ABSTRACT

Forty female volunteers participated in a study to investigate whether facial EMGs could be used as measures of affect during sexual arousal. Audiotaped narratives were used to induce the following affect-sexual states: 1) pleasant affect + sexual arousal, 2) unpleasant affect + sexual arousal, 3) pleasant affect + no sexual arousal, and 4) unpleasant affect + no sexual arousal. EMG activity was recorded bilaterally from the corrugator and zygomatic muscle regions. Corrugator muscle activity was significantly greater in response to the unpleasant stimulus conditions. This relationship held for both the non-sexual and sexual conditions, suggesting that corrugator muscle activity may provide a reliable index of negative affect during sexual arousal. Zygomatic activity was significantly greater during the sexual as compared to the non-sexual stimuli, but did not increase as a function of pleasant affect. Greater left than right corrugator muscle activity was observed in response to the sexual stimuli. Left muscle superiority was also noted for zygomatic muscle activity, in response to the sexual unpleasant stimulus. Issues related to the interpretation of lateralized muscle activity are discussed.


Research on the effects of emotion on erotic response has been prompted by clinical reports that certain affective states, such as anxiety and depression, interfere with sexual functioning (Masters & Johnson, 1970). In particular, the relationship between anxiety and sexual arousal has been studied extensively (cf. Barlow, Sakheim, & Beck, 1983). Clinical and empirical evidence suggests that anxiety can both facilitate and inhibit the sexual response. There also exists a sizeable literature relating the effects of trait-like affective processes, such as sex guilt and attitudes toward sexuality, on sexual arousal (Abramson & Mosher, 1975; Mosher, 1973; Mosher & Greenberg, 1969). The results of these studies have shown that high levels of sex guilt and negative attitudes toward a variety of sexual issues decrease sexual responsiveness to certain erotic stimuli. For example, a study by Mosher and Abramson (1977) found that negative attitudes toward masturbation resulted in significantly lower ratings of self-reported sexual arousal to films depicting masturbation. In addition, subjects who reported the lowest levels of sexual arousal also reported the highest levels of disgust, depression, shame, and guilt. Similar findings have been reported by Fehr and Schulman (1978).

The above findings are consistent with clinical reports suggesting that certain emotions may inhibit or facilitate sexual response. To date, however, there have been relatively few systematic attempts to examine the specific nature of the relationship between emotion and sexual arousal. The available evidence remains largely suggestive because the data are correlational and do not directly address questions related to the mediating effects of emotions.

The investigation of the interaction between emotional and sexual arousal has been hindered by the lack of rigorous measures of affect. Despite significant advances in the physiological measurement of sexual arousal (Barlow, Becker, Leitenberg, & Agras, 1970; Geer, Morokoff, & Greenwood, 1974), the measurement of emotional arousal has been restricted to the use of retrospective self-reports. Reliance on self-report measures has been criticized because of their susceptibility to bias from variables related to conditions of measurement and to indi-
Facial Responses to Sexual Arousal

March, 1986

vidual differences in subjects (Amoroso & Brown, 1973). Thus, other measures are needed.

One possibility is electromyographic (EMG) recording from facial muscles. In recent years, Schwartz and his co-workers have demonstrated that different patterns of facial muscle activity accompany the subjective experience of various emotions (Schwartz, Fair, Salt, Mandel, & Klerman, 1976; Schwartz, Fair, Mandel, Mieske, & Klerman, 1978; Schwartz, Ahern, & Brown, 1979; Sirota & Schwartz, 1982). Their findings indicate that unpleasant emotions are associated with increased corrugator activity while pleasant emotions are associated with increased zygomatic activity.

To date, facial EMG has successfully differentiated positive and negative emotional reactions to autobiographical recollection imagery (Schwartz et al., 1979), photographs of facial expressions (Dimberg, 1982), music (Cohen & Thayer, 1982), self-referent statements (Sirota & Schwartz, 1982), and counterattitudinal messages (Caccioppo & Petty, 1981). The results of these studies have been consistent in demonstrating that two distinct patterns of facial muscle activity are associated with positive and negative affect states.

It is worth noting that the facial musculature is not exclusively involved in the expression of emotion. Some investigators (e.g., Ekman, 1978) have drawn attention to the use of facial displays as conversational signals. Some of these are said to occur frequently during verbal interaction and to include facial movements indicative of punctuation, agreement, disbelief, and questions. The difficulties involved in distinguishing emotional and conversational muscle activity based on facial EMG recordings make it necessary to provide experimental conditions which reduce the probability of movement due to conversational factors. In studies examining facial muscle responses to emotional stimuli, subjects have been tested in isolation and have not been required to emit any verbal responses.

The purpose of the present study was to evaluate the potential utility of facial EMG recording as a measure of positive and negative affective responses during sexual arousal. EMG activity was examined in response to four stimulus conditions designed to induce the following emotions in association with sexual arousal: 1) pleasant affect + sexual arousal, 2) unpleasant affect + sexual arousal, 3) pleasant affect + no sexual arousal, and 4) unpleasant affect + no sexual arousal. In addition, facial muscle activity was recorded bilaterally, thereby permitting examination of the relative asymmetry of facial muscle response to the different affect-sexual conditions.

Method

Subjects

Subjects responded to advertisements posted on the Concordia and McGill University campuses. A total of 60 female volunteers, aged 18–39 yrs (X = 23.7 yrs), participated in the study. Subjects' mean number of years of education was 15.1, range = 11–20 yrs. Twenty pilot subjects were used to pretest the stimuli. The remaining 40 were randomly assigned to one of the four stimulus conditions in the main study.

The choice of female subjects was guided, in part, by findings suggesting that women are particularly well suited for research examining facial muscle responses to emotional stimuli (Schwartz, Brown, & Ahern, 1980). In addition, given that most of the research in this area has focused almost exclusively on the facial affective responses of women (Cohen & Thayer, 1982; Ekman, Friesen, & Ancoli, 1980; Ekman, Hager, & Friesen, 1981; Schwartz et al., 1976; Sirota & Schwartz, 1982), our use of female subjects facilitates cross-study comparisons.

Materials

Stimuli. Four audiotaped narratives, each of approximately 5-min duration, served as the experimental stimuli. The pleasant sexual narrative depicted an explicit sexual scene with mutually consenting partners, while the unpleasant sexual narrative described a non-consenting sexual encounter. The story of a young couple sailing was depicted in the pleasant non-sexual narrative, and an incident in which a woman is brutally beaten during a robbery was described in the unpleasant non-sexual narrative. The pleasant sexual and pleasant non-sexual narratives were adapted from stimuli employed by Heiman (1975). The unpleasant sexual and unpleasant non-sexual narratives were derived from Malamuth and Check (1980).

Questionnaires. Subjective emotional arousal was measured by a 7-point Likert-type rating form on which subjects indicated the degree to which they experienced the following emotions: “pleasant-unpleasant,” “felt happy-felt sad,” “felt good-felt bad,” and “felt angry-felt not angry.” This form included a scale measuring degree of sexual arousal.

All subjects completed the Sexual Opinion Survey (SOS) and the Sexual Arousalability Inventory (SAI). The SOS is a measure of the erotophobic-erotophilic disposition that has been shown to mediate approach-avoidance responses to sexual stimuli (Fisher, Byrne, & White, 1983). The SOS requires subjects to rate, on a 7-point scale, their degree of agreement or disagreement with 21 statements about a variety of sexual topics. Scores can range from 21 to 147. High scores indicate positive attitudes about sex and low scores reflect negative attitudes. The SAI requires subjects to rate the degree to which they find each of 28 activities to be sexually arousing. Scores on this instrument can range from a minimum of −28 to a maximum of 140. The SOS and SAI were included to provide infor-
Each subject listened to one of four audiotaped narratives, corresponding to the stimulus condition to which she had been assigned. Subjects were asked to imagine themselves as the woman in the story. At the conclusion of the narrative, the electrodes were removed and the subjects completed a second affect rating form, the SOS, and the SAI.

**Data Reduction**

Polygraph chart speed was reduced to 5mm/s such that the output resembled a solid bar of ink which increased in height as a function of increased pen deflection (amplitude). Data were sampled in 15-s blocks, at 10-s intervals, using the graphics tablet and stylus. This procedure permitted the calculation, in square millimeters, of the area of each data block representing the sum of EMG activity over a 15-s period.

EMG measures were scored independently by two experimenters who were blind with respect to stimulus condition. The average of these two scores was computed and used in all analyses.

**Statistical Design**

The self-report measures were analyzed as a 2(sexual content, non-sexual content) X 2(positive affect, negative affect) factorial, independent groups design. The EMG data were analyzed as a three-way mixed factorial design using content and affect as the between-groups factors and left-right side of face (laterality) as the within factor.

**Results**

**Individual Difference Measures**

Since there has been some concern over whether women who participate in sex research are typical of the general population, sample scores for the SAI and SOS are presented in order to provide information relevant to the generalizability of the findings.

The mean score on the SAI for the total sample was 90.8 (SD=17.0). Hoon, Hoon, and Wincze (1976) reported a similar mean score of 88 (SD=19.9) for their normative sample.

On the SOS, the present sample yielded a mean score of 97.9 (SD=17.2). Although no normative data are available on this scale, our mean sample is substantially higher than that reported by Kalogeropoulos and Brender (1984) in a sample of 25 predominantly undergraduate heterosexual women who responded to questionnaires about their sexual fantasies (X=71.8, SD=15.8). Higher scores on this scale indicate more positive attitudes toward sex. The lack of an extensive literature on this scale limits interpretation of this finding.

A two-way (content X affect) analysis of variance (ANOVA) revealed no significant differences between subjects in the four stimulus conditions on the SAI or the SOS.
**Affective and Sexual Responses**

*Pre-Test.* In order to assess the effectiveness of the stimuli in producing the intended affect states, 20 subjects (5 per condition) listened to and rated the narratives. The narratives with sexual content were rated as significantly more sexually arousing than those with no sexual content, $F(1/16)=91.3$, $p<.01$. With respect to affective tone, the unpleasant narratives were rated as significantly more negative, $F(1/16)=8.4$, $p<.01$, and unpleasant, $F(1/16)=18.3$, $p<.01$, than the pleasant narratives. The interaction component was not significant. The pretest data also indicated that the positive and negative stimuli produced affective reactions of comparable magnitude. Although baseline levels were not assessed prior to pre-test, ratings of positive and negative affect were approximately equidistant from the midpoint of bipolar rating scales.

*End of Relaxation (Baseline).* Initial comparability with respect to baseline affect ratings was assessed following the relaxation tape. There were no significant differences between groups on any of the affective dimensions.

*End of Stimulus.* Subjective ratings of affect following the stimulus tapes were analyzed using a two-way (content $\times$ affect) analysis of covariance (ANCOVA) with the post-relaxation rating used as the covariate. For each variable, examination of the covariate $\times$ condition interactions revealed that the assumption of homogeneity of regression had not been violated.

A significant main effect for content was obtained, $F(1/35)=22.3$, $p<.01$, on subjective ratings of sexual arousal. Sexual arousal was significantly greater in response to the narratives with sexual content.

Significant main effects due to affect were obtained for the following affective dimensions: “pleasant-unpleasant,” $F(1/35)=17.4$, $p<.01$; “felt good-felt bad,” $F(1/35)=24.5$, $p<.01$; and “felt happy-felt sad,” $F(1/35)=14.5$, $p<.01$. In each case, the unpleasant stimuli were rated as more negative than the pleasant stimuli.

The results of these analyses reveal that the intended affect-sexual states had been successfully induced. Of particular concern was whether subjective sexual arousal would be attenuated in the unpleasant condition. However, the interaction components were not significant, indicating that while the sexual pleasant and unpleasant conditions differed with respect to negative affect, subjective ratings of sexual arousal were comparable. The means of self-reported positive and negative affect ratings were as follows: Positive sexual (2.3). Positive non-sexual (3.0). Negative sexual (4.1), and Negative non-sexual (5.4). In each case, higher scores indicate greater negative affect.

**Analysis of EMG Measures**

*Inter-Rater Reliability.* As noted earlier, two experimenters independently scored the EMG data. Pearson Product Moment correlations were computed between the scores obtained by the two experimenters for 30 of 40 subjects. Correlations ranged from .74 to .98 with a mean of .90.

*EMG Analysis.* In order to obtain a global measure of activity for each muscle group, the EMG data for the second, third, and fourth minutes of the stimulus period were averaged. This time period was judged by the experimenters to contain the most salient affective components. There were no significant differences in muscle activity between the second, third, and fourth minutes of stimulus presentation. The sixth minute of relaxation was used as a baseline.

The EMG data were analyzed by three-way (content $\times$ affect $\times$ laterality) ANCOVAs using baseline scores as covariates. For the corrugator muscles, a significant main effect due to affect was obtained, $F(1/35)=6.00$, $p<.05$, indicating greater muscle activity in response to the unpleasant narratives as compared to the pleasant narratives. A significant laterality $\times$ content interaction was also obtained. A Newman-Keuls post hoc multiple comparison revealed that, in the sexual conditions, left muscle activity exceeded right muscle activity. No other significant effects were obtained for this muscle group. These results are presented in Table 1.

With respect to the zygomatic muscles, a significant main effect due to content was obtained, $F(1/35)=6.27$, $p<.05$. Zygomatic muscle activity was greater in response to the sexual conditions as compared to the non-sexual conditions. There were no significant differences between conditions as a function of affect. A significant three-way interaction

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**Table 1**

<table>
<thead>
<tr>
<th>Narrative Effect</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sexual</td>
<td>131.34</td>
<td>131.18</td>
</tr>
<tr>
<td>Non-Sexual</td>
<td>110.02</td>
<td>126.74</td>
</tr>
</tbody>
</table>

**Table 2**

<table>
<thead>
<tr>
<th>Narrative Effect</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sexual</td>
<td>139.89</td>
<td>140.62</td>
</tr>
<tr>
<td>Non-Sexual</td>
<td>135.77</td>
<td>115.01</td>
</tr>
</tbody>
</table>
was also obtained, \( F(1/35)=4.02, p=.05 \). Post hoc tests revealed that, in the unpleasant sexual condition, left muscle activity exceeded right muscle activity. These results are presented in Table 2.

**Discussion**

Previous research has demonstrated that facial muscle activity recorded from the zygomatic and corrugator sites can successfully differentiate positive and negative affect. The major aim of the present study was to determine whether the relationship between muscle activity and affect could be demonstrated during a state of sexual arousal. Our results show that corrugator muscle activity increased as a function of negative affect experienced by subjects in the presence of sexual arousal. These data attest to the robustness of the corrugator activity-negative affect relationship, and support the use of corrugator muscle recording as a measure of negative affect during sexual arousal.

In addition, we observed increased zygomatic activity in response to the sexual stimuli. Given that there have been no investigations of facial muscle response specifically to sexual arousal, it is difficult to account for this finding within a particular theoretical framework. Previous research, however, has shown that zygomatic activity varies as a function of positive affective experience. While positive affective experience may account for increased zygomatic activity in the positive affect-sexual condition, it is unclear how it can account for similar increases in the negative affect-sexual condition.

The results of the present study are not consistent with previous findings showing increased zygomatic activity to non-sexual emotional stimuli (e.g., Sirota & Schwartz, 1982). Two factors may have contributed to obscuring the zygomatic-positive affect relationship. The first relates to differences in the magnitude of affect change in response to the stimuli. Examination of the change scores in self-reported affect revealed that while the unpleasant stimuli produced approximately a 100% increase in negative affect, the pleasant stimuli were associated with a 10% increase in positive affect. This discrepancy in the effects of the stimuli, however, was not related to the differential efficacy of the positive and negative stimuli. Rather, in attempting to ensure a more homogeneous baseline for physiological measures by pre-exposing subjects to a relaxation procedure, we inadvertently induced a positive affect state. Post-relaxation affect ratings fell on the positive side of the bipolar scales, and as such may have attenuated the potential effect of the positive stimuli.

Another possibility relates to findings showing that smiles are not reactions to positive emotion exclusively, but may occur during negative emotion as well (Hager & Ekman, 1983). According to these authors, negative affect smiles are produced by muscles which lie in close proximity to the zygomatic major, such as the zygomatic minor, the buccinator or risorius muscles, and are more likely to be asymmetrical. Our findings showing asymmetrical muscle activity in response to the unpleasant, but not the pleasant, stimuli are consistent with this interpretation. In light of these considerations, it will be important for researchers in this area to consider increasing the number of recording sites in areas where similar facial movements may be indicative of disparate emotional states. In addition, special attention should be given to the potential affective consequences of baseline manipulations such as relaxation.

The results of the present study also bear on the issue of lateralization of facial muscle response. Although numerous investigators have reported lateralized facial muscle activity in response to positive and negative emotions, there is no consensus as to how these findings should be interpreted. Sirota and Schwartz (1982) have reported that subjects who were asked to "feel" emotions (spontaneous emotions) showed greater lateralization than subjects who were asked to "act out" but not feel emotions (voluntary emotions). Ekman et al. (1981), however, have reported that asymmetrical muscle activity is noted infrequently in response to spontaneous emotions. Although infrequent, when asymmetries are noted, left muscle superiority is observed.

With respect to the present study, subjects were not required to "act out" emotions, nor were they requested to voluntarily distort their facial expressions. Consequently, we presume that our data reflect spontaneous emotional expressions. Our findings are generally consistent with those of Ekman et al. (1981) concerning the lateralization of spontaneous emotion. Left muscle superiority was noted for corrugator muscle activity in the unpleasant conditions as well as for zygomatic activity in the unpleasant sexual condition. The remaining cells did not reveal significant left-right differences for either the corrugator or zygomatic muscles.

Lateralization of facial muscle response has been interpreted as indicating right hemisphere mediation of emotion (Sackheim, Gur, & Saucy, 1978) and as an index of spontaneous vs. voluntary emotional expression. In a recent review of evidence related to facial muscle neurophysiology, Rinn (1984) has argued against such interpretations. According to Rinn, the contention that the right hemisphere may mediate emotional expression is not consistent with more widely accepted theories of
hemispheric function. Furthermore, given our limited knowledge of the interaction between cortical and limbic structures in the production of facial muscle display, it may be premature to attribute lateralization, or its absence, to the voluntary or spontaneous nature of the emotional expression.

From a methodological perspective, Fridlund and Izard (1983) have noted several factors which oppose the interpretation of asymmetrical facial muscle response in terms of cerebral lateralization. For example, asymmetrical muscle activity may be due to inter-muscle differences in size, location, and ratio of innervation. It appears therefore, that for theoretical and methodological reasons, the significance of asymmetrical muscle activity remains, at best, ambiguous.

REFERENCES


Schwartz, G.E., Fair, P.L., Mandel, M., Mieske, M., &


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**Announcements**

**Conference on Psychophysiological Methodology and German Society for Psychophysiology Meeting**

From May 29th through 31st, 1986, the Fifteenth Annual Conference on Psychophysiological Methodology and the Fourth Annual Meeting of the German Society for Psychophysiology will be held at the University of Freiburg, Federal Republic of Germany.


**Respiratory Psychophysiology Symposium**

On September 18 and 19, 1986, the annual Respiratory Psychophysiology Symposium will be held in the Joint Academic Department of Psychiatry at University College London and The Middlesex Hospital Medical School.

Information regarding paper submission and hotel accommodations may be obtained from: Professor Rachel Rosser, Conference Organizer, Wolfson Building, The Middlesex Hospital, London W1N 8AA, England.

**Twenty-Sixth Annual Meeting Society for Psychophysiological Research**

From October 16th through 19th, 1986, the Twenty-Sixth Annual Meeting of the Society for Psychophysiological Research will be held at Le Centre Sheraton Hotel in Montreal, Quebec, Canada.

For information regarding submission of papers, contact: J. Michael Lacroix, Program Chairman, SPR 1986, Department of Psychology, York University, Glendon College, 2275 Bayview Avenue, Toronto, Ontario M4N 3M6, Canada. For registration and transportation information, contact: Joanne Fetzner, Convention Manager, SPR, 2380 Lisa Lane, Madison, WI 53711 (608/271-1500).

**Membership in the Society for Psychophysiological Research**

Information about membership in the Society for Psychophysiological Research and application forms may be obtained from the Society’s membership chairman: Dr. Marlon R. Koenigsberg, Department of Family Medicine, State University of New York, 1001 Humboldt Parkway, Buffalo, New York 14208.
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