of marketing campaigns (Baker, 2003, Bargh, 2002, Chartrand et al., 2008; Dimofte and Yalch, 2011; Friese, Wänke, & Plessner, 2006; Janiszewski, 1993; Moore, 1988; Shapiro, 1999, Zaltman, 2000).

We understand BA as images, emotions, colours, values and everything that consumers connect to the brand (Brown & Dacin, 1997; Aaker, 1996).

While building BA is an established process for most companies, measuring the effectiveness of the campaigns is still a challenge. However, measures of the effectiveness of building BA are useful at different stages of brand development (Keith & Petromilli, 2005; Low & Lamb, 2000; Creusen, et al., 2013; Revella, 2014).

One of the pioneering studies of neurobranding was McClure et al. (2004), where they compared anonymous testing of Coke and Pepsi and brand-cued testing of these two brands using fMRI. In the anonymous condition, the authors found a consistent neural response in the ventromedial prefrontal cortex which influenced behavioural preferences in beverages. In the brand-cued part there was a significant influence on behaviour in the choice of a brand and on the brain responses found. This experiment relates to brand loyalty and shows how brand image can determine preferences.

As shown in many studies (Krishnan, 1996, Aaker, 2005, Keller, 2003, Malaer et al., 2011), BA directly influence the image of a brand in a mind of the consumer (Bechara & Damasio, 2005), which, in turn, determines brand equity (Malaer et al., 2011). On the basis of two empirical studies of 167 brands Malaer et al. (2011) show that the implications of self-congruence for consumers' emotional brand attachment are complex and differ by consumer product involvement, individual consumer variables, and the type of self-congruence. Thus, it can be claimed that BA affects the financial performance of the brand, which means that they need careful study. Brands which have strong associations are more competitive (Brown, Kozinets, and Sherry, 2003).

Recent EEG studies of brand associations (Wang et al., 2004; Cui et al., 2000; Kong et al., 2000; Yang and Wang, 2002; Ma et al., 2007, 2010; Mao and Wang, 2008; Han et al., 2015) focused on the neural correlates of brand extensions employing a variety of psychophysiological markers of brain activity starting from memory function and to attention and language. For example, Ma et al., (2012) investigate the P300 component of event-related potential (ERP) correlated with brand extension for beverages. A higher similarity and coherence between the brand name in the prime and the product type in the probe produced an overlap of the similar stimuli in the prime and the probe, which resulted in a larger P300. They state that ERP is included in unconscious mental brand categorization and product groups, but not to the task difficulty and conscious evaluation (Ma et al., 2012). Another study with N400 ERP found useful for studying consumer perceptions of the Coke brand was done by Wang et al. (2012). They recorded N400 in response to a brand extension to a category which is not associated with brand attributes in consumer opinion, for instance, beverage (typical product of the brand, e.g. Coke branded soda water) and clothing (an atypical product, even though sometimes it is seen in the real market, e.g. Coke branded sport wear). Subjects were presented with a pair of sequential stimuli including a soft drink brand name and a product type which comprised of two categories: beverage, which was typical product extension for the particular brand and clothing which was an atypical product for the same brand. For the presentation of an atypical extension following the beverage brand name, the N400 response with frontal, fronto-central and central distribution was recorded in the subjects' brains. These findings help researchers to understand brand perception in more detail: in the human mind a brand consists of several attributes, which are activated while the brand name is being shown. When a link between a brand and these attributes is incongruent, N400 appears (Wang et al, 2012).

It is important to understand that any advertising is a message that is organized according to the rules of language and bears semantic meaning. Therefore, one may logically assume that the brain mechanisms of encoding and retrieval of semantic information might be equally applicable to processing marketing information. Among the various electrophysiological markers, we chose the N400 component of event-related potentials as a signature of semantic process, i.e. it varies systematically with the processing of the meaning of words.

N400

N400 is a component of an EEG signal, evoked by an anomalous or semantically incongruent word in a sentence or string of words.

This electrophysiological response was first observed by Kutas and Hillyard (1980). The N400 potential of ERP was found to reflect semantic incongruity: it occurred in response to a semantically anomalous word in a sentence context, such as city in the sentence 'He shaved off his moustache and city'.

N400 can be seen as a negative deviation of brain potential with the maximal amplitude peaking around 400 ms after the stimuli onset. In different experimental conditions, N400 can be detected in the broader temporal range of 250–500 ms after stimulus onset. N400 is a part of the brain's reaction to words and other stimuli, including visual and aural words, sign language, pictures, faces, nature sounds and smells (Kutas & Federmeier, 2000, 2011). N400 usually has a central or centro-parietal distribution of voltage on the isopotential map.

Kutas and Hillyard (1980) observed the subject's reaction to unexpected words in sentences outlying the previous context expected to register the P300 component, which was the attention correlate. The authors confirmed that the observed negativity was not only evoked by the unexpected action deviation of the potential but a correlate connected with the semantic processing of the stimuli. A variety of publications consider N400 in the paradigm of lexical or sentential meanings (Brown, 1993; Chwilla et al., 1995; Halgren et al., 2002; Kiefer, 2002; Kutas & Federmeier, 2011; Lau et al., 2008; Van Berkum, 1999).

We use the assumption that N400, which is traditionally used in the search for the semantic discrepancy of sentences, can also be a tool helping to find incongruent links between a particular brand and semantic association. Based on this, we hypothesize *that when an incongruent semantic brand association is presented, the N400 component appears.*

The purpose of this experiment is to determine whether the evoked potential of N400 can be used to investigate the presence or absence of brand associations for particular brands in a real-life context.

We assume that in the case of our BA experiment, the incongruent topics of the communities have become one of the factors for their failure. Managers of informal communities select topics that do not correspond with the brand and the content is not interesting to potential subscribers. Successful official communities select topics for content according to their brand development plan and the formation of brand associations. Potential subscribers perceive content as a part of the brand and, as a result, they remain in the community.

We recorded N400 in response to congruent and incongruent sentence endings in marketing and non-marketing contexts. In the main experimental condition, congruent and incongruent brand associations (nouns) presented before brand names were selected from the real marketing campaigns to build brand communities. In the control semantic memory N400 condition, the incongruent sentence endings evoked a significant fronto-centrally distributed N400 brain response at 300–500 ms.

METHODS

Brand selection

We interviewed 105 students of Higher School of Economics to identify 57 brands most often used in the following categories: sportswear, soft drinks, skin care, cafes, alcohol and technology.

We chose 30 out of 57 brands by the criteria of having 2 brand communities in social media (Vkontakte and Facebook). One community should be official with at least 2000 followers; another should be unofficial with at least 200 followers.

Brand association selection

For each brand, 5-6 of the most frequently discussed topics in communities were selected. For 30 brands, 60 communities (ie, 1 official and 1 unofficial community for each brand) were selected. From each community, we selected 2 or 3 topics.

Participants selection

Twenty-one healthy respondents aged 18 to 26 participated in the study, (14 women and 7 men). They all were right-handed native Russian speakers and had normal or corrected to normal vision with no history of neurological or psychiatric abnormalities. They were asked to fill out a questionnaire on familiarity of the brand names used in the experiment. All subjects gave their written consent to take part in the study and were paid for their participation. The experiments were performed in accordance with the Declaration of Helsinki with approval of the University of St. Petersburg Ethics Committee.

Experimental stimuli structure

To study the possibility of using the N400 component as an index of a stereotype accessibility we worked out visual stimuli of two types: short sentences (control probes) and brand statements (test probes). The experiment consisted of two different blocks of congruent (strongly associated) word combinations randomly interspersed with incongruent (weakly associated) ones.

In control trials (A), 104 congruent and incongruent short sentences consisted of a pronoun followed by a verb and ended by a key-word substantive were used as a stimulus. E.g. “I eat a shoe – I eat an apple”. 171 congruent and incongruent brand statements (B) consisted of “For me family and Nivea are associated – For me jokes and Nivea are associated” (Fig 1).

After the experiment, the subject filled out a questionnaire on the congruence/incongruence of the presented word combinations, evaluating each sample on a 5-point Likert scale.

The order of block (test/control) combinations was counterbalanced across all subjects, and within each block, stimulus sequences were individually randomized. To control subject’s attention, in 10% of trials, a probe was complemented by the following control question: "Do you think that the previous stimulus words are matched in meaning?”, to which the subject was supposed to reply by pressing "YES" or "NO" button on a keyboard. Each word in the pair or a sentence was presented on a computer screen for 500 ms with a 500–700 inter stimulus interval (ISI), followed by a 2000-3000 ms exposition of grey display before the beginning of the next trial marked by the fixation cross (ITI).

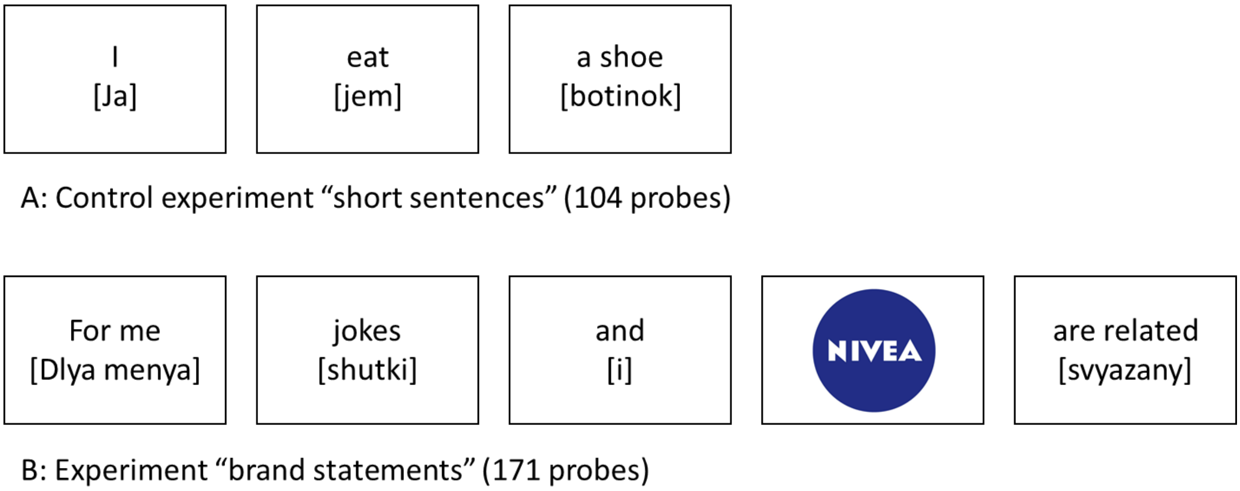

Figure 1. Experimental stimuli design

The experimental procedure

The subjects were set in a chair, at a distance of 40 centimetres from the monitor on which stimuli were presented. The subjects were instructed to fixate their gaze on the centre of the screen where a fixation cross was displayed, to focus on the visual stimuli presented and to respond to the control questions occasionally presented with a button press. After the EEG session, subjects’ familiarity with the brands was tested in order to discard unknown brands from the ERP analysis.

Electroencephalogram recording and pre-processing

During stimulus presentation, subjects’ EEG were registered using a 128-channel EEG setup (BRAINAMP DC) and the electrodes placed on the scalp according to the 10–20% electrode configuration system. EEG electrodes were on-line referenced to the average of all scalp electrodes and later off-line referenced to the average of the two ear electrodes. To control for vertical and horizontal eye movements, electrooculogram (EOG) readings were taken via two electrodes placed below the left eye and lateral to its outer canthus. The sampling rate was 500Hz. Electrode impedances were kept below 10 kΩ.

EEG data analysis was carried out offline using Matlab software with Brainstorm interface inside. Data were re-referenced to the average reference, band-pass filtered (1–30Hz), and bipolar EOG channels were reconstructed for vertical (VEOG) and horizontal (HEOG) eye movements from monopolar EOG recordings. Continuous data were then epoched into segments starting 200 ms before the stimulus onset and ending 600 ms after. In both test and control conditions the stimulus was the ending word in the sentence (‘shoe’ and ‘related’ in Fig.1, respectively). The prestimulus interval of -200–0 ms was used as a baseline. All epochs were then averaged separately for each stimulus type (test, control). Finally, ERPs obtained for the congruent word combinations were subtracted from those obtained for the corresponding incongruent word combinations, in order to further evaluate the difference in the spatio-temporal characteristics of the N400 component of the difference ERP between the experimental conditions.

The statistical significance of the resulted difference was checked using non-parametric permutation test at a significance level $\alpha=0{,}05$.

RESULTS

Fig. 2.1 presents the global field power analysis data for the test and control conditions averaged for all subjects. In this figure, the difference in the amplitude and dynamics of the activity recorded in the two conditions can be clearly seen. In the context of short control sentences, the semantically incongruent word evoked the larger negative deflection between 300 and 500 ms after the stimulus onset (Fig. 2.1(A)). The permutation test ($p<0.05$) showed that this difference was significant at this time interval. In the context of brand message, a difference between responses to the ‘related’ ending word in the context of weak and strong brand associations was observed later, e.g. between 550 and 650 ms (Fig. 2.1(B)). This difference was also significant as the permutation test revealed (Fig. 2.2(B)).

The fronto-central voltage distribution of the N400 potential can be seen on the topograms (Fig. 2.3(A) and Fig. 2.3(B)): N400 topography of the control condition seems to be more focal as compared to the brand-association context. In the structure of the permutation test, the same clusters of electrodes show a significant difference in response to congruent and incongruent stimuli.

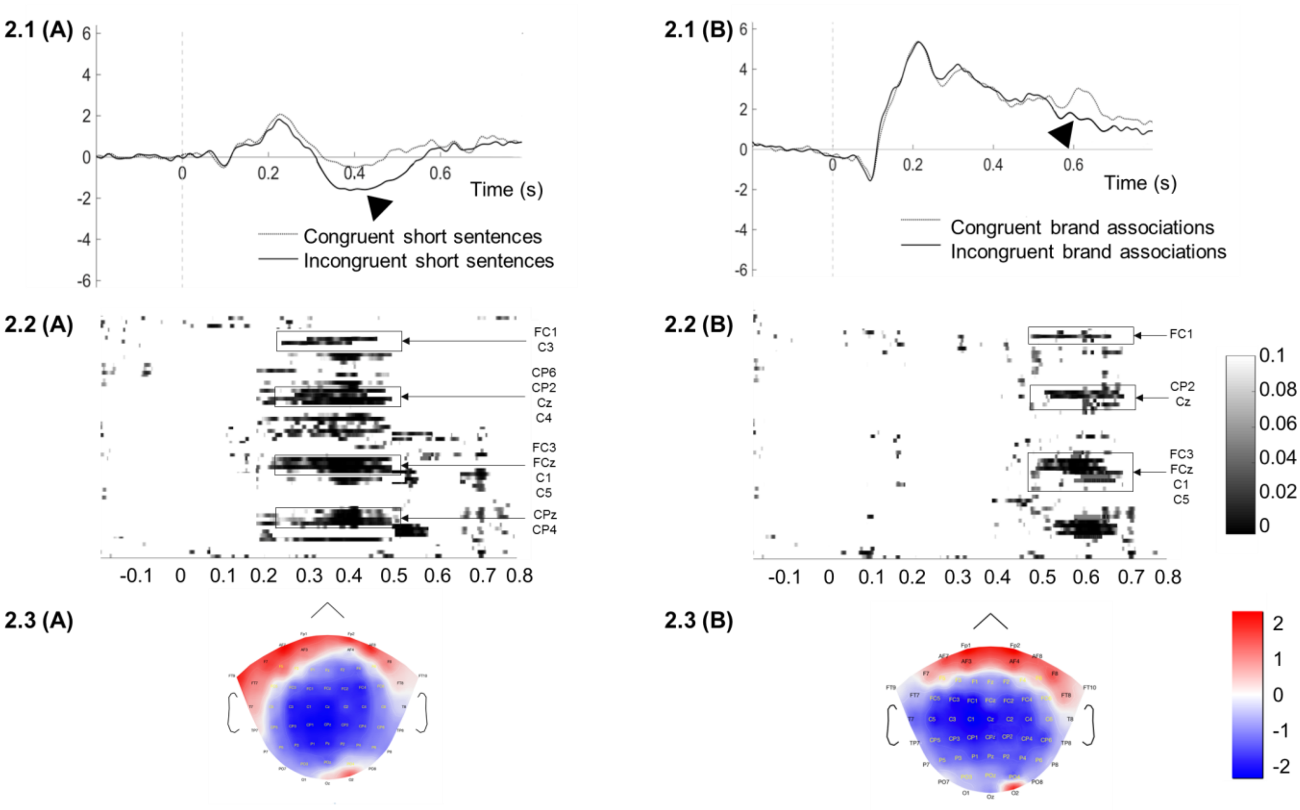

Figure 2. Brain response to control probes (A) and brand statements (B)

2.1. The visualization of the brain response to semantically incongruent probes (A) and the N400 responses in the brand association context (B).2.2. The results of the spatially corrected permutation test: along the Ox-time axis, along the Oy-electrode axis, the colour codes the reliability of the differences in the amplitude of the ERP in control probes (A) and brand statements (B). 2.3. The isopotential map of electrical activity reflecting the processing of incongruent and congruent control probes (A) and brand statements (B), built for the difference wave incongruent/congruent probes.

DISCUSSION

We recorded EEG during the visual presentation of brand statements and non-marketing control conditions represented by short three-word sentences. The semantically anomalous sentence endings and incongruent brand statements evoked larger negative deflections of ERP potentials peaking 400 ms after the stimulus onset in both conditions.

The maximal difference between the weak and strong brand statements peaked at about 600 ms, which was 100 ms later than the N400 in the control condition of semantically incongruent statements. As evidenced in previous N400 findings, this may be caused by a different structure of the experimental (brand-association) probe, as well as the marketing context. For example, various experimental manipulations of memory load, probe speed and background or font colours, often lead to the prolonged N400 responses. For instance, a study in which 10 words a second were presented (Kutas, 1987) showed the peak delay at 80–100 ms in comparison with the probes when words were presented at a slower tempo (1 or 2 words a second). In an experiment which studied the influence of visual blurriness of words using the N400 effect of semantic priming in the test probe, the target probes blurred 33% of every letter and then a dotted matrix was laid on (Holcomb, 1993). The effect peak was delayed by 40 ms in the probes where target words were blurred. A similar delay (80 ms) was found in a semantic priming study with masked primes (Holcomb, 2009). In another study (D'Arcy, 2005) the subjects read one or two sentences and held them in their working memory to later compare them with a third sentence. The peak delay was about 50 ms with a high memory load. The delay correlated with the individual patterns of the working memory. Understanding the temporal differences obtained in our study requires further research in a branding context.

In the N400 research studying brand perception, most publications consider brand extension based on brand associations. For example, it was found that N400 correlates with the processing of categorization in brand extension where there is incongruence between the product category and the previously presented brand (Wang et al., 2012; Lin et al., 2015; Fudali-Czyż et al., 2016). In Wang et al., (2012), 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 clothing product name which had little attributes belonged to the soft drink category evoked large N400 component peaking at 400 ms and distributed over most brain areas from frontal to parietal–occipital area, and its amplitude was larger in frontal, fronto-central and central areas.

The distribution of N400 voltage on the scalp in our study corresponds well to the findings of Wang et al. (2012) and other context-dependent N400 effects that tends to have a centro-parietal scalp distribution, with a small but consistent bias to the right side of the head when visual presentation is used (Kutas, Petten, Besson, 1988). The difference in temporal domain can be explained by difference in the task types: in the experiment of Wang's group, the anomalous endings were substantiated by the product name, not the BA adjective, the number of words in the control sentence were larger (five words) instead of two in Wang or three in our control task. Processing a message consisting of more words could be more demanding in terms of memory load and therefore can be related in prolonged brain response.

From the isopotential maps of voltage distributions obtained for N400 in both conditions, it is hard to infer whether the source of avidity for BA is different from the traditional semantic N400. As we assume that BA effect is context-dependent, i.e. priming related, we can infer that it is likely to originate in the anterior temporal cortex and possibly the angular gyrus as may be inferred from the model proposed by Lau, Phillips and Poeppel (2008).Although, as they, and Kutas and Federmeier (2011), state, the localization of sources using EEG measurements is methodologically challenging, more importantly N400 is a highly distributed process both spatially and temporally – such that many experiments find a network of brain regions (Halgren et al., 2002). Even the hemispheric lateralization can be misleading because of fissure nature of N400 responses and the left hemisphere sources can project to the contralateral scalp areas (Tse et al., 2007).

As for the selection process of brand associations, besides the content analysis of brand communities, it is possible to use the data from the brand web sites, advertisement history and publications in press for creating a more complicated list of brand associations.

For accurate confirmation of the method it is necessary to conduct a study based on the data about other kinds of brand associations such as visual or sound brand associations developed by brand managers working on the Russian market (Wang et al., 2012; Cui et al., 2000). The study should be maintained for separate brands and the subjects should be the target audience of the brands.

We find it particularly exciting that strong and week associations of the brands can be reflected in the brain activity of consumers. Our hypothesis that the neural correlate of meaning representation can be of use to evaluate the effectiveness of the brand message was confirmed. This opens new horizons for objective measurements in marketing. Moreover, as shown by previous research, men and women have different information-processing strategies. It means men are described as "selective processors" who rely on heuristics or overall themes, while women can be defined as "comprehensive processors" who integrate information details (Meyers-Levy 1989; Meyers-Levy and Maheswaran 1991; Meyers-Levy and Sternthal 1991). This may open a new avenue to test how gender influenced BA is processed in the brain. Brand image and particularly brand associations can be perceived in different ways among genders. For example, women have a more positive attitude toward, and a higher purchase intention of, luxury brands versus non-luxury brands than men (Stokburger-Sauer, 2013). Moreover, women have a higher level of brand-evaluation involvement, when comparative advertising is not shown (Chang, 2007) and a stronger correlation with online consumer reviews, which also affects their purchase intention (Bae & Lee, 2011).

It would be interesting to test the hypothesis that traditional marketing research methods such as in-depth interviews or surveys can help to identify some associations they do not have an opportunity to find out all of these latent associations. We think that EEG could detect these extra associations.

Further, the current research methodology, based on N400 evoked potential can be used for testing such marketing stimuli as semantic brand associations.

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