The Neural Correlates of Celebrity Power on Product Favorableness: An fMRI Study

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ABSTRACT

Advertisements featuring celebrities have increased over the years. While we know that the effectiveness of celebrities stems from a transfer of positive affect from celebrity to product, it is still unclear whether celebrities are also able to improve product favorableness in commercials. In the current study, by employing a functional magnetic resonance imaging (fMRI) experiment that presented subjects with a combination of a celebrity face and a car that was familiar to their culture, we investigated the neural correlates of celebrity power on car favorableness in advertising. The results showed that neural activity in brain areas associated with reward, memory, semantics, and attention was higher when viewing a combination of a celebrity face and a car compared to viewing a combination of a non-celebrity face and a car. Furthermore, it was found that the scores of car favorableness were positively correlated with neural activity of left orbitofrontal cortex (OFC), left anterior insula and left higher-order visual cortex in the occipital lobe. This suggests a possible "transfer effect" of positive attitude, and a feeling for the celebrity, while making a preference-judgment for car.

Key Words: Celebrity, Functional MRI, Favorableness, Advertisement, Neuromarketing

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Introduction

Several research evaluated neural correlates involved in product favorableness according to the design or the shape (Erk *et al.,* 2002; Schaefer *et al*., 2006; Schaefer & Rotte, 2007), brand name (McClure *et al*., 2004; Koenigs & Tranel, 2007), brand logo (Bruce *et al*., 2014) and price (Plassmann *et al*., 2008). These results suggest that product favorableness is more related to affective processing than to strategy-based reasoning (Schaefer & Rotte, 2007).

However, the studies above mentioned have focused on favorableness based on product information. Favorableness is affected not only by product information but also by commercial advertising. One of the popular methods in commercial advertising is to introduce celebrities in product advertisements. Advertisements featuring celebrities has increased over the last decade (Pringle & Binet, 2005). General belief in this trend is that celebrities may enhance the recall of advertising messages and make advertisements more believable (Kamins *et al*., 1989; Petty *et al*., 1983). Several possible explanations for positive effects of celebrity on commercial advertising were proposed. One possible explanation is that a celebrity's face may serve as a reinforcing stimulus, which results in the transfer of reward from that celebrity to the product (Till *et al*., 2008; Walther *et al*., 2005). Another possibility is that a celebrity's face may

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trigger the episodic memory in a consumer and help infer the celebrity's semantics (Spreng *et al.*, 2009; Brambati *et al.*, 2010) Recent studies using fMRI indicate that celebrity endorser credibility has a modulating effect on product preferences and memory (Klucharev *et al.*, 2008; Stallen *et al.*, 2010).

The work by Stallen *et al.*, (2010) indicates that the effectiveness of celebrities stems from a transfer of positive affect from celebrity to product. However, to the best of our knowledge, little is known about the neurobiological account of celebrity power on product favorableness.

Therefore, the aim of this study was to investigate the neural correlates of celebrity power on car favorableness in commercial advertising. To this end, we employed an fMRI experiment that presented participants with a combination of a celebrity face and a car (CFC) that were familiar to their culture. As a control condition, we presented participants with a combination of a non-celebrity (ordinary) face and the same car (NCFC). We measured the participants' favorableness toward the car by asking them to make an estimate of car favorableness during fMRI data acquisition. We hypothesized that the neural activity in brain areas associated with reward, memory, semantics, and attention processing would be higher when viewing a CFC compared to viewing an NCFC. Specifically, we hypothesized that viewing a CFC would show more activation in the OFC related to transfer of reward from celebrity to product (Fairhall & Ishai, 2007; Ishai A. 2008). We also expected that the activation of posterior cingulate cortex (PCC) and temporal pole would be stronger when viewing a CFC, because episodic memory and semantics are associated with PCC (*et al.*, 2009; Huijbers *et al.*, 2012) and temporal pole (Gorno-Tempini & Price, 2001; Brambati *et al.*, 2010; Ross & Olson 2012) respectively.

Finally, we anticipated that the activation of occipito-temporal networks related to visual attention processing would be increased when viewing a CFC. From a prior study, we know that processing in the higher-order visual cortex, occipital lobe, and in the inferior temporal cortex is modulated by attentional processing (Kanwisher & Wojciulik, 2000). Therefore, we expected increased neural activity in these brain regions because celebrities enhance attentional processing.

Methods

Participants

Thirty-three Korean males (mean age 20.6 years) participated in the study. All subjects were right-handed, were not on any medication, and free from any history of neurological or psychiatric illness. To evaluate a familiarity with celebrities, we selected subjects using a questionnaire screening their interest in celebrities. All participants agreed to participate in our fMRI study and provided written informed consent according to the local ethics committee. The study protocol was approved by the Institutional Review Board at Kyungpook National University Hospital.

fMRI paradigm

We showed the subjects, in the MRI scanner, 20 trials (blocks) of a car paired with a celebrity face (CFC) and another 20 trials of a car paired with a non-celebrity face (NCFC). These blocks appeared in random order. During each block, a compact sedan appeared on the left side of the screen without a face. Then while the compact sedan remained on the screen, a face (celebrity or ordinary person) appeared next to the sedan and while the sedan appeared again, subjects were instructed to make an estimate of car favorableness on a 4-point scale, with 1 indicating "lowest favorableness" and 4 indicating "highest favorableness" by pressing one of the four buttons. The two buttons on the left hand corresponded to lower car favorableness and the two buttons on the right hand corresponded to higher car favorableness. Finally, each block ended with black cross hair centered on the screen (Fig. 1). We selected color portraits of Korean celebrities (movie and music stars) and Korean non-celebrities of both genders from publicly available Internet sources. We used the color photograph of the same compact sedan in all blocks to prevent any effects of brand or color on subjects' perception of the car.

To assess the overall car favorableness, scores from all the twenty blocks were summed-up for both the celebrity and non-celebrity groups respectively. Thus, maximum score for car favorableness was 80 points and minimum score for car favorableness was 20 points.

fMRI data acquisition

Functional image data were acquired on a 3.0 T GE EXCITE scanner (Milwaukee, WI) equipped with a transmit–receive body coil and a commercial eight-element head coil array. T2*-weighted echo planar imaging was used for fMRI acquisition. The following acquisition parameters were used in the fMRI protocol: echo time (TE) = 40 ms, repetition time (TR) = 3000 ms, field of view (FOV) = 22 cm, acquisition matrix = 64×64. Using a mid-sagittal scout image, 31 contiguous axial slices, with 4-mm thickness each, were placed along the anterior–posterior commissural (AC–PC) plane covering the entire brain. A three-dimensional, T1-weighted anatomical scan was obtained for structural reference.

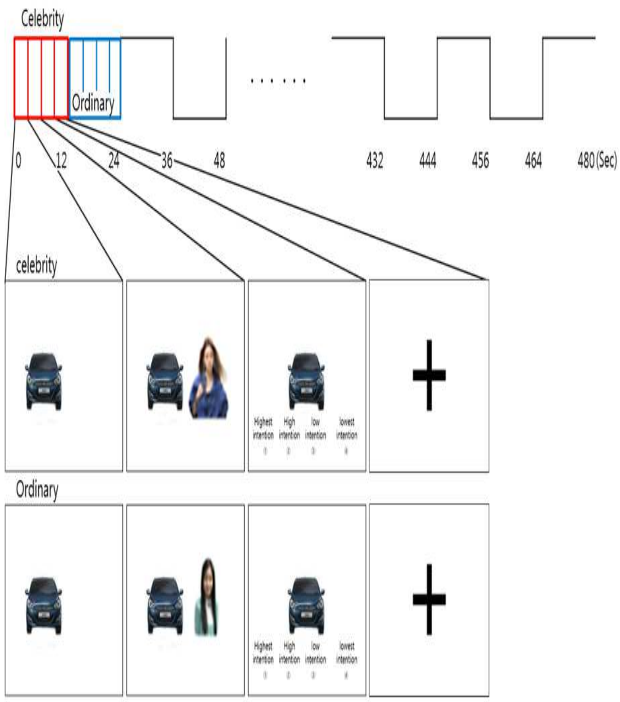

Figure 1. Experimental fMRI paradigm. Subjects were shown 20 trials (blocks) of a car paired with a celebrity face and another 20 trials of a car paired with a non-celebrity face, These blocks appeared in random order. During each block, a compact sedan appeared on the left side of the screen without a face. Then while the compact sedan remained on the screen, a face (celebrity or non-celebrity (ordinary) person) appeared next to the sedan and while the sedan appeared again, subjects were instructed to make an estimate of car favorableness on a 4-point scale, with 1 indicating "lowest favorableness" and 4 indicating "highest favorableness" by pressing one of the four buttons

fMRI data analysis

Image processing and statistical analyses for fMRI data were performed using the statistical parametric mapping [SPM8 (http://www.fil.ion.ucl.ac.uk/spm) on MATLAB (Math Works, Inc., Natick, MA, USA)]. All functional images were corrected for sequential slice timing and were realigned to the first image in order to adjust for head movement between scans. The realigned images were then mean-adjusted by proportional scaling and spatially normalized to correct for a Montreal Neurological Institute template based on the standard stereotaxic coordinate system. The normalized images were subsequently smoothed with a Gaussian kernel of 8-mm full-width at half maximum (FWHM). The first five volumes of each subjects' fMRI data were discarded to allow for longitudinal relaxation time equilibration.

A first-level analysis was computed subject-wise using the general linear model. A boxcar function was convolved with the hemodynamic response function. Statistical parametric maps of the t statistic were generated for each subject and the contrast images were stored for second-level analysis. In within-group analysis of fMRI data, contrast images from the analysis of individual subjects were analyzed by one-sample t-tests, thereby generating a random-effects model, allowing inference to the general population. The SPM{t}s threshold was set at $p < 0.05$, and the false discovery rate (FDR) corrected for multiple comparisons across the whole brain. The resulting activation maps were created and displayed by projection onto an anatomically standardized mean T1 image of all subjects to identify the anatomical correlates of the activity. To make direct comparisons of brain activations between two conditions (CFC vs. NCFC), we analyzed the contrast images for the main effects using a two-sample t-test. SPM {t} s were thresholded at $p < 0.05$ and FDR-corrected for multiple comparisons across the whole brain. The result of the activation map was displayed by projection of an anatomically standardized mean T1 template.

Correlation analysis

We used Pearson's correlation to determine the partial correlations between the mean percentage changes in BOLD fMRI signal, in the activated brain regions, and favorableness scores. For statistical significance the p value was set at $p < 0.05$.

Dominance index measurement

Dominant hemisphere was established by analysis of individual maps using regions of interest based on hemisphere by the Wake Forest PICK Atlas adapted for SPM 8. Dominance is not distinct but can vary with the statistical threshold. Therefore, we employed the bootstrapping algorithm for generation of robust lateralized index (LI) at different thresholds (Brown *et al.*, 2005). A mean dominance index (DI) for each threshold was calculated according to

$$DI = \frac{\left(\sum activation_{left}\right) / mwf - \sum activation_{right}}{\left(\sum activation_{left}\right) / mwf + \sum activation_{right}}$$

“Activation” is the number of activated voxels and “mwf” is the mask weighting factor (Brown *et al.*, 2005). When using symmetrical masks, "mwf" is equal to 1. The result is a dominance index between -1 and +1 where -1 is complete right dominance and +1 is complete left dominance.

Statistical analysis

We used a two-sample t-test to determine group differences for behavioral outcomes (favorableness scores) using SPSS v.19 (SPSS Inc.). Statistical significance was set at $p < 0.05$.

Results

Behavioral outcomes

Subjects demonstrated higher score for car favorableness when presented in combination with a celebrity face (mean±standard deviation, 58.27±10.06) than with a non-celebrity face (42.27±7.56, $p<0.00001$). This behavioral result is in line with fMRI results showing higher neural activity in the left primary motor cortex and supplemental motor area when viewing a combination of a celebrity face and a car (Fig. 3). The two buttons on the right hand corresponded to higher car favorableness and those on left hand to lower favorableness. Increased neural activity in the left primary motor cortex, and left supplemental motor area explained the observation that subjects pressed buttons on the right hand more frequently than buttons on the left hand.

Within-group analyses (car with a face vs. baseline)

One-sample group analysis revealed significant activations in brain areas associated with attention, memory and visual processing on presenting a car in combination with a face (celebrity or non-celebrity) compared to baseline condition of only a cross hair (car with ordinary face > baseline) ($p < 0.05$, FDR corrected for multiple comparison at whole brain level, Fig. 2a and Fig. 2b). Areas of activation are summarized in Table 1.

Between-group analysis (car with celebrity face vs. car with non-celebrity face)

Between-group analysis exhibited significantly higher activation of the following areas in the CFC over NCFC condition (car with celebrity face > car with ordinary face): lateral and medial OFC, anterior insula, temporal pole, PCC, higher-order visual cortex in the occipital lobe, and the inferior temporal cortex ($p < 0.05$, FDR corrected for multiple comparison at whole brain level, Fig. 3a and Table 2). Additionally, the left primary motor cortex and left SMA showed higher activation revealing that subjects pressed buttons on the right hand more frequently in this comparison. All activations in this contrast appear to be predominantly lateralized in the left hemisphere (Fig. 3b). In the opposite contrast, NCFC > CFC, no significant activation was found in any regions.

Correlations between brain activations and behavioral outcomes

We found positive correlations (Figure 4) between the scores for car favorableness and BOLD activity in each brain areas studied namely, left OFC (r = 0.301, $p = 0.020$), left anterior insula (r = 0.267, $p = 0.039$), left temporal pole (r = 0.280, $p = 0.030$).

Discussion

The goal of this study was to investigate the neural correlates of celebrity power on favorableness in car advertisement using fMRI. To the best of our knowledge, this is the first study to examine the neural response to an effect of celebrity on favorableness toward cars. We found that the neural activity in brain areas associated with reward, memory, semantics, and attention processing was stronger when viewing a combination of a celebrity face and a car than when viewing a combination of an ordinary face and the same car. Furthermore, celebrity context showed higher left-lateralized brain activity.

Medial OFC showed higher activation with a CFC trial than with an NCFC trial. The medial OFC encodes actual experienced pleasantness and is associated with the pleasantness of several rewarding stimuli. Higher activity in the medial OFC in a CFC trial is therefore consistent with previous findings that the medial OFC is crucial for preference judgments of product (Paulus & Frank, 2003; McClure *et al.*, 2004; Koenigs & Tranel, 2008; Plassmann *et al.*, 2008; Bruce *et al.*, 2013; Erk *et al.*, 2002).

Furthermore, the functional coupling between the fusiform gyrus and the OFC increased when viewing famous faces (Fairhall & Ishai, 2007; Ishai A. 2008). Therefore, our result seems to suggest that face of celebrity as a “motivationally salient and rewarding” stimulus could transfer positive affect from celebrity to car and thus, this increased activation of medial OFC might in turn affect participant’s attitudes. Although the activity of OFC was increased when viewing beautiful, attractive, and sexually relevant faces (O'Doherty *et al*., 2003; Kranz & Ishai 2006; Ishai 2007), higher activation of medial OFC in the current study is unlikely to represent the reward related to the physical attractiveness of the famous faces because male and female faces were randomly included in our experiment.

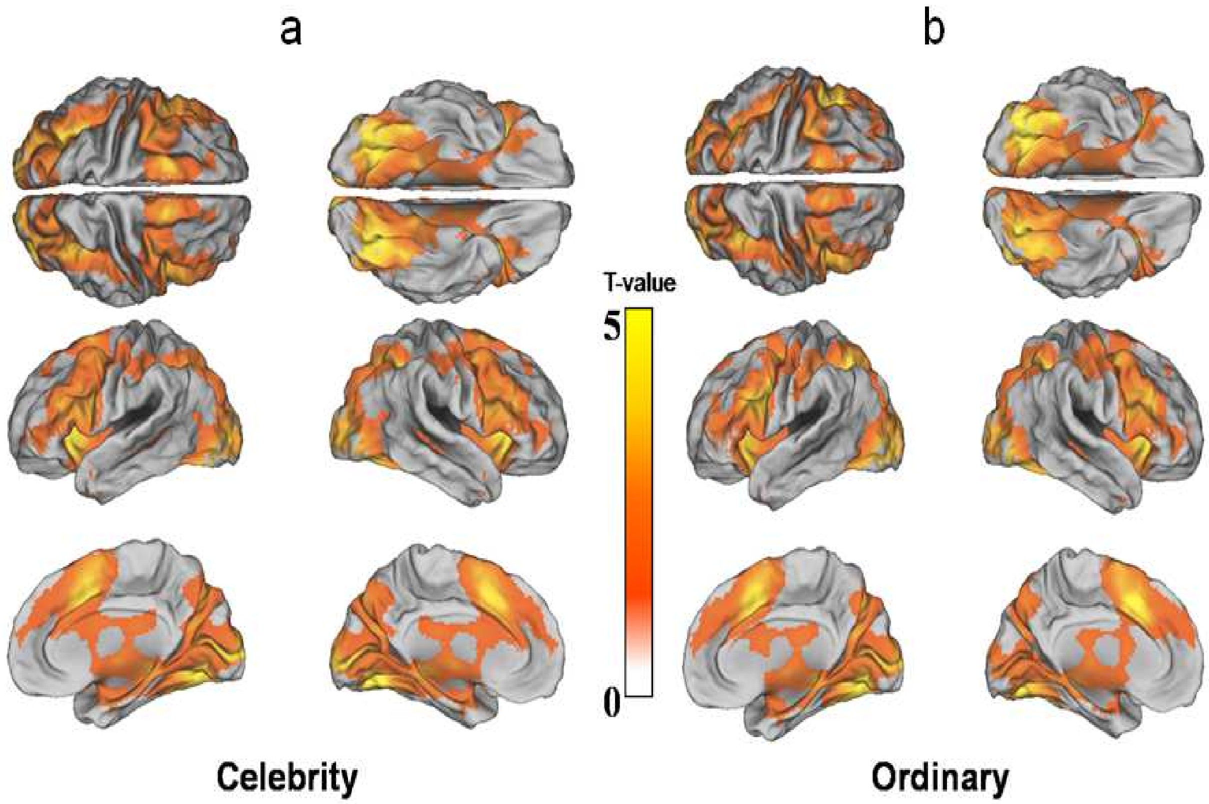

Figure 2. One-sample group analysis revealed significant activations in brain areas associated with attention, memory, visual processing (a) when contrasting a car presented in combination with a celebrity face over baseline condition of cross hair and (b) when contrasting a car presented in combination with a non-celebrity (ordinary) face over baseline condition of cross hair. Activation maps were thresholded at *P*<0.05 (FDR corrected for multiple comparison at whole brain level)

Table 1. Regions of activation from within-group analysis (FDR corrected: *P*<0.05)

	Region		Cluster size	Coordinates(mm)			Peak T
				x	y	z	
One-Sample celebrity	Precentral	L	2885	-44	8	32	12.60
	Cerebellum	R	6051	38	-46	-30	12.48
	Insula	R	1808	32	22	2	12.14
	Cuneus	R	1247	16	-92	2	12.03
	Cerebellum	L	5550	-38	-42	-30	12.01
	Fusiform	R	1591	32	-66	-16	11.81
	Fusiform	L	1502	-28	-76	-12	11.70
	Frontal Inferior Operculum	R	1213	60	16	30	11.08
	Cerebelum Crus 1	L	1152	-40	-54	-28	11.04
	Cingulum Mid	L	562	-10	22	38	10.99
One-Sample general	Cerebelum 6	L	1547	-38	-52	-28	12.47
	Fusiform	L	1367	-28	-78	-12	11.87
	Frontal Inferior Operculum	R	1212	56	20	32	11.74
	Supplementary Motor Area	L	1729	-8	16	46	11.71
	Fusiform	R	1462	32	-66	-16	11.62
	Precentral	L	2588	-44	6	30	11.56
	Temporal Mid	L	51	-54	4	-30	3.46
	Temporal Inferior	L	89	-34	8	-40	2.45
	Temporal Mid	R	205	50	-24	-10	3.03

L = left, R = right

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Table 2. Between-group analysis exhibited significantly higher activation of the following areas in car with celebrity face > car with non-celebrity (ordinary) face ($p < 0.05$, FDR corrected for multiple comparison at whole brain level)

	Region		Cluster size	Coordinates(mm)			Peak T
				x	y	z	
Two-sample	Postcentral	L	1901	-54	-12	52	7.62
	Lingual	L	507	-14	-78	-10	6.01
	Precuneus	L	669	-4	-56	24	5.61
	Parietal Superior	L	131	-24	-42	62	4.60
	Paracentral Lobule	L	278	-8	-20	54	4.44
	Precuneus	L	669	-6	-42	66	4.43
	Cingulum Mid	L	474	-2	-32	34	4.41
	insula	L	424	-46	-24	16	5.90
	Temporal Mid	L	287	-50	-66	2	4.93
	Cuneus	R	63	18	-96	8	4.12
	Frontal Mid Orbital	L	24	-32	34	-14	3.82
	Temporal Pole Superior	L	44	-42	6	-18	3.71
	Frontal Mid Orbital	R	25	4	48	-10	3.61

L = left, R = right

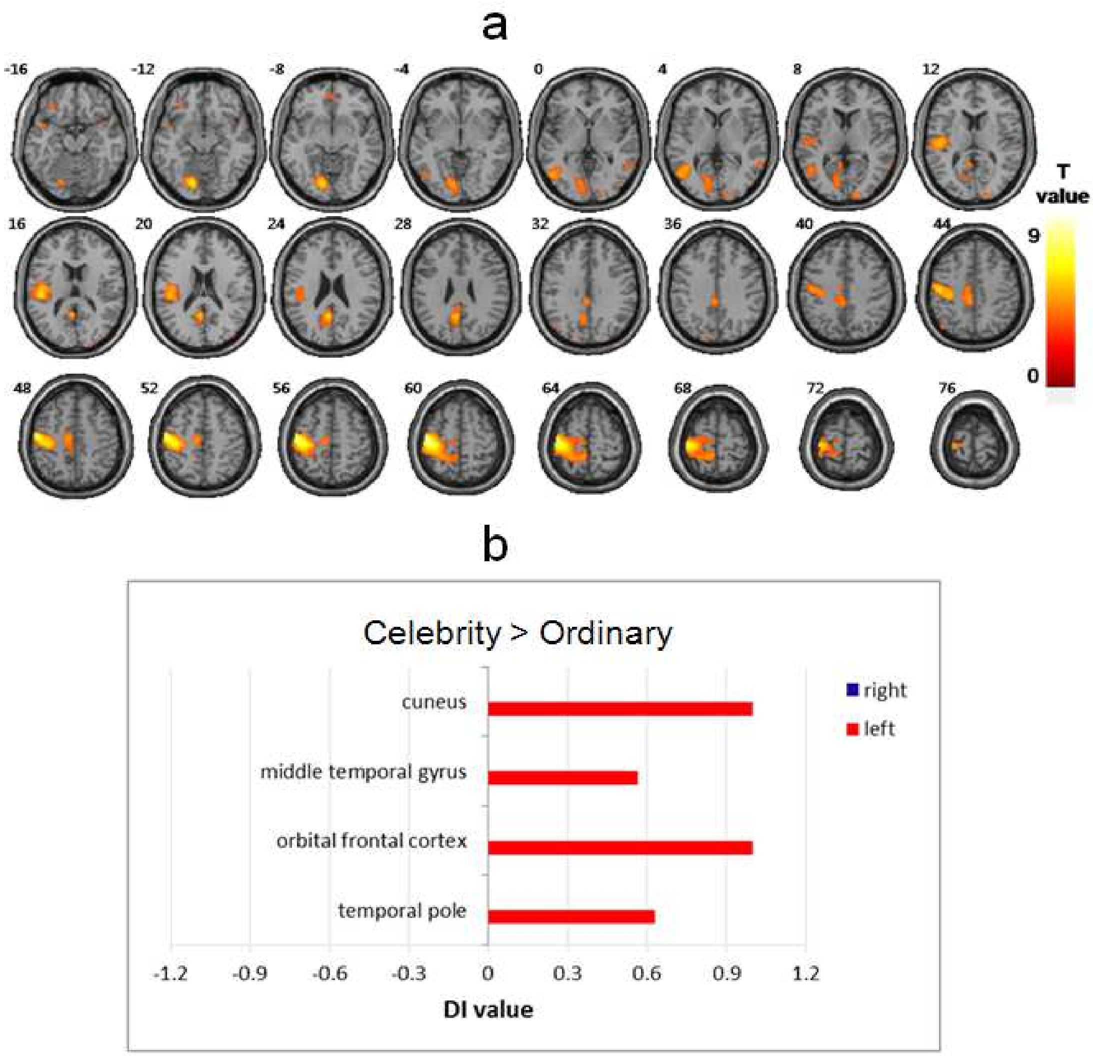

Figure 3. (a) Two-sample between-group analysis for car with celebrity face vs car with ordinary face (car with celebrity face > car with non-celebrity (ordinary) face) exhibited significantly higher activation in the lateral and medial OFC, anterior insula, temporal pole, PCC, higher-order visual cortex in the occipital lobe, and the inferior temporal cortex ($P<0.05$, FDR corrected for multiple comparison at whole brain level) **(b)** Dominance index in two-sample result for car with celebrity face > car with ordinary face. OFC: orbitofrontal cortex, PCC: posterior cingulate cortex, DI: dominance index

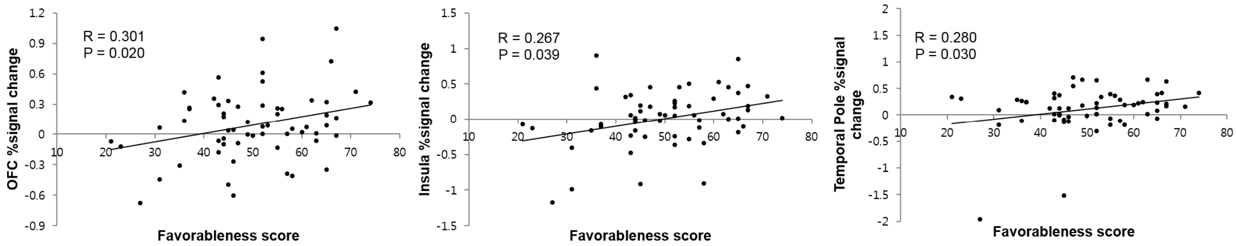

Figure 4. Positive correlations between the BOLD activity and scores for car favorableness in the left OFC, left anterior insula and left temporal pole

Lateral part of OFC showed higher activation in the CFC trial than in the NCFC trial with the same car. Moreover, the neural activity of lateral OFC showed positive correlation with favorableness scores. Several studies have indicated that the lateral part of OFC is often linked to the evaluation of negative reinforcers and unpleasantness of stimuli (Small *et al*., 2001; Small *et al*., 2003). However, Noonan *et al*. (2012) recently demonstrated that lateral OFC is related to assigning credit for rewards to particular choices, and link representations of specific stimuli to specific rewards. Therefore, our result seems to support this recent finding in that lateral OFC plays an important role in linking a car to a celebrity's face and transfer of reward from celebrity to car.

The BOLD activity of left anterior insula showed positive correlation with favorableness scores. Previous studies demonstrated that the activation of insula is related to preference judgments for soft drinks (Paulus & Frank, 2003) and limousines (Erk *et al*., 2002). It is also a key neural structure of salience network that detects the most relevant stimuli, among internal and external stimuli, in order to guide behavior (Menon & Uddin, 2010). Accordingly, celebrity face in this study may be an emotionally salient and important stimulus, which could lead to increased activation of the insula. Furthermore, the correlation with favorableness scores may suggest that emotional salience for celebrity could affect participant's favorableness for cars. Another possible mechanism that could explain stronger neural response in the insula to celebrity face is associated with somatic marker hypothesis (Bechara *et al*., 1997; Verdejo-García & Bechara, 2009). According to somatic marker hypothesis, decision-making, including preference judgments, may be influence by subjective feelings in relation to somatic signals instead of rational thinking. The insula has been considered as a key neural structure mediating translating somatic signals into subjective feelings (Singer *et al*., 2009). Therefore, celebrity face may induce positive somatic marker and feelings, which could increase the activation of the insula.

Other brain areas that showed significant activation in a combination of a celebrity face and a car include temporal pole and PCC. Anterior temporal lobe including temporal pole play a crucial role in social memory in relation to representing and retrieving social knowledge such as people, their names and biographies and social concepts (Ross & Olson, 2010; Olson *et al*., 2013). In particular, the anterior temporal lobe is involved in encoding and storing emotionally tagged social knowledge, which may guide the OFC-based decision processes (Olson *et al*., 2013). In addition, it is a key area in recognizing famous faces (Gorno-Tempini & Price, 2001; Brambati *et al*., 2010; Ross & Olson 2012) a function that is also attributed to PCC (Leveroni *et al*., 2000; Nielson *et al*., 2010). Another functional role of PCC is its association with episodic memory (Spreng *et al*., 2009; Huijbers *et al*., 2012). Moreover, the PCC is related to representing specific situation of episodic memory and orienting people in specific place and time (Ranganath & Ritchey, 2012). Therefore, activation of PCC may be involved in retrieving specific episodic memory in relation to celebrities' faces.

In this study, the increased activation of insula, PCC and temporal pole in the context of celebrity face showed left-lateralized brain activity. This result is consistent with previous research that fame activates left-lateralized neural network. For example, famous faces and names activated more left hemisphere networks than right hemisphere networks (Nielson *et al*., 2010). It has been demonstrated extensive activation of left prefrontal and temporal cortex in expert context in order to elaboration of semantics

(Klucharev *et al*., 2008). Furthermore, the left anterior temporal lobe is involved in processing unique semantic information of famous faces (Brambati *et al*., 2010; Ross & Olson 2012). A lesion-analysis study demonstrated that left-lateralized anterior temporal lobe damage was associated with an inability to retrieve proper names of famous faces (Semenza, 2006). Therefore, it is possible that the activation of distributed left-lateralized neural network in this study is associated with representing and retrieving specific information of celebrity.

The neural activity of left occipitotemporal network was higher in a CFC trials compared to NCFC trials. Visual processing in higher-order visual cortex in the occipital lobe and the inferior temporal cortex could be modulated by attentional processing (Kanwisher & Wojciulik, 2000). Furthermore, the OFC may play a crucial role in "top-down" object recognition (Bar *et al*., 2006). Therefore, the predictive information about objects, processed in the OFC, is fed back to the higher-order visual cortex to facilitate attention to object recognition (Fenske *et al*., 2006). Based on these observations, the higher neural activity of the left occipitotemporal network found in this study may be associated with increased attention towards a celebrity's face. This in turn could lead to enhancing the strength of product–celebrity paring and in facilitating the retrieval of explicit memories about the celebrity. The result of higher neural activity of left occipitotemporal network seems to be in accordance with the previous finding that attention plays an important role in the learning of associations between products and positively valenced stimuli (Pleyers *et al*., 2009). The positive correlation between the BOLD activity of the left higher-order visual cortex in the occipital lobe and favorableness scores further suggest that the increased attention by celebrity may enhance favorableness in the processing of a car advertisement.

Conclusion

This study showed that the neural activity in brain areas associated with reward, memory, semantics, and attention processing is higher when a car is viewed in combination with a celebrity face than when viewed along with a non-celebrity face. Furthermore, the favorableness scores positively correlated with the neural activity of left OFC, left anterior insula and left higher-order visual cortex in the occipital lobe. Taken together, these results suggest that a positive attitude and feeling for celebrity, along with unique memory and semantics of it, may have a transfer effect on preference-judgments for cars. Therefore, the current study provides evidence for neural mechanisms related to celebrity power on favorableness of cars.

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Author Disclosure Statement

The authors declare that there are no conflicts of financial interest.

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