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Neurophysiological evidence for the country-of-origin effect: an event-related potential study

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Consumers often rely on observable cues that hint at the hidden quality of a product. The aim of this study was to investigate brain activities associated with the country-of-origin (COO) effect and consumer evaluation of a product design. Electroencephalogram recordings were used to observe event-related brain potentials associated with the COO effect and design evaluation. We found that the frontocentral N90 and parieto-occipital P220 amplitudes are involved in forming preference to design, whereas the COO effect is processed in the centroparietal P500 amplitude. We also found a significant interaction effect between COO and design preference with regard to reaction times. Specifically, participants tended to spend more time making a preference decision when they did not like the product design made in a country with a favorable COO. These results imply that the two cognitive processes, evaluation of COO and formation of design preference, are activated independently at an early stage. It also suggests that these two processes interact with each other toward the end of the decision phase. Together, the results of this study provide neuropsychological evidence supporting a significant role of COO in the formation of design preference. Future studies are required to further delve into other neurophysiological activities associated with the COO effect. ***NeuroReport*** **25:274–278 © 2014 Wolters Kluwer Health | Lippincott Williams & Wilkins.**

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Introduction

When product quality is not immediately apparent, consumers rely on observable cues that may signal the hidden quality of a product. With increasing globalization and blurred trade barriers, how consumers evaluate a product made in a foreign country has been of keen interest to corporations, consumer researchers, and policy makers for many decades. Since the publication of Schooler [1], which demonstrated that consumers respond differently to products identical in all features, except for the name of the country of manufacture, numerous studies have been dedicated to understanding ways in which the country of product origin influences consumer preference formation [2,3]. These studies have argued that the key factor affecting this process is the image of the country formed based on prior knowledge and experience with the country (e.g. country image [4]). The impact that a country's image has on consumer evaluation of a product is referred to as the country-of-origin (COO) effect [5]. The COO is defined as the country in which a product is manufactured and is obviously one of potential cues influencing consumer evaluation of a product. Although exactly how the COO influences consumer judgment is still a matter of debate, much literature has been built on the assumption that the COO serves as a cognitive cue triggering the top-down process of decision making. That is, the semantic cue of COO activates memory about a certain country, which is in turn used to infer hedonic (e.g. authenticity, status, and symbols) and utilitarian qualities (e.g. performance and value) about a product made in that country [6–8]. In particular, COO influences consumers' assessment of product value and thus plays a role in their purchasing decision [9–11].

However, it is important to note that, although this proposition has served as the most important conceptual base for investigating the COO effect in numerous studies, to our knowledge, there is no scientific evidence to date showing that COO information indeed activates such processes. Although most previous studies focusing on survey evaluations and behavioral experiments have supported the COO effect, the underlying neurophysiological explanation for this effect still remains unknown. Moreover, we believe that our subliminal mental processing, which is not easily detected by a non-neuroscientific method, may also influence the evaluation of products in the context of considering their brands, and ultimately drive our purchase intention. Consequently, there are

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growing demands for neuromarketing technologies; they could reveal the hidden information about consumer preferences that is unobtainable through conventional methods [12]. Therefore, a neurophysiological approach to consumers' preference-decision processes can help us better understand how neuropsychological factors such as COO information interactively influence a consumer's evaluation of product design, and ultimately affect the consumer's purchasing behavior. In this study, we used electroencephalography (EEG) to assess the brain activities associated with the COO effect, specifically with regard to the evaluation of product design. We investigated the extent to which the semantic cue of COO would trigger any meaningful EEG reflections in the context of forming preferences for mobile phone designs. As early event-related potential (ERP) components are known to be more susceptible to sensory (i.e. bottom-up) factors than the later cognitive (i.e. top-down) ERP components [13,14], we investigated a pronounced early ERP component with regard to its possible modulation by the perceptual design preference and a dominant late ERP component with regard to its possible modulation by the COO effect. This is because we assumed that a stimulus design may serve as a bottom-up factor, and a semantic cue of COO information may be associated with a top-down factor. In addition, we examined an intermediate ERP component with regard to a possible interaction between them.

Methods

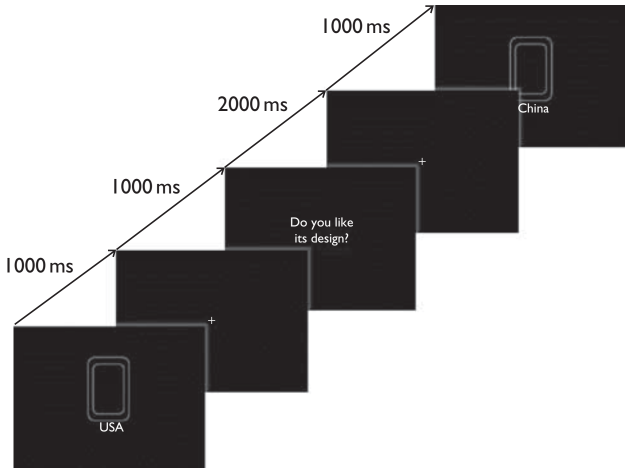
Participants

Fifteen healthy Korean participants (seven women, mean age: 23 years, age range: 19–28 years; all were either undergraduate or graduate students in Korea) underwent EEG recordings in this study in accordance with the ethical guidelines established by the Declaration of Helsinki (World Medical Association, 1964; 2002). Participants provided informed consent before the start of the experiment. All had normal or corrected-to-normal vision.

Stimuli and experimental procedure

In this study, the COO effect was assessed in terms of mobile phone design. As shown in Fig. 1, the sample mobile phone (stimulus) was intended to represent the appearance of a commercial mobile phone with specific regard for its outer shape and the shape of its inner display screen. The inner and outer shapes of a phone either have round or rectangular corners. To systematically develop design variations, we used two design factors: 'symmetry' and 'harmony'. These have previously been regarded as the primary components involved in the evaluation of design esthetics [15]. Specifically, we incorporated the 'symmetry' element with regard to the positioning of the outer and inner shapes of mobile phones (i.e. whether or not the inner shape was placed in a balanced position relative to the outer shape). We manipulated the 'harmony' element such that the corner edges of the inner shape had outlines either the same as or opposite to those of the outer shape. For example, when the corners of the inner shape were round, the corners of the outer shape were either also round or rectangular. The stimulus had the COO information at the bottom (i.e. whether it was made in the USA or China). Each stimulus was subtended at 5.73° (visual angle) and was presented using a presentation software (E-prime 2.0 Professional; Psychology Software Tools, Sharpsburg, Pennsylvania, USA). Each stimulus in white was presented for 1 s on a black background. After a 1-s interval, participants were asked to indicate whether or not they liked the stimulus (i.e. design preference). To identify the COO effect of a particular country, we conducted a survey among 38 Korean respondents (20 women, mean age: 23 years, age range: 19–31 years; all were either undergraduate or graduate students in Korea). The respondents were asked to specify on a seven-point scale the extent to which they believed a mobile phone made in a certain country would have good design, with 1 being 'not likely at all' and 7 being 'highly likely'. The survey respondents indicated that mobile phones originating in the USA were most likely to have a good design, whereas mobile phones originating in China were least likely to have a good design. Hereafter, we use 'favorable COO' and 'unfavorable COO' to refer to the COO effects associated with 'made in the USA' and 'made in China', respectively.

Fig. 1



A task flow diagram of sample stimuli.

Electroencephalogram acquisition

EEG signals were recorded using a BrainAmp DC amplifier (Brain Products, Gilching, Germany) with an actiCAP consisting of 32 Ag/AgCl electrodes (Brain Products). Their placement was in accordance with the

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international 10–10 system: a reference electrode was placed on the tip of the nose and the AFz electrode was used as a ground. Electrode impedances were maintained below 5 kΩ before recordings. EEG was recorded at 500 Hz (analog band-pass filter 0.5–70 Hz). Vertical and horizontal eye movements were monitored using two pairs of bipolar electrodes. The electro-oculogram was corrected offline using the independent component analysis method [16]. Epochs containing other artifacts (maximum amplitude, ± 100 μV and maximal gradient voltage step, 50 μV/ms) were rejected from further analysis. Three participants were excluded on the basis of poor data quality.

Data analysis

Behavioral analysis consisted of assessing reaction times. Reaction times were collected within their individual 95% confidence intervals. Three dominant ERPs were analyzed to investigate early (bottom-up processing, possibly for design preference), intermediate (a possible interaction between design and COO evaluation), and late (top-down processing, possibly for COO information) ERP components: N90, P220, and P500, respectively. Depending on the areas of the brain at which these activities were most pronounced (i.e. regions of interest), the following corresponding electrodes were selected for analysis: for N90 (a minimum peak from 40 to 140 ms poststimulus), 12 frontocentral electrodes (F3, Fz, F4, FC5, FC1, FC2, FC6, C3, Cz, C4, CP1, and CP2); for P220 (a maximum peak from 170 to 270 ms poststimulus), six parieto-occipital electrodes (P3, P4, P7, P8, O1, and O2); and for P500 (a maximum peak from 300 to 700 ms poststimulus), five centroparietal electrodes (CP1, CP2, P3, Pz, and P4). All the time windows were based on their grand averages while taking individual variations into account. Baseline corrections were performed using the prestimulus interval, 0–500 ms. The amplitudes and latencies of each peak were compared for the ERP analysis. An offline filter (0.5–30 Hz) was applied to the final results to display the ERP components clearly. To examine the COO effect and design preference, the EEG and reaction time data were averaged across stimuli using the differing qualities of symmetry and harmony. The data were then analyzed using a repeated-measures analysis of variance with two factors, labeled COO (favorable vs. unfavorable) and design preference (like vs. dislike). When necessary, the Greenhouse–Geisser correction was used.

Results

We found a significant interaction effect between the COO and design preference with regard to reaction times [$F(1,11) = 9.48$, $P < 0.05$]. Subsequent analysis revealed that the favorable COO (627.05 ms, SE = 135.54 ms) yielded significantly longer reaction times compared with the unfavorable COO (270.19 ms, SE = 28.23 ms) among the participants who did not like the design [$F(1,11) = 8.87$, $P < 0.05$; Fig. 2a]. However, we did not find any significant COO effects on the reaction time among those who liked the design [$F(1,11) = 0.56$, NS].

As for the ERP analysis, we found that the level of frontocentral N90 amplitudes was greater when the participants liked the design in comparison with when they did not [$F(1,11) = 6.63$, $P < 0.05$; like: − 3.38 μV; dislike: − 2.12 μV], whereas the N90 amplitudes were not significantly different in terms of different COOs [$F(1,11) = 0.01$, NS]. We found no significant difference in N90 latencies between the participants who liked the design and those who did not [$F(1,11) = 4.09$, NS]. In addition, the level of parieto-occipital P220 amplitudes observed was also different in terms of design preference [$F(1,11) = 7.13$, $P < 0.05$]. Specifically, we found that the participants who liked the design (11.65 μV) yielded higher P220 amplitudes than those who did not like that design (10.43 μV). The P220 latencies exhibited no significant differences. Further, we found that the subsequent centroparietal P500 amplitudes were significantly higher for the favorable COO (13.87 μV) compared with the unfavorable COO [12.50 μV; $F(1,11) = 5.88$, $P < 0.05$]. The P500 amplitudes [$F(1,11) = 0.82$, NS] and latencies [$F(1,11) = 3.97$, NS] showed no significant differences in terms of design preference.

Figure 2b shows topographies for N90 and P220 in terms of design preference, as well as those for P500 in terms of COO information. The activity of N90 around the frontocentral region was prominent for the preferred design and that of P220 around the parieto-occipital region was prominent for the nonpreferred design. The pronounced activity of P500 was concentrated in the centroparietal region for the favorable COO. Figure 2c illustrates ERP time courses of four different conditions for the Fz electrode, in which the frontal N90 component was distinctively modulated by design preference.

Discussion

We observed that ERP components reflected substantial mental processes associated with design preference and the COO effect. As the ERP reflection of design preference appeared at the early stages of information processing, such as the frontocentral N90 and parieto-occipital P220, design evaluation seems to be processed before the assessment of COO; this was processed ~ 400 ms poststimulus. It has previously been established that early ERP components are likely to be affected by the bottom-up (sensory or physical) process, whereas later ERP components tend to reflect higher cognitive processing [13,17]. This interpretation is supported by previous studies, whereby the evaluation of COO required the semantic processes of a COO name, and semantic processes are often reflected in the later ERP components, roughly 400 ms poststimulus [18,19]. Be-

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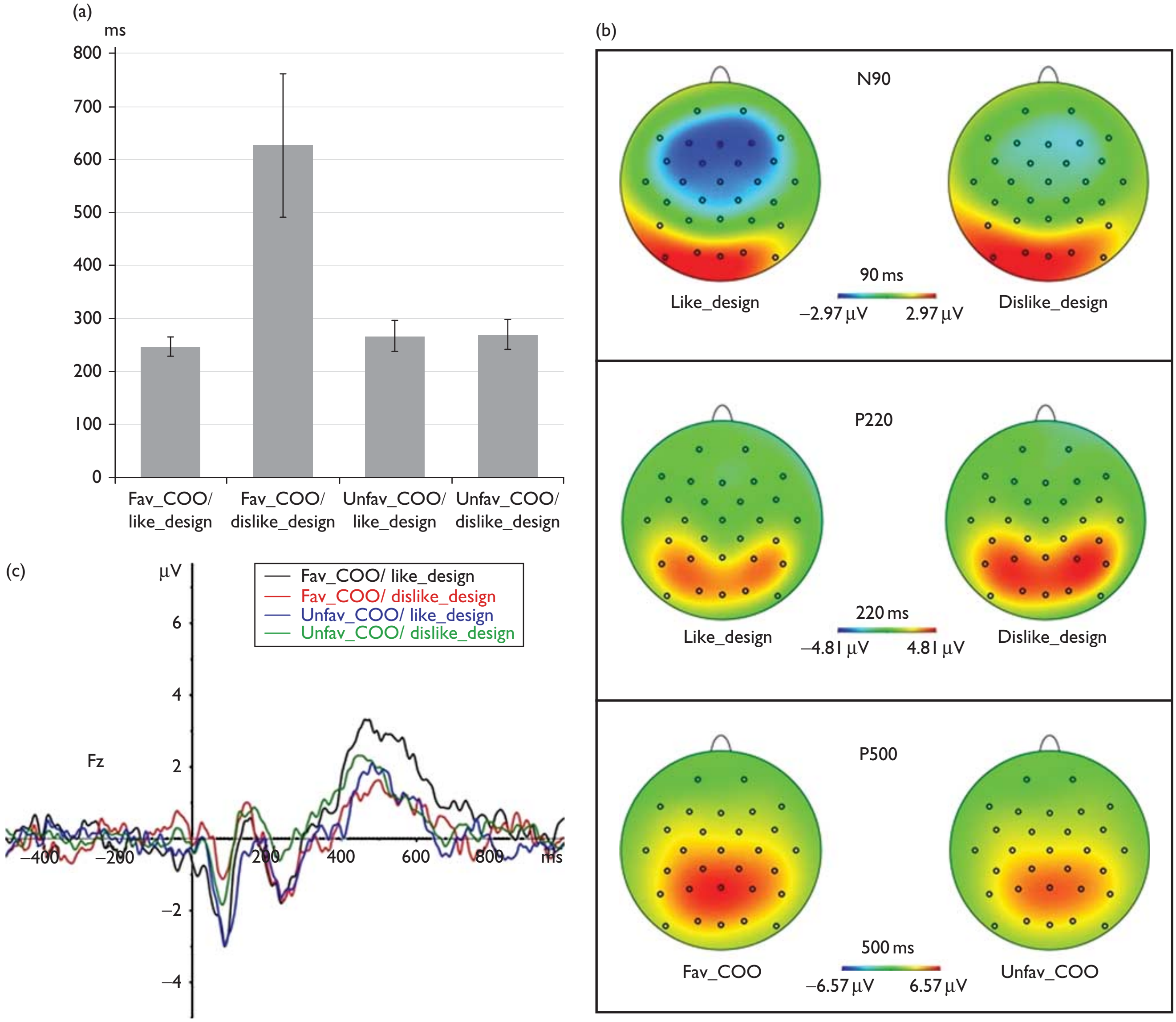
Fig. 2



(a) Reaction times and (b) topographies for N90 and P220 grand-averaged across the COO effect, as well as for P500 grand-averaged across the design preference effect; (c) ERP time courses for the Fz electrode. Vertical bars in the reaction times indicate the SEs of the mean. All the topographies are shown from the vertex view, with the nose on the upper side. COO, country of origin; 'Dislike_design', dislike response; 'Fav_COO', favorable country of origin; 'Like_design', like response; 'Unfav_COO', unfavorable country of origin.

cause the retrieval of semantic memory was observed around 400 ms poststimulus [19], the P500 component observed in our study during this time window might represent the retrieved COO image from participants' memory. Further, the P500 reflection of the COO effect was observed around the parietal region, which processes symbolic and nonsymbolic representations [20]. Therefore, the early N90 and P220 components may represent the primitive design evaluation, whereas the later P500 component may reflect the cognitive assessment of COO in the associative parietal cortex.

The sequential ERP reflections of design preference and COO effects across the different brain regions, that is, frontocentral N90, parieto-occipital P220, and centroparietal P500, indicate that two processes, preference decision and COO evaluation, may be dissociated and activated independently at the early perceptual phases. Given that the frontal N90 component could be modulated by design preference, the evaluation of product design may occur around the frontal region, where value-based preference judgment [21,22] and decision making occur [23,24]. However, there seems to

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be a subsequent interaction between design preference and COO effect with regard to the participants' reaction times. The favorable COO yielded significantly longer reaction times compared with the unfavorable COO, particularly when consumers did not like the design stimulus. A delayed response time indicates a mental conflict when forming a preference. That is, it is difficult for participants to reject the design that they do not like if it is made in the favorable COO. The parietal P500, the late ERP component associated with the COO effect, might also be related to the delayed reaction time we observed, given that long-latency evoked potentials have been found to be associated with the delayed reaction time [25].

Although we observed main effects of design preference and COO information on ERP components, the reaction times showed only interactive modulation. In general, task-relevant electrophysiological correlates have advantages over behavioral responses (e.g. reaction times). This is because subtle neurodynamic changes sometimes do not manage to modulate one's behaviors, but can be explicitly detected in terms of ERPs because electrophysiological measures vary directly with brain dynamics. For example, although a certain experimental condition is reflected in terms of significant ERP changes during the task performance, it may not be associated with any significant alterations in the participants' performance. Presumably, that condition may not have been strong enough to influence the performance stage of behavioral processing.

Conclusion

The results of the current study provide compelling neurophysiological evidence that COO influences product design preference. Future studies are required to further delve into other neurophysiological activities associated with the COO effect. For example, the extent to which consumers weigh COO in their product evaluation could vary in terms of how the COO information is presented. It would be interesting to identify brain activities accounting for the framing effect that reinforces or lessens the effect of COO on consumer judgment.

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Conflicts of interest

There are no conflicts of interest.

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