STUDY OF POSED EMOTION IN FACIAL EMG ASYMMETRY

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Summary.—37 subjects’ facial electromyographic activity at the corrugator and zygomatic muscle regions were recorded while they were posing with happy and sad facial expressions. Analysis showed that the mean value of EMG activity at the left zygomatic muscle region was the highest, followed by the right zygomatic, left corrugator, and right corrugator muscle regions, while a happy facial expression was posed. The mean value of EMG activity at the left corrugator muscle region was the highest, followed by those for the right corrugator, left zygomatic, and right zygomatic muscle regions while a sad facial expression was posed. Further analysis indicated that the power of facial EMG activity on the left side of the face was stronger than on the right side of the face while posing both happy and sad expressions.

Facial asymmetry is a phenomenon in which the intensity of emotional facial expression on one side of the face is stronger than on the other side of the face as observed directly (e.g., Borod, 1993; Borod, Haywood, & Koff, 1997). Studies using facial electromyography (EMG) technique (e.g., Schwartz, Ahern, & Brown, 1979; Larsen, Norris, & Cacioppo, 2003; Zhou & Hu, 2004) have also verified facial asymmetry in emotional expression. Two major hypotheses have been proposed to explain the neurophysiological mechanisms of facial asymmetry: the right hemisphere dominance hypothesis (e.g., Borod, 1993) and the valence hypothesis (Davidson, 2000). The right hemisphere dominance hypothesis states that the right hemisphere is dominant over the left hemisphere for emotional communication. Since the right hemisphere controls the left side of the face through direct nerve innervations to facial muscles, the right hemisphere dominance hypothesis predicts stronger intensity of facial expression of emotion on the left hemiface (Borod, 1993; Borod, et al., 1997). The valence hypothesis states that the hemispheric asymmetry depends on emotional valence: the right hemisphere has dominance for negative emotions, and the left hemisphere has dominance for positive emotions (Davidson, 2000).

The objective of the present study was to investigate further the facial asymmetry using EMG activity at the zygomatic and corrugator muscles while posing happy and sad facial emotions. Since previous studies using

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behavioral assessment have repeatedly documented facial asymmetry phenomenon (Borod, 1993; Borod, et al., 1997), EMG activity was hypothesized also to display lateralized facial muscle responses to posed emotional expression. The experimental findings of specific patterns of EMG activity would provide empirical evidence to support the right hemisphere dominance hypothesis or valence hypothesis of emotion.

**Method**

Undergraduate students (11 men and 26 women) at Humboldt State University participated. Subjects were recruited from various psychology courses and received extra credit as compensation. The subjects’ ages ranged from 18 to 28 years ($M=20.5$, $SD=2.3$). All subjects were right-handed, as assessed with the Chapman and Chapman scale (1987).

The experiment was conducted individually in a private suite of a laboratory in the Department of Psychology. Each of the 37 subjects participated in one laboratory session during which each sat in a chair with a headrest. Two 6-mm silver-silver chloride cutaneous disk electrodes were placed on the subject’s left corrugator muscle region, and two other electrodes were placed on the right corrugator muscle region to record EMG activity (Zhou & Hu, 2004). Two electrodes were placed on the subject’s left zygomatic muscle region, and two other electrodes were placed on the right zygomatic muscle region to record EMG activity (Zhou & Hu, 2004). The electrode placement and EMG signal-collecting procedures were the same as previously reported (see Zhou & Hu, 2004).

The conversation between experimenters in the observation room and the subject in the recording room was through an intercom system during the experiment. Each subject was given two conditions, Look Happy and Look Sad. In the Look Happy condition, each subject was first asked to sit still in the chair in a sound-attenuated and electrically shielded room while 32 sec. of baseline EMG signals were recorded. Two minutes after baseline period, the subject was asked to pose a happy facial expression in response to a verbal command “Look Happy” for 32 sec. during which the EMG signals were recorded.

Thereafter, the experimenter entered the recording room and asked the subject to read and make a single mark on a 100-mm horizontal visual analog scale of feelings of affect. The 100-mm horizontal line was used to indicate how much each subject felt a particular emotion during the 32 sec. of the posed emotion period. The Pleasantness scale ranged from 0 to 100 with 100: mostly pleasant located at the right end of the scale and 0: mostly unpleasant located at the left end of the scale.

The Look Sad condition started after the subject rested for 5 min. The subject repeated the same cycle of a recorded baseline of EMG activity, a recorded period of EMG activity while posing a sad facial expression in re-
sponse to a verbal command “Look Sad” and marking a visual analog scale of feelings of pleasantness. The order of posing happy and sad facial expression was counterbalanced with an ABBA design. Half of the subjects first posed a happy facial expression and then posed a sad facial expression. The other half of the subjects first posed a sad expression and then posed a happy expression.

The ratings of Pleasantness on the visual analogue scale were quantified by measuring the length in millimeters from the left end of the scale to the mark. The means and standard deviations of ratings for Pleasantness were calculated for both conditions accordingly.

The EMGs were analyzed using the Fast Fourier Transform (FFT) spectral analysis technique as reported previously (see Zhou & Hu, 2004). The ratio of the spectral power of EMG frequency band of 20 Hz to 500 Hz between posing emotions and baseline periods was calculated for statistical analysis.

Results and Discussion

The mean ratings of Pleasantness were 69.5 mm (SD=13.7) in the Look Happy condition and 42.2 mm (SD=10.9) in the Look Sad condition. A paired t-test comparing the difference between two posed conditions indicated the subjects made significantly higher ratings of Pleasantness in the Look Happy condition than in the Look Sad condition (t_{6}=9.13, p<.0001). Analysis also indicated that the subjects generally reported experiencing increased emotional feelings of pleasantness, with a mean rating of 69.5 on a scale of 0 to 100 while posing a happy expression. These results suggest that posing a happy expression moderately elicited pleasant feelings. This finding is consistent with our recent study that positive emotion was effectively elicited by viewing pleasant photographs (Zhou & Hu, 2004). However, the subjects reported experiencing a mild unpleasantness having a mean of 42.2 on a scale of 0 to 100 while posing a sad emotion. Because the rating of 50 indicates a neutral emotion rating on a scale of 0 to 100, it seems that posing an unpleasant facial expression elicited a relatively mild negative emotion.

Table 1 presents the means and standard errors for ratios of EMG spectral power recorded over the corrugator and zygomatic muscles of the left and right sides of subjects’ faces between the periods of posed emotion and baseline under the Look Happy and Look Sad conditions. As can be seen in the table, the subjects generated the highest ratios of EMG spectral power/ratio between the periods of Look Happy and baseline at the left zygomatic muscle, followed by data using the right zygomatic, left corrugator, and right corrugator muscles. The subjects generated the highest ratios of EMG spectral power between the periods of Look Sad and baseline at the left corrugator muscle, followed by data using the right corrugator, left zygomatic, and the right zygomatic muscles.
Table 1
Means and Standard Errors of Ratios of EMG Spectral Power Recorded Over Left and Right Corrugator and Zygomatic Muscles Between Posed Emotion and Baseline Periods (N=37)

<table>
<thead>
<tr>
<th>Condition</th>
<th>Ratio of EMG Spectral Power</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Left Corrugator</td>
</tr>
<tr>
<td></td>
<td>M    SE</td>
</tr>
<tr>
<td>Look Happy</td>
<td>1.51 0.16</td>
</tr>
<tr>
<td>Look Sad</td>
<td>2.79 0.44</td>
</tr>
</tbody>
</table>

One-way within-subjects analysis of variance with univariate follow-up pairwise comparisons indicated that the left zygomatic muscles generated significantly higher ratios of EMG spectral power between the periods of Look Happy and baseline than the right zygomatic muscles (F_{1.56} = 5.63, p < .02). The left zygomatic muscles generated significantly higher ratios of EMG spectral power between periods of Look Happy and baseline than the left corrugator muscles (F_{1.36} = 20.4, p < .0001), and the right zygomatic muscles generated significantly higher ratios of EMG spectral power between periods of Look Happy and baseline than the right corrugator muscles (F_{1.36} = 22.35, p < .0001). No significant difference was found between the left and right corrugator muscles in the ratios of EMG spectral power between periods of Look Happy and baseline than the right zygomatic muscles.

One-way within-subjects analysis of variance with univariate follow-up pairwise comparisons indicated that the left corrugator muscles generated significantly higher ratios of EMG spectral power between periods of Look Sad and baseline than the right corrugator muscles (F_{1.36} = 4.94, p < .03). No significant difference was found between the left and right zygomatic muscles, between left corrugator and left zygomatic muscles, and between right corrugator and right zygomatic muscles in the ratios of EMG spectral power between periods of Look Sad and baseline.

The present study indicated that the subjects generated higher ratios of EMG power at the zygomatic than at the corrugator regions between the periods of posing happiness and baseline and that the subjects generated higher ratios of EMG power at the corrugator muscle regions than at the zygomatic muscle regions between the periods of posing sadness and baseline (see Table 1). These results are consistent with previous findings that viewing pleasant pictures elicited greater EMG activity over the zygomaticus major than over the corrugator supercili and that viewing unpleasant pictures elicited greater EMG activity over the corrugator supercili than over the zygomaticus major (Larsen, et al., 2003; Zhou & Hu, 2004).

An important finding of the present study was the lateral effects of facial asymmetry indexed by facial EMG activity while posing happy or sad emotions. We found that subjects generated significantly higher EMG power
at the left zygomatic muscle region than at the right zygomatic region while posing a happy emotion and that subjects generated significantly higher EMG power at the left corrugator muscle region than at the right corrugator region while posing a sad emotion. This finding is consistent with the reports of recent studies in which researchers found that negative emotional expressions elicited relatively greater activity in the left corrugator muscle than right corrugator muscle and that positive emotional expressions elicited relatively greater activity in the left zygomatic muscle than in the right zygomatic muscle (Dimberg & Peterson, 2000; Zhou & Hu, 2004). However, the finding was not consistent with the report of the previous study in which researchers observed that positive emotional expressions elicited significantly greater EMG activity at the right zygomatic muscle than at the left zygomatic muscle (Schwartz, et al., 1979).

Our findings also demonstrated that the left side of the face (both corrugator and zygomatic muscles) generated higher facial muscle activity than the right side of the face regardless of the valence of the expression. The findings provide empirical evidence consistent with the right hemisphere dominance hypothesis of emotion which suggests that the right hemisphere was specialized for emotion regardless of emotional valence and that the right hemisphere is dominant over the left hemisphere for emotional expression of all types (Borod, 1993). Although some of the previous studies’ findings support the right hemisphere dominance hypothesis of emotion (Borod, 1993) and others support the valence hypothesis of emotion (e.g., Davidson, 2000), it is important to mention that quite different measurements and methods have been used in the studies of facial asymmetry of emotion and that there are still some perplexing problems to be unraveled in subsequent studies.

REFERENCES


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