AN ANALYSIS OF THE ENCODING AND DECODING OF SPONTANEOUS AND POSED SMILES: THE USE OF FACIAL ELECTROMYOGRAPHY

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ABSTRACT: Twenty subjects judged 80 video segments containing brief episodes of smiling behavior for expression intensity and happiness of the stimulus person. The video records were produced under instructions to (a) pose, (b) experience a happy feeling or (c) to both experience and show a happy feeling. An analysis of the integrated facial electromyogram (EMG), recorded over four muscle regions (*zygomaticus major, depressor anguli oris, corrugator supercilii,* and *masseter*), showed that judgments of happiness and of intensity of expression could be predicted in a multiple regression analysis (multiple $R = .64$ for perceived happiness and .79 for perceived expression intensity). The perception of happiness was affected by EMG activity in regions other than *zygomaticus major.* The use of parameters other than the mean of the integrated EMG, namely variance, skewness, kurtosis and properties of the amplitude distributions across time, provided accurate classification of the elicitation conditions (pose happiness versus experience happiness) in a discriminant analysis. For the discrimination of posed and felt smiles variables describing aspects of facial activity in the temporal domain were more useful than any of the other measures. It is suggested that facial EMG can be a useful tool in the analysis of both the encoding and decoding of expressive behavior. The results indicate the advantage of using multiple-site EMG recordings as well as of using amplitude and temporal characteristics of the facial EMG measures.

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Ekman and Friesen (1982) found that 'felt' smiles can be distinguished from those that are 'false' (unfelt, masking, or posed smiles). Specifically, they suggest that felt smiles (or those reflecting an underlying positive affect) are characterized by the presence of activity of the *zygomaticus major*, the muscle that pulls the corner of the mouth up, and are between two-thirds of a second and four seconds in length. Strong felt smiles are also marked by the action of the *orbicularis oculi*, the muscle that surrounds the eye and causes wrinkling or crow's-feet at the corner of the eye. False smiles, both those that mask an underlying negative affect and those that are posed in the absence of a positive emotion, are characterized by an absence of activity of the *orbicularis oculi* and the presence of activity in other facial muscle regions.

Felt smiles also differ from false ones in the temporal nature of their onset, apex, and offset; onset time is the period from the first overt appearance of the muscle activity to the moment when the activity does not further increase, apex time is the time the expression is held at the highest level, and offset time is the period from the first sign of muscle relaxation until the expression has vanished from the face. Specifically, Ekman and Friesen (1982) suggest that false smiles differ from felt smiles in that the apex is too long, the onset is shorter and the offset is either irregular or abrupt. Weiss, Blum, and Gleberman (1987), who found evidence for some of these notions, also found that smiles reflecting an underlying positive affect and posed smiles differ regarding regularity (smoothness of activation of the facial muscles), with felt smiles being more regular. Recently, Ekman, Friesen, and O'Sullivan (1988) reported additional evidence that smiles masking an underlying negative affect can be distinguished from smiles reflecting an underlying positive affect by traces of activity in muscle regions other than *zygomaticus major* and *orbicularis oculi*.

While Ekman and Friesen's (1982) definitions of the terms 'felt' and 'false' smiles have some face validity, a closer consideration of their assumptions shows that they are employing a categorical view of expressive behavior that is problematic in some regards. 'Felt' smiles are seen as direct and accurate readouts of emotional states; in contrast, 'false' smiles are viewed as a voluntary effort by the sender to control a social interaction by projecting an emotional state that is discrepant from the feeling state of the sender. However, much of the time an expression can not be labeled simply 'felt' or 'false' as elements of both may be present. Examples of such instances are: attenuating, consciously or unconsciously, an emotional expression that reflects the underlying emotional state in order to conform to display rules (e.g., Ekman, 1984), or showing emotional facial expressions as habits (e.g., smiling when greeting). Fridlund (1989) elaborates on the difficulty of using such a dichotomous taxonomy, particularly regarding facial expressions shown in a noninteractive setting such as is typical for a laboratory situation. While we do agree that the 'felt - false' distinction is an over-simplification, it seems plausible to assume that facial expressions vary on a continuum with regard to the degree to which they reflect either an underlying emotion or a voluntary effort, and to assume that in many instances smiles may present a complex combination of the two. However, as the present study is an attempt to examine the differences between emotion evoked and voluntary facial expressions in the temporal domain using a different measurement approach (facial electromyography) than has been used in the studies reviewed above, a decision was made to compare only smiles that can be seen as primarily emotion evoked and smiles that can be seen as primarily voluntary/controlled.

In the studies cited earlier, facial muscle activity was measured using FACS (Ekman & Friesen, 1978), an anatomically based facial coding system. This system allows the reliable description of overt facial behavior (Ekman, 1982), but is less useful for the detection of subtle facial movements and for assessing differences in intensity; furthermore, using FACS is relatively time consuming (Ekman, Friesen, & O'Sullivan, 1988). Because the differences between primarily emotion evoked and primarily voluntary or controlled smiles are supposedly found mainly in subtle additional facial expressions or in the time course of the smiles (Ekman, Friesen, & O'Sullivan, 1988; Weiss, Blum, & Gleberman, 1987), the use of facial electromyography (EMG) in this context seems desirable. Facial EMG allows for the detection of subtle movements, which need not be overt and, when a suitable sampling rate is used, provides a good description of the time course of the movements (Fridlund & Izard, 1983; Fridlund & Cacioppo, 1986). It should be kept in mind, however, that little is known about the relationship between facial EMG measures and observable facial behavior, which complicates the comparison of measures derived from facial EMG with those derived from scoring overt facial behavior (Cacioppo & Tassinary, 1987).

Ekman, Friesen, and O'Sullivan (1988) and Weiss, Blum, and Gleberman (1987) studied the differences between emotion evoked and voluntary or controlled smiles only on the sender, or encoding, side. This approach neglects an important aspect of expressive behavior, that is, the influence on the receiver and the receiver's reaction to the behavior. We felt it to be equally important to establish the impact of differences between emotion evoked and posed[1] smiles not only regarding the encoding process but

[1]One may argue, in the light of the Facial Feedback literature (Manstead, 1988; Matsumoto, 1987; Winton, 1986), that a posed smile will be accompanied by a congruent affective state. We acknowledge this possibility, but base our distinction on the assumption that posed smiles will reflect an underlying positive emotional state to a markedly lesser degree

also regarding the decoding process. Our primary interest in the latter case is which aspects of the appearance of emotion evoked or posed smiles may be related to the observer's decoding of the sender's affective state. The approach, then, considers not only the nature of the expression but also the communicative significance of that expression.

It is important to realize that the relationship between the encoding process and the attribution process involved in a decoding of affective state is not straightforward. Some markers of an affective state may not be perceived by a receiver, while some attributions are based on cues that do not actually distinguish between different states on the sender side (but are based, for example, on stereotypes). To capture these phenomena an attribution model that takes these relationships into account has to be applied. Scherer (1982) suggested the use of a modified Brunswikian lens model to study the communication process. The design of this study relates to both sides of the lens model. The differentiation between encoding and decoding processes permits the identification of actual markers, regardless of whether the actual markers are used in the attribution process, as well as the identification of perceived markers, that is, of markers that are used by observers, regardless of whether these markers actually differentiate between conditions (for further discussion of the distinction between markers and decoding inferences also see, Ekman (1978), and Hager (1982)).

The first task in the encoding analysis was the selection of appropriate EMG parameters to measure the temporal characteristics of facial behavior. Cacioppo, Marshall-Goodell, and Dorfman (1983) have earlier proposed the use of eight parameters of the integrated EMG signal to describe both the amplitude and the temporal dimension of a skeletal muscular activity. The two goals of the present study were, therefore, (a) to assess the differences between the posed and felt smiles on the basis of the amplitude and temporal dimensions of the facial EMG suggested by Cacioppo, Marshall-Goodell, and Dorfman (1983), and (b) to measure the degree to which parameters of the facial EMG response of the sender are correlated with observers' judgments of 'happiness of the sender' and 'intensity of the smile'.

The parameters of the EMG identified by Cacioppo, Marshall-Goodell, and Dorfman (1983) characterize the time course of the facial action

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than will emotion evoked smiles. This assumption was confirmed in the present study by a comparison of physiological data and the self-reports of the senders (for more detail see Hess, Kappas, McHugo, Lanzetta, & Kleck, 1989). It has also been suggested that affects evoked in a laboratory setting, especially by mental imagery procedures, might also contain a posed component, reflecting the subject's attempt to play the role of an emotional person in order to comply with the demand of the laboratory condition (Ekman & Fridlund, 1987).

on a different level than those employed by Ekman and Friesen (1982); specifically, they describe the center of gravity of the EMG response, the temporal variability of the response and whether this response is symmetrical about the center of gravity (that is, if amplitudes increase or decrease over the time of the response or are symmetrical around the center of gravity).[2] As the *zygomaticus major* is the muscle that dominates in the smile, it was expected that the parameters describing aspects of the time domain of the EMG activity of this muscle would discriminate between the elicitation conditions. Furthermore, it was expected that posed smiles would be characterized by the presence of facial muscle activity usually not associated with a positive state to a larger degree than would emotion evoked smiles. On the decoding side no detailed data are available to point to aspects of the facial action that might be salient for the observer. We assumed, however, that the same parameters that distinguish between emotion evoked and posed smiles on the sender side would be used by observers in making their judgements. There is evidence suggesting that emotion evoked and voluntary smiles differ in the activity of the *orbicularis oculi* muscle (e.g., Ekman & Friesen, 1982; Ekman, Friesen, & O'Sullivan, 1988; Kappas, McHugo, Lanzetta, & Hess, 1988). As the smile episodes analyzed here were part of a larger study of facial expressions of differing valence, the EMG sites employed were selected to allow the distinction among four affective states while still keeping the total number of electrode pairs low. *Orbicularis oculi* measures were therefore not taken, even though they would have been useful for the present analysis (see Hess, Kappas, McHugo, Lanzetta, & Kleck, 1989).

Method

Overview

Video records of both posed smiles and smiles recorded while an underlying positive affect (happiness) was present were selected from a pool of such expressions recorded during an experiment conducted to assess the effects of facial behavior on experienced emotion. Special care was taken that the subjects did not attempt to feel an emotion in the 'pose' condition and did actually experience an emotion in the 'feel' condition. Observers

[2]The interpretation of the time-amplitude parameters requires episodes to be of the same length and to be anchored to a common event; it is not meaningful across a longer segment with an unknown number of events. The EMG data employed in this study conformed with these assumptions; for further detail see Hess, Kappas, McHugo, Lanzetta, & Kleck (1989).

assessed the video records on the dimensions of perceived happiness of the sender and intensity of the smile.

Elicitation Conditions

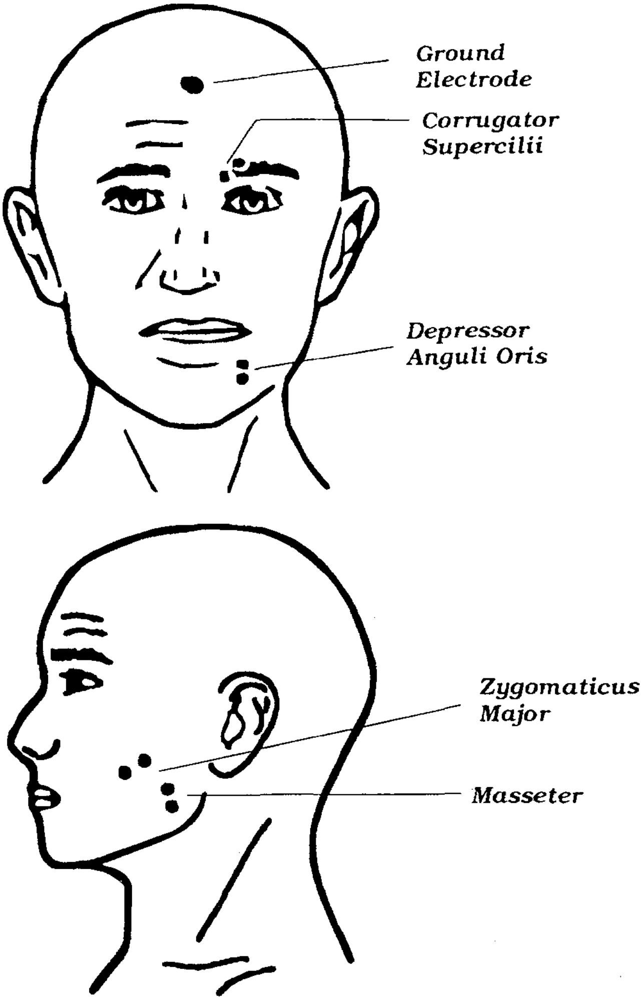
The smile records were obtained from three different elicitation conditions (Hess, Kappas, McHugo, Lanzetta, & Kleck, 1989). In the first, subjects were asked to generate an emotional feeling and in the second to pose an emotional expression while not feeling the emotion. The subjects were told that it was necessary to pose a smile as effectively as possible, because the pose condition would be used to disentangle the influence of bodily movements and emotional state on physiological measures. In the third condition subjects were instructed to both feel the emotion and to clearly display the appropriate expression. As the smiles obtained from the third elicitation condition were likely to involve some combination of felt and posed smiling behavior they were not included in the analysis of the encoding process; the analysis of the decoding process employed expressions taken from all conditions. The subjects generated and posed four different emotions: peacefulness, happiness, anger and sadness. Only the records from the happiness condition were used in this study. Self-report measures obtained from the senders indicated that subjects reported significantly more happiness in the 'feel' condition and in the 'feel and show' condition than in the 'pose' condition. There was no significant difference in the level of self-reported happiness between the 'feel' and the 'feel and show'. Thus the emotion evoked expressions were associated with a higher level of underlying emotional feeling than are the voluntary/controlled expressions (Hess, Kappas, McHugo, Lanzetta, & Kleck, 1989). Mean *zygmaticus major* intensity, as well as the FACS intensity scores (see below), indicated that on average the expressions from the 'felt' condition were the weakest expressions and the expressions from the 'feel and show' condition the strongest.

Subjects. Thirty female undergraduates participated in the expression elicitation experiment. Twenty volunteered from an introductory psychology class and participated for extra course credit, while 10 were recruited on campus and paid $10 for the two hour session.

Dependent measures. During each of the tasks facial EMG measures were taken over four muscle sites: *corrugator supercilii* (moves the brows down and together), *depressor anguli oris* (draws the corners of the mouth down), *zygomaticus major* (pulls the corners of the mouth up) and *masseter* (jaw muscle); data were collected at a sampling rate of 5 Hz. Measures of

FIGURE 1

Electrode Placement



the heart rate, skin conductance, and skin temperature were also taken, but are not of relevance for this report and will not be discussed further. The electrodes were placed on the left hemiface and the placements followed the guidelines established by Fridlund and Cacioppo (1986), as shown in Figure 1.

A Grass Instruments Model 79C polygraph with 7P511F amplifiers was used, and the raw EMG signals were passed through contour-following integrators (Fridlund, 1979) with a time constant of 200 msec. Following each task a self-report measure of emotional feeling state was taken. All subjects were unobtrusively videotaped; subjects were informed at the end of the experiment that they had been video taped and were given the opportunity to have their records erased.

EMG parameters. Mean, variance, skewness, and kurtosis of the amplitude distribution and of the amplitude distribution over time were calculated on the basis of the raw A/D values. To calculate the amplitude distribution over time, every amplitude value $Y_{(i)}$ is multiplied by the time value $X_{(i)}$ at that instant (the unit is seconds; it is calculated as $\frac{\text{datapoints}}{\text{samples per seconds}}$). Mean time, the first property of the distribution of time, is computed by the following formula:

$$\hat{\mu}_{(x)} = \frac{\sum_{i=1}^{N} X_{(i)} * Y_{(i)}}{\sum_{i=1}^{N} Y_{(i)}}. \tag{1}$$

The result is the mean EMG response in seconds. Similarly, the variance time is computed using the following formula:

$$\hat{\sigma}_{(x)}{}^2 = \frac{\sum_{i=1}^{N} (X_{(i)} - \hat{\mu}_{(x)})^2 * Y_{(i)}}{\sum_{i=1}^{N} Y_{(i)}}. \tag{2}$$

In a similar fashion skewness and kurtosis times are computed using equations 3 and 4.

$$\hat{\gamma}_{1(x)} = \frac{\sum_{i=1}^{N} (X_{(i)} - \hat{\mu}_{(x)})^3 * Y_{(i)}}{\hat{\sigma}_{(x)}{}^3 * \sum_{i=1}^{N} Y_{(i)}}. \tag{3}$$

$$\hat{\gamma}_{2(x)} = \frac{\sum_{i=1}^{N} (X_{(i)} - \hat{\mu}_{(x)})^4 * Y_{(i)}}{\hat{\sigma}_{(x)}{}^{4} * \sum_{i=1}^{N} Y_{(i)}} - 3. \tag{4}$$

Additional detail on the computation and use of these measures is given in Cacioppo, Marshall-Goodell, and Dorfman (1983).[3]

Decoding task

Subjects. Twenty psychology graduate students (10 males and 10 females) were paid $10 for their participation in the one hour session.

Stimuli. All smiling episodes were FACS coded for intensity.[4] To provide the raters with a range of expressions of different intensity, 40 weak smiles (A or B on FACS) and 40 strong smiles (D or E) were selected. This resulted in a sample of 80 smiles; the data for two of the smiles were subsequently excluded from further analysis because of missing data. The final data set consisted of 26 felt smiles, 30 posed smiles, and 22 smiles from the third elicitation condition (feel and show). Each video episode was approximately 30 seconds in length. The expressive episodes were edited onto two stimulus tapes in different orders. For any stimulus person who contributed more than one item to the set, the episodes were edited so that the distance between the two items was maximized. The stimulus persons contributed on average 2.7 episodes.[5]

Task. The 20 judges were asked to rate each expressive episode on two 7-point Likert scales: happiness of the sender (not happy-extremely happy) and intensity of the smile (no smile-intense smile). The judges were told that the stimulus persons were subjects in an experiment during which they both experienced emotional feelings and posed emotional expressions. They were also told that the subjects were not aware that their expressive responses were being videotaped.

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[3]A hypothetical example that illustrates these waveform parameters has been prepared and is available with reprints from the authors.

[4]For all episodes the presence of AU12 was assessed and, if it was present, the intensity was scored on a scale from A-E. The FACS ratings were made by a trained FACS coder (U. Hess), who had previously established an acceptable level of reliability.

[5]It must be acknowledged that multiple contributions from stimulus persons could pose a dependency problem from a statistical point of view. In the analysis to follow, however, only three stimulus persons contributed more than three episodes to the set of eighty.

Results

As noted previously, Cacioppo, Marshall-Goodell, and Dorfman (1983) suggest eight different statistical parameters of the integrated EMG to capture aspects of the amplitude distribution and the dynamic development of the EMG signal. Since facial EMG was measured over four muscle sites, this yielded 32 predictor variables. In order to reduce this relatively large number of predictors, a Principal Components analysis (using SPSSX procedure FACTOR) was conducted. A ten factor solution emerged (criterion: eigenvalue > 1.00). The first four factors showed high loadings for the four time parameters across the four muscles and loadings lower than .36 for any of the other variables. These were identifiable as: Time variance, Time mean, Time skewness, and Time kurtosis; the four factors were associated with eigenvalues of: 6.17, 4.96, 3.95, and 3.09 respectively. Together these factors accounted for 56.8% of the variance. The remaining factors were not characterized by high internal consistency and could not be clearly identified. Together all ten factors explained 88.5% of the variance. On the basis of the factor analysis, the 16 time variables were replaced by the factor scores for the first four factors. Thus for the following analysis, 20 predictor variables were employed: (a) the four factor scores describing Time mean, Time variance, Time skewness, and Time kurtosis; and (b), for each of the four muscle sites, the first four moments for amplitude distribution (mean, variance, skewness, and kurtosis).

Discriminating Elicitation Conditions

The first set of analyses was conducted to investigate the differences between emotion evoked and posed smiles on the sender side (encoding). A discriminant analysis approach was employed, with the parameters describing the amplitude and time dimension of the EMG response as predictors and elicitation condition as the group variable. For this analysis only data from the 26 smiles in the 'feel' condition and the 30 smiles in the 'pose' condition were used, since the discriminant analysis assumes the presence of distinct nonoverlapping groups. This assumption is not met by the smiles from the elicitation condition where subjects were instructed to both feel and show the emotion.[6] The analysis was conducted using the

[6]For the correlational multiple regression approach employed to investigate the relationship between the observers' ratings and the EMG parameters, smile episodes from all elicitation conditions could be used.

TABLE 1

Discriminant-Analysis for Elicitation Condition Using Amplitude Distribution and Amplitude Distribution Across Time of the Integrated EMG

Step	Entered	Lambda[a]	Standardized canonical discriminant function coefficient
1	Depressor: kurtosis	.89	.42
2	Zygomatic: skewness	.81	.74
3	Time variance	.77	.46
4	Time mean	.79	−.32
5	Time kurtosis	.71	.29
6	Zygomatic: variance	.69	−.90
7	Zygomatic: mean	.65	.88
8	Zygomatic: kurtosis	.63	−.35

Chi^2 (8, N = 56) = 23.48, $p < .005$
[a]Lambda: Wilk's lambda (ratio of within-groups sum of squares to total sum of squares)

four time factors and the sixteen amplitude distribution parameters. Overall, the elicitation condition (pose or feel) could be predicted with 82% accuracy from the EMG measured at four facial sites; the episodes from the 'feel' condition were predicted with 80.8% accuracy, and those from the 'pose' condition with 83.3% accuracy. Table 1 shows the variables entering the equation and the standardized canonical discriminant function coefficients for each variable after all significant variables were entered.

The standardized canonical discriminant function coefficients indicate the contribution of each variable to the discriminant score. Because the analysis is based on a relatively large number of variables compared to cases, it is not advisable to interpret these coefficients other than as rough estimates of the contribution made by any specific variable. An inspection of the variables that enter the discriminant equation shows that the prediction is based not only on zygomatic mean, but also on variables that describe the time course of the expression and depressor activity. This finding is consistent with our predictions that smiles reflecting an underlying positive affect would differ from posed smiles in (a) aspects of the temporal domain of the EMG and in (b) muscle activity in regions other than the *zygomaticus maior.*

Predicting Observer Ratings

The second set of analyses focused on the relationship between measures of facial EMG of the sender and observers' judgments of the facial expressions using a stepwise multiple regression approach. Two judgments were obtained: happiness of the sender and intensity of the smile. The parameters of EMG describing the amplitude and temporal dimensions were entered as predictor variables. First order correlations with the criterion were calculated. The highest first order correlations of EMG parameters with 'happiness of the sender' and perceived 'smile intensity' were $r(78 = -.52$ and $r(78) = .61$ respectively ($p < .001$ in both cases).

As noted above, we expected that the variables in the regression-equation for the prediction of happiness of the sender would be (a) variables describing the time domain of the muscle activity and (b) variables indicating muscle activity in regions other than the *zygomaticus major*. Regarding the regression equation for ratings of the intensity of the smile, we predicted that the mean activity of *zygomaticus major* would enter the equation.

Owing to the relatively large number of measures that were entered into this analysis, the individual variables that constitute the regression equation cannot always be considered highly robust and replicable. However, the general characteristics of the variables that are good predictors of the dependent variables can be discussed. Two variables entered as predictors of observer's ratings of happiness of the sender: Despressor skewness (*beta*: $-.52$) and Masseter mean (*beta*: .38). The multiple R was $R(78) = .64$; $p < .001$. Table 2 shows the results for the multiple regression analysis with perceived intensity of the smile as the criterion.

An argument can be made that ratings of smile intensity and happiness of the sender might be confounded to some degree. To assess the cues relevant for perceived happiness of the sender alone a multiple regression analysis was performed on the residuals, after intensity ratings had been partialled out of happiness ratings. The correlation between perceived smile intensity and perceived happiness was $r(78) = .83$, $p < .001$. The multiple correlation between the EMG parameters and the residuals was $R(78) = .38$, $p < .01$. The variables entering the equation were again a distribution variable and a variable describing activity in muscles other than the *zygomaticus major*. This indicates that the perceived happiness of the sender is not only dependent on the intensity of the smile but can be predicted from facial EMG parameters.[7]

[7]A complete description of the results is beyond the scope of this paper, and is available from the authors.

TABLE 2

Multiple Correlation Between EMG Parameters and Observer Judgements of the Intensity of the Smile

Variables	Multiple R	Adjusted R^2	Beta
Zygomatic: mean	.68	.45	.68
Depressor: skewness	.75	.55	−.34
Masseter: mean	.78	.59	.29
Depressor: variance	.79*	.61	.18

*$p < .001$

The results regarding the relationship of parameters of the facial EMG of the sender on one hand and observer's ratings of happiness of the sender on the other confirm our first hypothesis that variables indicating activity in muscles other than the *zygomaticus major* would enter the regression equation. Contrary to our second hypothesis, however, none of the four time course variables entered the equation.

Discussion

Encoding Smiles

We had expected that posed and felt smiles would be discriminable not only on the basis of activity of the *zygomaticus major*, which is largely responsible for the smile expression, but also by (a) activity in other muscle regions and (b) by variables describing the temporal characteristics of facial movements. These expectations were confirmed, though the evidence for (a) must be viewed as tentative since only one variable, depressor kurtosis, entered the regression equation. These findings replicate results by Ekman, Friesen and O'Sullivan (1988). Furthermore, they are consistent with the suggestions by Ekman and Friesen (1982) that aspects of the time course of the expression may distinguish between emotion evoked and posed smiles. However, the EMG parameters employed in this study do not provide for a direct comparison with the measures of the time course of the expression employed by Ekman and Friesen (1982). As Fridlund, Schwartz, and Fowler (1984) suggested, this is the case particularly if EMG measures describing both amplitude parameters, and aspects of the muscle activity in the time domain, are employed.

The second set of variables that was expected to contribute to the differentiation between posed and felt smiles consisted of parameters describing aspects of the time domain of the EMG activity of the *zygomaticus major*. This prediction was confirmed. It should be noted, however, that high coherence was found for each of the four time-course-related variables across the four muscle-sites. The inclusion of time variance, time mean, and time kurtosis, therefore, bears not only on *zygomaticus major* activity, but also on the temporal characteristics of the smiling episode as a whole. The temporal differences between the smiles elicited spontaneously and those that are posed may be due to the dual innervation pathways for voluntary and spontaneous facial actions (see Rinn, 1984).

While Ekman, Friesen, and O'Sullivan (1988) distinguish between 'masking smiles' and 'felt smiles' on the basis of traces of FACS scored activity in muscle regions other than the *zygomaticus major*, the present study has attempted to distinguish between posed and emotion-evoked smiles. The theoretical basis for the search for activity in these other muscle regions is the assumption that masking smiles are typically employed by the sender to cover a negative emotion, and the traces of muscle activity are seen as an outcome of this underlying negative emotion. In the present study the facial expressions were shown while nothing much was apparently felt, so why is there still activity in muscle regions other than the *zygomaticus major* that distinguishes between posed and felt smiles? *Depressor anguli oris* activity has been shown to relate to negative emotions, sadness in particular (Hess, Kappas, McHugo, Lanzetta, & Kleck, 1989). The importance of the distribution of depressor EMG values, as expressed by the kurtosis parameter, therefore fits the assumption of concurrent negative affect as suggested by Ekman, Friesen, and O'Sullivan (1988). Another reason might be that posed smiles require a conscious effort and that other muscle regions are innervated, either as a consequence of the effort [e.g., corrugator due to concentration] or because the coordination of the intentioned facial movement is not very precise. There was, however, no evidence for effort related differences in muscle activity between the two tasks in our data.

Decoding Smiles

As noted earlier, parameters describing activity in muscles *other* than the *zygomaticus major* have medium to high correlations with observers' ratings of the happiness of the sender. Mean EMG activity of the *zygomaticus major* region, however, is a good predictor only for observers' ratings of smile intensity. Parameters describing temporal aspects of the facial action were not found to correlate with the observers' ratings. This is contrary to our expectation that subjects would use those cues that actually discriminate between elicitation conditions. There are several possible explanations for this finding. First, as the parameters suggested by Cacioppo, Marshall-Goodell and Dorfman (1983) are very sensitive, the differences in the time course of the facial actions captured by these parameters could be too subtle to be detected by the raters. This hypothesis could be tested by a discrimination learning task, possibly using synthetic stimuli. Secondly, we did not explicitly ask the raters to discriminate between elicitation conditions. Given the possible presence of positive affect in the posed condition and blends of emotional states in the emotion evoked condition, the dependent measures used in our study might not serve to establish whether the decoder perceived the expression to be emotion evoked or posed. The emphasis in this explanation lies with the appropriateness of the dependent measure; raters were able to distinguish between emotion evoked and posed smiles, but the question was not asked in a way that the data reflects this ability. On the other hand, observers might have different modes of assessing facial expressions that are dependent on the context of the judgement task. It is a viable assumption that subjects employ different processes when confronted with a 'lie detection task' than when confronted with a task in which continuous parametric judgments of smile intensity and happiness are demanded (Hess, Kappas, & Scherer, 1988; see also Buck, 1983). Modifications of both the dependent measures and the context provided for the rating task could help clarify the relation between facial expression as assessed by facial EMG and the attribution processes of decoders.

The utility of the method employed in the present study lies not only in the advantages inherent in the use of facial EMG (Fridlund & Izard, 1983) relating to sensitivity, but also in its appropriateness given the complex nature of dynamic facial expressions. Moreover, we feel that the use of EMG for the study of decoding of emotional expression opens a door for those who have not felt this measure to be appropriate for their paradigms in the past.

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