Facial EMG pattern evoked by pleasant and unpleasant odor stimulus

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ABSTRACT

Activities of venter frontalis, corrugator, levator labii superioris and greater zygomatic muscles were measured for five male subjects while they made pleasant, unpleasant and neutral facial expressions, and while they were presented pleasant, disgusting, and neutral odors. Pleasant expression and odor activated zygomatic muscles while unpleasant expression and odor increased corrugator muscle activity.

Keywords: EMG, odor, facial expression, pleasant and unpleasant emotions

INTRODUCTION

Emotions are displayed by verbal and non-verbal behaviors such as actions and facial expressions. Facial expressions are important especially in social context, because they convey information of one's emotions to others. Researchers have tried to identify which the part of the face is the important source of the information. Some researchers have developed coding rules of face action such as Ekman and Friesen's FACS[1] and Izard's Max[2]. Although their procedures have substantial validity and reliability, they require trained experimenter and consume a lot of time, especially in coding of a series of facial expressions.

Facial electromyogram (EMG) is another procedure to measure and to code facial expressions. EMG is easily quantified, objective index that requires less time and effort. It has been found that facial EMG is affected by emotionally evoked stimulus presentation, and by imaging emotional events. In a series of experiments, Schwaltz and colleagues have reported that pleasant thoughts increased zygomatic muscle activity, whereas unpleasant thought increased corrugator muscle activities[3] [4] [5] .

In our previous study[6], three parts of facial muscles (venter frontalis, corrugator muscles, greater zygomatic muscle) were measured while subjects were required to make pleasant and unpleasant facial expressions on the first session, and presented pleasant(gamma-undecalactone) and disgusting (iso-Valeraldehyde) odor stimuli on the second session. Average muscle activity showed that pleasant expression and odor stimulus increased zygomatic muscle activities, and unpleasant expression and odor activated corrugator muscle. But their activities were so small that the results did not reach significant

level. And there would be one prodcedural deficient. In the experiment, subjects had the experience of making facial expression many times prior to the presentation of odor stimulus. That could facilitate EMG emission on the following odor presentation trials.

In our present study, facial EMG is monitored in experimental sessions where subjects are presented pleasant of disgusting odor stimulus, before subjects are making pleasant and unpleasant facial expressions. We compare activities in four groups of facial muscles to identify the region of the muscles that differentiates pleasant and unpleasant emotions.

METHOD

Subjects were healthy five male undergraduates aged from 21 to 23 years old. Experiment was conducted in a electrically shielded sound proof room, where temperature and humidity were maintained at 24±0.5℃, 50±5%, respectively. In an adjacent room, a digital polygraph (Nihonkoden Sanei, EE2514) and an equipment for odor presentation were placed. EMG were monitored through miniature AG/CL electrodes (Nihonkoden), and processed by the digital polygraph with 5 ms sampling time. Facial EMG was recorded from four regions, forehead (venter frontalis), over the eyebrow (corrugator muscles), beside nose (levator labii superioris muscle) and cheek (greater zygomatic muscle) (Figure 1). These positions to be placed was under Fridlund and Cacioppo's guideline [7].

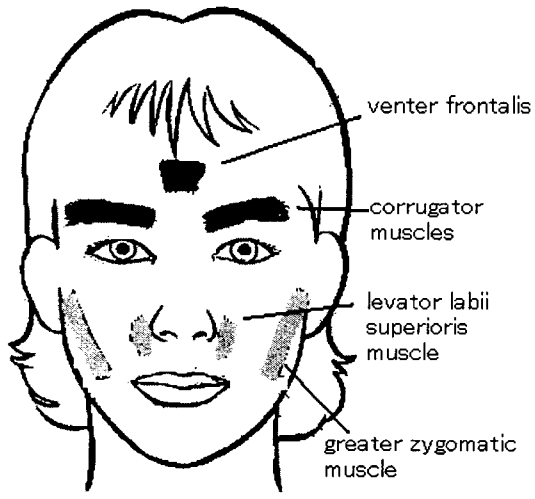

Fig. 1. EMG recorded region of facial muscles.

In the preliminary session, following to the attachment of electrodes, subjects were asked to rate pleasantness of several odor stimuli to determine pleasant and unpleasant stimuli used in this experiment. Lemon and iso-Valeraldehyde were selected as the representatives of pleasant and disgusting odors. Liquid of odor essence was placed in the heated bottle of the equipment, and the airflow moved the odor to in front of the face of subjects through teflon tube. Flow rates were 500 ml/min for iso-Valeraldehyde, and 250 ml/min for lemon and neutral odorless airflow. The experimental chamber was always ventilated so that odor was soon removed. In the first experimental sessions (Odor presentation), subjects experienced 5 sessions of 44 trials, of which 22 were assigned to pleasant odor (Lemon) , 22 were to unpleasant odor (iso-Valeraldehyde), and the rest were to neutral odor (air) presentation. A trial was 10 second odor presentation followed by 45 sec odorless period to replace air. Experiment was intermitted in every 6 trials to prevent odor habituation. These three odor types of trials were presented by random order, and consisted one block. The subjects experienced 3 sessions, each consisting 3 blocks of trials.

In the second experimental session (facial expression), the subjects were instructed to make 10 second

pleasant facial expression, then make unpleasant expressions. This block of expression trials were repeated 15 times, and consisted one experimental session. The subjects received total of 5 sessions.

EMG was recorded throughout experimental session, and stored in digital data recorder. After the completion of experiment, the data was analyzed by signal processing software (BIMTUS).

RESULTS

First 5 sec period of each trial was used for FFT analysis. Power value from 60 Hz to 220 Hz is summed up for each facial muscle, and for each experimental condition. For three subjects out of 5, power value in odor presentation sessions was so small that the following analysis could not be made. These subjects did not emit few EMG while they were presented odor stimulus. In the following analysis, the results are limited to the two subjects.

Comparisons of summed power value revealed that, for the subject 1, making pleasant expression produced larger greater zygomatic muscle activities, and unpleasant expression activated greater corrugator muscles (Figure 2, 3). This was also the case of subject 2 (Figure 4, 5), but the size of muscle activities was smaller than that of subject 1. The size of muscle activities was about four times smaller on odor presentation sessions compared with the case of facial expression. Comparison of lateral differences on muscle activities showed that left side of muscle was more activated for both subjects.

Discriminant analysis was performed to test how much power value of muscle activities in each trial predicted pleasant and unpleasant expressions or odor presentation. Discriminat rate was 98.3 percent for subject 1 on facial expression sessions, 100 percent on odor presentation sessions. The rates of 88.4 percent, and 100 percent were obtained for subject 2. These discriminant rates indicated that EMG data was almost perfect predictor of the subjects' pleasant or unpleasant emotions.

DISCUSSION

Out of 5 subjects, data of three subjects was eliminated because of small amount of EMG on odor presentation sessions. For the rest of two subjects, presentation of pleasant and disgusting odors activated greater zygomatic and greater corrugator muscles, which corresponded to the results on EMG data on facial expression trials. These results are coincident with the results of our prior experiment. This suggests that odor stimulus makes emotional responses that appears on facial expressions.

One of the reasons that make facial EMG analysis difficult is that the size of EMG was very small, especially to odor presentation. Ideas and procedure are needed that enable small amount of EMG changes to be detectable.

In the current experiment, pleasant and unpleasant emotions are detected more on the left side of facial EMG. Consideration would be needed to the possibility that emotions are likely to express on the left side and pleasant and unpleasant emotions are expressed on the left side.

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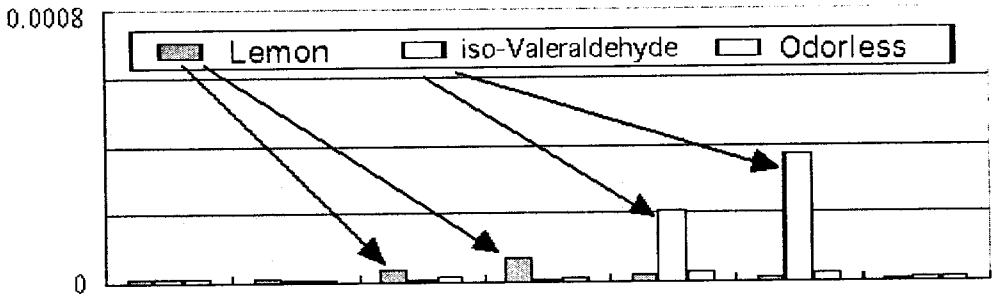

Fig. 2. Power value for each region of facial muscle and for each odor of Subject 1 on Odor Presentation trials.

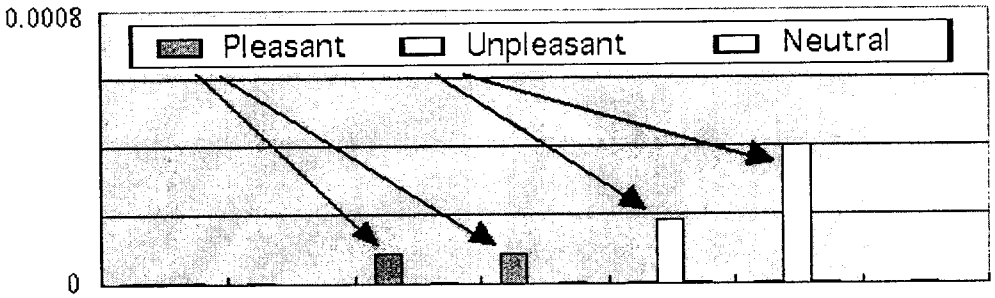

Fig. 3. Power value for each region of facial muscle and for each odor of Subject 1 on Facial Expression trials.

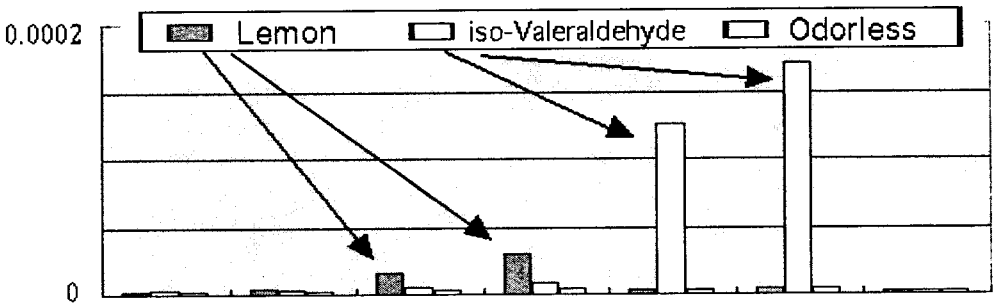

Fig. 4. Power value for each region of facial muscle and for each odor of Subject 2 on Odor Presentation trials.

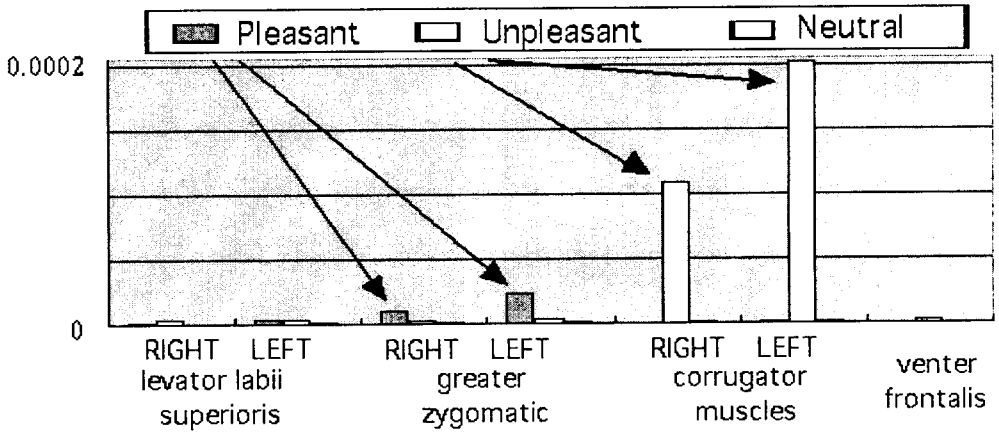

Fig. 5. Power value for each region of facial muscle and for each odor of Subject 2 on Facial Expression trials.