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Neural activity associated with enhanced facial attractiveness by cosmetics use

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HIGHLIGHTS

- Using fMRI, we investigated the neural basis of made-up face processing.
- The OFC showed greater activity for made-up faces than for faces without make-up.
- OFC activity reflected increasing facial attractiveness by cosmetics use.
- We show a direct link between the OFC and enhanced attractiveness of made-up faces.

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ABSTRACT

Previous psychological studies have shown that make-up enhances facial attractiveness. Although neuroimaging evidence indicates that the orbitofrontal cortex (OFC) shows greater activity for faces of attractive people than for those of unattractive people, there is no direct evidence that the OFC also shows greater activity for the face of an individual wearing make-up than for the same face without make-up. Using functional magnetic resonance imaging (fMRI), we investigated neural activity while subjects viewed 144 photographs of the same faces with and without make-up (48 with make-up, 48 without make-up, and 48 scrambled photographs) and assigned these faces an attractiveness rating. The behavioral data showed that the faces with make-up were rated as more attractive than those without make-up. The imaging data revealed that the left OFC and the right hippocampus showed greater activity for faces with make-up than for those without make-up. Furthermore, the activities of the right anterior cingulate cortex, left hippocampus, and left OFC increased with increasing facial attractiveness resulting from cosmetics use. These results provide direct evidence of the neural underpinnings of cosmetically enhanced facial attractiveness.

1. Introduction

Facial attractiveness plays an important role in social interaction, and attractive people are often more valued in mate choice [1]. People tend to be positively biased toward attractive individuals, even during infancy [10]. Previous psychological studies have suggested that several factors, including symmetry, averageness, and skin texture, contribute to the enhancement of facial attractiveness [4,13,15]. In particular, these studies suggested that facial symmetry reflects developmental health and genetic quality and that facial averageness reflects heterozygosity.

The use of cosmetics, which is nearly universal among women in contemporary societies, has been a popular practice throughout history and can be observed in many cultures [20]. Previous psychological studies have indicated that make-up enhances attractiveness [12,13]. For example, Mulhern et al. investigated how various make-up types enhance female facial attractiveness and showed that eye make-up plays a critical role in increasing facial attractiveness [12]. Furthermore, Nash et al. demonstrated

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that female faces with make-up were perceived as healthier, more confident, and having greater earning potential than women without make-up. They argued that cosmetics enhance facial attractiveness because foundation creates a uniform skin texture and conceals imperfections, and eye and lip make-up increase eye and lip symmetry [13]. Taken together, these results suggest that make-up might have a profound effect on facial impressions by improving facial features.

Previous neuroimaging studies have shown that the orbitofrontal cortex (OFC) shows greater activity for the faces of attractive people than for those of unattractive people, suggesting that the OFC is associated with increased facial attractiveness [2,8,14]. Furthermore, several studies have demonstrated that the medial part of the OFC is engaged when individuals are exposed to various types of rewards other than attractive faces, including social approval and monetary incentives [6,9,11,18]. These results have indicated that attractive faces are processed as rewards. Nevertheless, because previous studies employed faces of different individuals as attractive and unattractive stimuli, they do not prove whether OFC activity is associated with enhanced facial attractiveness of the same individuals by modulatory measures such as cosmetics use.

We conducted an fMRI study to determine whether the OFC shows increased activity when subjects view made-up faces. During fMRI scanning, subjects were presented with photographs of faces with make-up, faces of the same individuals without make-up, and scrambled images of these faces and were asked to rate the attractiveness of the faces. Our methodology enables us to directly investigate whether the OFC encodes the difference in attractiveness between the same faces with and without make-up. We predicted that the faces with make-up would be rated as more attractive than those without make-up and that the OFC would be activated by increased subjective values of made-up faces.

2. Materials and methods

2.1. Subjects

A total of 28 healthy volunteers (14 females and 14 males; age range, 20–26 years; mean age, 20.7 years) were paid for their participation in this study. No pathological findings were identified in the brains of any of the participants. All of the subjects were right-handed and had normal or corrected-to-normal vision. After the subjects were given a detailed description of the study, they provided their written informed consent in accordance with the Declaration of Helsinki and the guidelines approved by the Ethical Committee of Tohoku Fukushi University.

2.2. Stimuli and tasks

To collect face photographs, we recruited 48 female volunteers (age range, 18–25 years; mean age, 21.5 years) who did not participate in this fMRI study. The participants were told that the photographs would be used only for research purposes, and they provided their written informed consent. The participants were asked to present a neutral facial expression and look directly into the camera. Photographs were taken under two conditions: a make-up condition and a no-make-up condition. All of the images were then downloaded onto a computer and edited using Adobe Photoshop and Adobe Illustrator to increase the uniformity between the photographs. We also generated a scrambled image of each face from the no-make-up photographs using MATLAB. The photographs of faces without make-up were cropped to 20×20 pixels and then placed randomly on the original face contour; the luminance and color information for the scrambled images were identical to those of the no-make-up images. Therefore, the experimental stimuli consisted of 48 face photographs with make-up, 48 face photographs without make-up, and 48 scrambled images.

During the fMRI scanning, the subjects were asked to fixate on the center of a screen and to rate each face photograph for attractiveness on a 6-point scale ranging from 1 (very unattractive) to 6 (very attractive) by pressing a button with the first three fingers of both hands (Fig. 1. They were also asked to press the button with either their left or right little finger when they saw a scrambled image. The stimuli were presented on a screen mounted on a head coil through a projector outside the scanner room. Each stimulus was presented for 2.5 s. The inter-stimulus interval, during which the cross-fixation was constantly presented, ranged from 5000 to 10,000 ms to maximize the efficiency of the event-related design [3]. The combinations of buttons and fingers were counterbalanced across the subjects. The entire fMRI task was divided into two consecutive runs, each of which lasted approximately 11 min. Half of the face photographs with make-up, the face photographs without make-up, and the scrambled images were used in the first run, and the other half of each group was used in the second run. The same face with and without make-up was separated into distinct runs. The order of the two runs was counterbalanced across the subjects.

2.3. Image acquisition and analysis

Whole-brain imaging was performed using a 3.0-Tesla MRI scanner. A T2*-weighted echo planar imaging (EPI) sequence sensitive to BOLD contrast was used for functional imaging with the following parameters: repetition time (TR) = 2500 ms; echo time (TE) = 30 ms; flip angle = 90°; 80×80 acquisition matrix; field of view (FOV) = 240 mm; in-plane resolution = 3×3 mm; and 43 axial slices, with a slice thickness of 3 mm and an interslice gap of 0.5 mm. A high-resolution (spatial resolution $1 \times 1 \times 1$ mm) structural image was also acquired using a T1-weighted, magnetization-prepared rapid-acquisition gradient echo pulse sequence. The head motion of each subject was restricted by surrounding the head with firm padding. Visual stimuli were presented on a screen mounted on a head coil through a projector outside the scanner room. The responses of the subject were collected using a magnet-compatible response box. The EPI images were acquired during two consecutive runs. The first four scans in each run were discarded to allow for T1 equilibration effects.

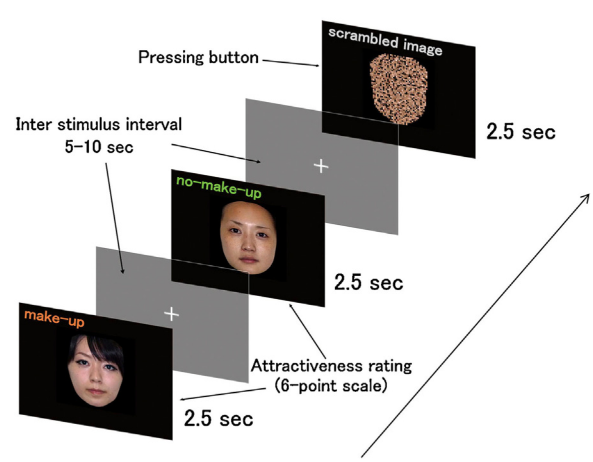

Fig. 1. *Experimental design and stimuli.* During the fMRI scanning, 144 images were presented one by one in random order. The subjects were asked to rate each face (full-make-up and no-make-up) according to attractiveness on a 6-point scale by pressing a button with the first three fingers of both hands but to press a button with the little finger for scrambled images.