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The facilitative effect of facial expression on the self-generation of emotion

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Twenty-seven female undergraduates completed three tasks: (1) feel four emotions (happiness, sadness, anger, peacefulness); (2) express these emotions, without trying to feel them; and (3) feel and express clearly these four emotions. During each trial subjects pressed a button to indicate when they had reached the required state, and the latency from emotion cue to button press was measured. Heart rate, skin conductance and EMG from four facial sites (brow, cheek, jaw and mouth) were recorded for 15 s before and after the button press and during a baseline period prior to each trial. Self-reports were obtained after each trial. Facial EMG and patterns of autonomic arousal differentiated among the four emotions within each task. Shorter self-generation latency in the Feel-and-Show versus the Feel condition indicated the facilitative effect of facial expression on the self-generation of emotion. Furthermore, the presence of autonomic changes and self-reported affect in the Show condition supports the sufficiency version of the facial feedback hypothesis. The self-generation method employed as an emotion elicitor was shown to reliably induce emotional reactions and is proposed as a useful technique for the elicitation of various emotional states in the laboratory.

INTRODUCTION

The face has long been recognized as an important source of information for observers concerning the underlying emotional state of a person. Afferent feedback from the emotional facial display has also been postulated to be an input to the experience of the emotion. The notion of the face serving both output and input functions was put forward by, among others, Charles Darwin (1965/1872). The view that feedback from emotion-specific facial reactions can be causal for other components of emotional reactions, such as subjective experience and autonomic reactions (the facial feedback hypothesis), was more recently advocated by authors such as Tomkins (1962, 1984), Gellhorn (1964) and Izard (1971, 1977). Following Tourangeau and Ellsworth (1979) the facial feedback hypothesis can be broken down into three separate hypotheses. The necessity hypothesis states that an appropriate facial expression is necessary for the subjective experience of an emotion; the sufficiency hypothesis states that, even in the absence of an emotionally salient cue, the appropriate facial expression is sufficient for a subjective emotional experience; the causally weakest hypothesis, the monotonicity hypothesis states that there should be a monotonic and positive relationship between intensities of facial expression and the subjective experience of emotion.

In recent years, research pertaining to the facial feedback hypothesis (FFH) has flourished,

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but consistent evidence has been found only for the monotonicity hypothesis, while the evidence for the sufficiency and necessity versions has been less clear. However, a number of critiques have been leveled against these results (Matsumoto, 1987; Laird, 1984). Winton (1986) pointed out that only a dimensional version of the FFH, rather than a categorical version, has been tested. That is, most researchers have employed only one positive and one negative emotion, demonstrating only that the manipulation of facial expression changes emotional experience on a positive-negative dimension (see Izard, 1977 for a description of studies contrasting more emotional states).

Another important critique relates to the use of self-report as the major dependant variable in the majority of studies supporting the FFH, enhancing the likelihood that demand effects may have mediated the results (see also, Buck, 1980; Hager and Ekman, 1981; Strack et al., 1988). The standard paradigm used to investigate the monotonicity hypothesis involves first inducing an emotion (using, for instance, films of the desired valence, or anticipation of shock or reward) and then leading subjects to modulate (exaggerate or inhibit) their facial reactions to the stimuli. Several studies, using this paradigm, have shown effects consistent with the hypothesis (Kopel and Arkowitz, 1974; Kleck et al., 1976; Lanzetta et al., 1976; Colby et al., 1977; Zuckerman et al., 1981; Kraut, 1982; Kappas et al., 1989). As mentioned above, however, the demonstrated effects pertain only to a pleasant/unpleasant dimension and have not been shown to be emotion-specific within a given valence.

Finally, although a substantial portion of the literature supports at least the dimensional interpretation of the monotonicity hypothesis, there have also been failures to replicate these effects (e.g., Tourangeau and Ellsworth, 1979). However, Tourangeau and Ellsworth's study (1979) has been the subject of considerable debate, especially concerning the adaquacy of their test of the FFH (Ellsworth and Tourangeau, 1981; Hager and Ekman, 1981; Laird, 1984; Tomkins, 1981).

The paradigm commonly employed to test the notion that facial expressions alone suffice to elicit an emotional state (sufficiency hypothesis) uses deliberate facial expressions, frequently elicited by 'muscle by muscle' instructions or by requesting subjects explicitly to show a specific emotional expression. Recent studies using this paradigm have also generally supported this notion (Laird, 1974; Laird and Crosby, 1974; Duncan and Laird, 1977,1980; Rhodewalt and Comer, 1979; McArthur et al., 1980; Kellerman and Laird, 1982; Laird et al., 1982; Kleinke and Walton, 1982; Edelman, 1984; Ekman et al., 1983; Levenson et al., 1990). Winton (1986), however, points out that for this version of the FFH as well a majority of the findings pertain only to a conceptually weaker, dimensional interpretation of the hypothesis. That is, they show that self-reports (and autonomic data) indicate a negative emotional state if a 'negative facial expression' was shown and a positive emotional state when a 'positive facial expression was shown', but do not find (or do not test for) a differentiation of emotions within the same valence, such as a discrimination between sadness, fear and anger. An exception is the study by Ekman et al. (1983), which was replicated by Levenson et al. (1990), who found differences between negative emotions using the directed facial action task.

In summary, while there is consistent evidence that displaying positive facial expressions leads to indications of positive mood, and displaying negative facial expressions leads to negative mood, less evidence exists for a differentiation between emotions within the same valence (such as sadness, anger, fear or disgust).

As mentioned above, a major criticism of studies confirming the basic hypotheses of the FFH concerns the demand characteristics inherent in the research paradigms employed (Buck, 1980; Hager and Ekman, 1981; Strack et al., 1988). As it is frequently obvious that a given experiment is targeted at facial expression and emotion, it is a reasonable assumption that subjects, even within 'muscle-by-muscle paradigms', might guess the hypothesis and feel compelled to report emotional feelings when they recognize a specific facial expression as emotional (e.g., a smile), especially when the expression is held for a prolonged period of time (for a detailed theoretical discussion of differences between muscle-by-muscle designs compared to other experimental paradigms see Izard, 1990). Even if subjects do not report explicit awareness of the hypothesis, their recognition of their facial expression as being typical for a specific emotional state might trigger other cognitive reactions. These reactions, rather than the facial manipulation, may produce the effects reported (Winton, 1986).

Some researchers have attempted to design experiments that rule out the demand hypothesis. Strack et al. (1988), for instance, asked subjects to hold a pen in their mouth, either with their lips or their teeth, while rating cartoons. From the subjects view this was done to study 'psychomotoric coordination' in an experiment having relevance for handicapped people, but actually the pen holding served to inhibit smiles in one condition (lips) but not the other (teeth). The results of this study supported the monotonicity hypothesis, as subjects holding the pen in their teeth found the cartoons funnier than those holding it in their lips. Few studies have considered physiological reactions or other measures indicative of subjective states as an appropriate dependent measure. However, for the above reasons, those measures, that are less susceptible to demand effects than self-reports, are well suited to the purpose.

Another important point concerns the emotion induction procedure chosen. A problem frequently found when using emotion-evoking stimuli is that subjects, because of individual differences in the evaluation of the stimulus, react differentially to the same stimulus; thereby making it difficult to insure that all subjects actually felt the intended emotions. A method that has been found to induce a specific emotion quite reliably is mental imagery (e.g., Craig, 1968; Fridlund et al., 1984; Grossberg and Wilson, 1968; Lang, 1979; Schwartz, 1982; Schwartz et al., 1980; Schwartz et al., 1981). In one variant of this procedure subjects are asked to report an occasion during which they previously felt the emotion in question and are then asked to imagine this occasion as vividly as possible. This approach, however, has several limitations: (a) the images tend to lose salience when reported, (b) subjects may be reluctant to report potent, but highly personal, emotional situations and (c) subjects vary in the amount of time they take to imagine the situation and the time they are able to sustain the feeling state. This makes it difficult to choose the correct sampling period for physiological dependent measures.

To overcome the limitations of the approach described above, a variation of the mental imagery technique was employed in the present experiment. Subjects were simply asked to generate a specific emotion, which they do primarily using mental imagery (according to debriefing interviews) and press a button when the emotional state in question has been generated. Physiological measures are sampled during the period of time immediately preceding and following the button press. This method is similar to a method employed by Rusalowa et al. (1975), with the exception of the subjects controlling the sampling period by pressing the button. This self-generation procedure increases the likelihood that subjects will use the most salient internal cues available to them and that the period of time when the physiological data are collected is actually the period of time during which subjects are experiencing the subjective emotional state in question.

The present study was designed to examine the monotonicity and the sufficiency hypotheses within a paradigm that responds to the criticisms that have been raised regarding studies of the FFH. The two hypotheses were tested for both autonomic reactions and self-reports of emotion. Unlike most previous studies, two negative and two positive emotions were employed in order to test both hypotheses for emotions of the same and of different valence, and special care was taken to reduce demand characteristics and to induce specific emotions. Subjects performed three tasks. For the first task they were asked to generate several emotional states. The second task consisted of posing the facial expression for these emotional states and the third task consisted of generating the emotional state and showing the appropriate facial expression.

The monotonicity hypothesis was tested by comparing the condition where subjects were asked to generate an emotion (Feel) with the condition where subjects were asked to both generate and display the same emotion (Feel-and-

Show). Because the criterion for the subjects to press the button was the same for both tasks, it was not expected that subjects would report more emotional feeling under the Feel-and-Show condition. Instead, we expected that adding the facial expression would facilitate the generation of the subjective feeling, so that subjects would reach the emotional state faster and thus press the button earlier. We assumed that individuals would subjectively set a level of emotional feeling at which they would press the button during the first task and then press the button in a subsequent task when they reached this previously self-determined level. The expected augmentation of the emotional reaction by the addition of the facial expression would, therefore, result in reaching this level faster. Consequently, the latency of the button press is the dependent measure for which we expected differences between the Feel and the Feel-and-Show conditions.

The comparison of the condition where subjects were asked to pose an emotional expression (Show) with the self-generation condition on one hand (Feel), and the condition where subjects were asked to generate an emotion while expressing it facially on the other hand (Feel-and-Show), is relevant for an assessment of the sufficiency hypothesis. For the self-reports of emotional feeling this version of the FFH predicts that subjects will indicate feeling the emotion that they were asked just to pose. Correspondingly, it was expected that the autonomic patterns for this condition (Show) would not be different from those obtained in the self-generation condition (Feel), although the level of intensity might differ.

The present experiment also addressed some of the concerns raised by Izard (1990). First, he takes up the critique by Winton (1986) that studies of the FFH are generally not designed to test the categorical version of the FFH. In this study, however, two positive and two negative emotions were employed. Second, Izard claims that most studies do not employ self-initiated emotional expressions, but rather demand experimenter-manipulated expressions in a context which may be perceived as 'irrational and intrusive' by the subject. In the present study, however, a self-generation procedure was employed as the emotion induction method, giving the subjects control over the experimental situation. Further, subjects were given an acceptable reason ('technical demands') for the modulation of facial expression, making the induction procedures more acceptable and less intrusive. Most subjects did indeed feel that the manipulations requested were reasonable and accepted the goal presented in the cover story.

METHOD

Overview

To reduce experimental demand owing to subjects becoming aware that facial expressions were of primary interest, a cover story was employed. The subjects were told that the experiment was a methodological study designed to assess the disturbing effects of 'facial and bodily movements normally accompanying emotions' on physiological measures. They were introduced to three tasks: one where they were asked to generate several emotional states (Feel), one where they were asked to pose these emotions (Show) and a third where they were asked to do both (Feel-and-Show). These instructions emphasized that the subjects were to feel an emotion in the first task, without mentioning expressive behavior at all, and to use a lot of expression in the second and third tasks. Similarly, subjects were specifically instructed not to feel the emotions during the second task (Show), while they were supposed to do so in the first and third tasks. The debriefing interviews indicated that the subjects understood the instructions as intended. Thus, a situation was created where the subjects felt no demand to show facial expression in the Feel condition and no demand to feel emotions in the Show condition, since they accepted generally the necessity for the study not to feel emotions in the Show condition.

All subjects completed the three different tasks, and each task was performed for four different emotions (happiness, anger, sadness and peacefulness). Subjects performed each of the tasks for all four emotions before going on to the next task. Within each task the order of emotions was counterbalanced over subjects. The three tasks were repeated in the second half of the experimental session. The experiment thus consisted of 24 trials (4 emotions × 3 tasks × 2 repetitions). For the first task (Feel) subjects generated the four emotions; for the second task (Show) subjects posed the expressions associated with these emotions, but no direct reference to the face as a locus of expression was made; and for the third task (Feel-and-Show) subjects both felt and expressed clearly the four emotions. The tasks were presented in this order to all subjects. Subjects were given a hand-held button, which they pressed when they felt they had reached the intended state/expression. During all tasks the integrated facial EMG, heart rate, skin conductance, and the latency of the button press were recorded *. The facial responses of the subjects were unobtrusively videotaped. To avoid subjects being self-conscious in front of a camera subjects were told that they were video-taped only after the experiment. They were then given the option of having the video-recording erased. Following each trial, subjects completed an emotion profile, indicating their feeling state (see below).

Subjects

30 female undergraduate volunteers were recruited to participate in an experiment concerning 'emotion and physiology'. 20 were enrolled in an introductory psychology class and received extra course credit for their participation; 10 subjects were recruited from different dormitories and paid 10 dollars for the 2 h session. The data from two subjects were later excluded due to equipment malfunctioning.

Dependent measures

Facial EMG. Facial muscular activity was assessed with four pairs (bipolar placement) of Med Associates Inc. Ag/AgCl miniature surface electrodes. The four electrode sites chosen were corrugator supercilii, zygomaticus major, depressor anguli oris and masseter (brow, cheek, mouth and jaw, respectively), on the left side of the subject's face. Electrode placements were according to Fridlund and Cacioppo (1986). All pairs were referenced to a forehead ground electrode placed near the midline. Beckman electrode electrolyte was used as the conducting medium, and the skin was cleansed with water and alcohol and lightly abraded with a pumice stone. The electrodes were stored in a carbon rod storage container (Tassinary et al., 1990). A Grass Instruments Model 79C polygraph with 7P511F amplifiers was used to amplify the raw EMG signals; 60 Hz notch filters were used for noise reduction. The raw EMG was passed through custom contour-following integrators (Fridlund, 1979) with a time constant of 200 ms. The smoothed EMG signal was then sampled at 5 Hz by the laboratory computer and stored on disk. The muscle sites were chosen because previous research has shown them to be effective for discrimination among sad, angry and happy facial expressions, (e.g., Cacioppo et al., 1986; Fridlund et al., 1984; Schwartz et al., 1973; Schwartz et al., 1976; Schwartz and Weinberger, 1980; Sirota and Schwartz, 1982; Smith et al., 1986; Teasdale and Rezin, 1978).

Skin conductance. Skin conductance level (SCL) was measured using Beckman Ag/AgCl miniature electrodes placed on the second segment of the first and third fingers of the left hand (bipolar placement). A saline/Unibase preparation was used as the conducting medium (Lykken and Venables, 1971). A Coulbourn Instruments Skin Conductance Coupler (S 71-22) was used; it was adjusted for each subject's skin conductance baseline at the beginning of the task, and the sensitivity was set at 500 mV/μMho. The analogue output was visually monitored through a Coulbourn Instruments DC Meter (R13-03) and was sampled at 200 ms intervals.

Heart rate. A photoplethysmographic finger-clip, connected to a Gulf and Western Applied Science Laboratories Pulse-Watch (model 420), was attached to the second finger of the subject's left hand. The output of the Pulse-Watch (heart rate in bpm) was sampled at 5 Hz.

* Skin temperature was recorded from the fourth finger of the left hand, but this measure proved to be highly prone to recording artifacts and technical difficulties and was not included in any of the analyses reported in this paper.

Self report. Immediately following each trial, subjects indicated on five-point Likert-scales (0 = not at all, 4 = very intensely) how intensely they had felt each of four emotions (happiness, anger, sadness, other). The difficulty of the task was rated on a seven-point Likert-scale (0 = not at all, 6 = very difficult).

Button-press latency. For each trial the period between the display of the emotion label on the subject's CRT and the subject's button press, indicating that they had reached a particular state and/or expression, was recorded in ms.

Procedure

Each subject first signed a consent form, which explained that the study had 'something to do with emotion' and that physiological measures would be taken. After the electrodes had been attached, the subject was lead to the experimental room and seated in a comfortable chair. Initial instructions were given and the laboratory intercom system was explained. The experimental room was dimly lit and contained a CRT terminal to the right of the subject, where experimental instructions (e.g., emotion labels) would be displayed. An array of buttons was attached to the chair's right armrest, and subjects used these to signal their perceived success after each trial. The self-report questionnaire was then explained. The instructions for each of the three tasks were given by the experimenter right before that task.

All subjects completed the three tasks: Feel, Show and Feel-and-Show, in this order; the tasks were then repeated in the same sequence. Within each task the subject was asked to feel, show or feel as well as show four emotions (happiness, anger, sadness, peacefulness). The emotions were presented in a low-active, high-active, low-active, high-active order (low-active = peaceful and sad; high active = happy and angry). The four different possible sequences were counterbalanced within each subject and over all subjects.

Before each trial a 10 s baseline was taken for each of the physiological measures, during which the subject was prompted with the phrase 'baseline period' on her CRT. 2 s after the baseline period, the label for the emotion to be generated/posed was displayed. The subject then attempted to generate or pose the requested emotion and signaled the completion of the task by pressing the hand-held button. If the trial was completed successfully the data from 15 s before to 15 s after the button press were stored. The subject was then prompted on the monitor to complete the self-report questionnaire.

Between trials a minimum pause of 45 s was employed, following which the subject could signal the experimenter that she was ready to continue. Subjects were encouraged by the instructions to wait until they felt that the effects of the previous trial had diminished completely. The experimenter could also postpone the start of the next trial if the heart rate and/or SCL were not within 10% of the last baseline.

In the Feel condition subjects were asked 'to generate an emotion':

> We want you to try to generate an emotion. This task might sound strange or even funny to you, but it is possible. Please try to generate a – happy/angry/sad/peaceful – feeling. When you feel the emotion, press this button. Try to hold that feeling for a few seconds. It is essential that you really try to feel that emotion. If it takes you a while to get there, that's all right. We have enough time for you to complete the task as most people manage to complete it in approx. 5 min

To familiarize subjects with the paradigm, a practice trial was introduced, for which they were asked to generate 'interest'. For the Show condition the subject was told to try to express an emotion but not to attempt to feel it. It was emphasized that the subject should try not to feel the emotion but just express it (as this condition was supposed to serve as a control condition to assess the effect of expressive behavior alone on the psychophysiological measures taken). It was stressed that it was extremely important for the purpose of the experiment, which was supposedly examining the disturbing effects of expressive behavior on physiological measurement, to follow the instructions as closely as possible. The subject was instructed to press the button when she thought that she had produced the requested expression, and hold the expression for a few seconds. Success and self-report ratings were obtained after each posing trial.

In the Feel-and-Show condition subjects were asked to generate and express clearly the four emotions. The procedure was parallel to the other two tasks. It was emphasized that the subject should both feel the emotion and show it at the same time. Following the completion of the tasks, all three were repeated in a full replication. The order of tasks was the same, but within the tasks the sequence of emotions differed, and abbreviated versions of the instructions were used.

At the end of the experiment, the subjects were debriefed regarding the purpose of the experiment and written permission for further use of the video records was obtained. A semi-structured interview was conducted to assess the methods subjects used for the emotion-generation tasks, and their awareness of the experimental hypotheses was probed.

Artifact control and data reduction

The video records for all subjects were inspected for movements that would disrupt the psychophysiological measures (e.g., scratching, yawning or poking at the electrodes) and for instances when the subject obviously failed to comply with the instructions (e.g., stopped expressing an emotion and started to look around or browsed through the questionnaires). The temporal locations of these episodes within a given trial were determined and the corresponding autonomic and EMG data were deleted. Artifacts due to equipment malfunctioning (evidenced by out of range measurements, extremely rapid changes in skin conductance or heart rate, etc.) were also deleted. As baselines were stored only as averages over the 10 s baseline periods, the complete baseline, estimated by averaging the two neighboring baselines, was replaced if the videotape rating revealed possible problems during that period.

The data for each psychophysiological measure were averaged over the 30 s period surrounding the subject's button press. Initial analyses revealed the data distributions to be non-normal, therefore scores were z-transformed within subjects (e.g., Ben-Shakkar, 1985,1987) using the baseline and trial means. As baselines were taken before each trial difference scores could be calculated to correct for the observed baseline drift. All statistical analyses were performed on the resulting standardized difference scores.

Data analyses

Three-factor multivariate analyses of variance (task × emotion × repetition) were performed for the four EMG measures, heart rate and skin conductance to determine if these data could be collapsed over repetitions. No main effect for repetition emerged for any of the four EMG sites; however, there were weak task by repetition interactions for zygomaticus major ($F(2,19) = 4.55$, $P < 0.024$), depressor anguli oris ($F(2,18) = 3.87$, $P < 0.040$), masseter ($F(2,19) = 4.99$, $P < 0.018$), and corrugator supercilii ($F(2,18) = 6.02$, $P < 0.010$) EMG. These interactions were caused by a tendency for expressions of happiness and sadness to be weaker in the second Feel repetition, while being stronger in the second Show repetition. A main effect of repetition for heart rate ($F(1,17) = 17.63$, $P < 0.001$) emerged, but no interaction with task or emotion. For skin conductance, no main effect of repetition but a significant emotion by repetition interaction ($F(3,18) = 9.02$, $P < 0.001$) was found.

As no task by repetition interaction was found for skin conductance and heart rate, it was deemed justifiable to collapse over repetitions to increase reliability for the analysis of task effects. The analysis of the EMG data was performed for both the collapsed and the non-collapsed data sets, and no differences in the results emerged for the emotion and task effects. In the following, therefore, only the results of analyses performed on the collapsed data are reported.

RESULTS

Facial EMG

Significant task and emotion effects, as well as interactions, emerged for all four facial EMG measures in univariate analyses of variance. The emotion by task interaction was to be expected and is due to the two 'low active' emotions (peacefulness and sadness). Because peacefulness is characterized by an absence of expressive behavior in all tasks, the expression does not differ in intensity between the Feel and Show conditions as it does for the other emotions. For sadness the level of difference was reduced compared to the 'high active' emotions (happiness and anger).

The results are shown in Fig. 1. The EMG results across the four emotions (collapsed over tasks) are in concordance with specific patterns of facial muscle activity associated with happy, sad and angry imagery, as found by Schwartz and associates and in our laboratory (Cacioppo et al., 1986; Fridlund et al., 1984; Schwartz et al., 1973; Schwartz et al., 1976; Schwartz and Weinberger, 1980; Sirota and Schwartz, 1982; Smith et al., 1986). Specifically, looking at the results from the Feel condition which should best reflect spontaneous emotional expressions, the two negative emotions (angry and sad) were characterized by significant increases in corrugator supercilii activity (brow); anger can be differentiated from sadness by the additional presence of activity in the masseter region (jaw). In the happy condition the zygomaticus major (cheek) was the dominant muscle ($P < 0.05$). Peacefulness is characterized by a significant decrease in zygomaticus major activity, activity at the other three sites was at baseline level (all significance levels were calculated as difference from 0 and were significant at least at the $P < 0.05$ level).

These results indicate, that subjects showed facial expressions consistent with the emotional state they were supposed to generate or to pose. Further, these patterns of muscle activity for the four emotions are consistent throughout the three tasks. The level of activity was lowest for the Feel task (see Fig. 1), where subjects were asked to generate, but not express, an emotion and highest for the Show condition. This finding can, however, not be seen as strong support for a necessity version of the facial feedback hypothesis, as subjects have not explicitly been instructed to suppress facial expression for this task. During the

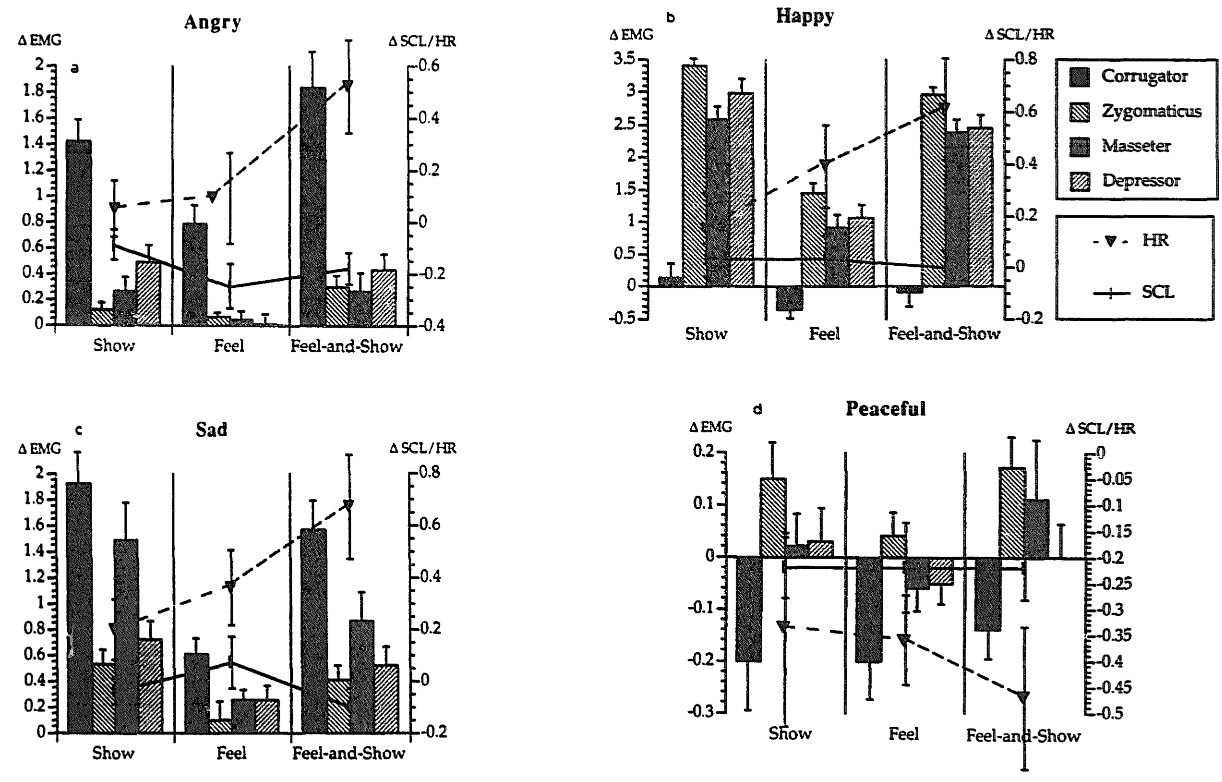

Fig. 1. Standardized difference scores for m. corrugator supercilii, m. zygomaticus major, m. depressor anguli oris, m. masseter, heart rate and skin conductance level by elicitation condition and emotion: (a) angry (b) happy (c) sad and (d) peaceful. The presentation order differs from the presentation order in the experiment.

first task subjects were simply instructed to 'generate an emotion', without being told how to accomplish that goal. For the replication of the first task, it can be argued that subjects interpreted the tasks as: 'feeling with no expression', 'no feeling with expression' and 'feeling and expression'. Thus, there may have been a demand effect not to show facial expression for the feel task that was stronger in the replication. However, the subjects showed visible facial expression in both the first and second replication of the feel condition, as assessed by video rating (not reported here).

Skin conductance and heart rate

A two-factor univariate analysis of variance (task × emotion) for skin conductance showed a significant effect for emotion ($F(3,23) = 7.71$, $P < 0.001$) * but not for task. Heart rate showed a significant emotion effect ($F(3,21) = 13.44$, $P < 0.001$) and a significant task effect ($F(2,22) = 4.26$, $P < 0.05$). No significant interactions between emotion and task emerged either for skin conductance or for heart rate. The Feel-and-Show condition was characterized by a higher heart rate than the Feel and the Show conditions, whereas the Show condition had the lowest heart rate changes of the three tasks (univariate F-test: Show vs. Feel and Feel-and-Show; $F(1,23) = 5.61$, $P < 0.05$). The difference between the Feel and the Show conditions, however, was not significant (univariate F-test: $F(1,23) = 3.22$, $P < 0.086$).

For heart rate changes this pattern of results is consistent with the hypothesis that in the Feel-and-Show condition the addition of facial expression to the self-generated emotion made the task easier for the subject, if one assumes that heart rate changes could be fast enough to precede the subjects' awareness of their emotional state.

Regarding the differences between the four emotional states, both anger and happiness were characterized by significant increases from baseline in HR but not skin conductance. Sadness and peacefulness were both characterized by a significant decrease of SCL, but only for peacefulness a decrease in HR was found.

* If repetition is included as a factor, then the emotion effect is significant at $P < 0.01$ ($F(3,18) = 5.50$).

TABLE I

Means and standard deviations for self-reports of emotional state by emotion and elicitation condition [a]

Condition	*Show*	*Feel*	*Feel-and-Show*
Emotion			
Angry			
angry	1.32 (1.1)	2.84 (0.81)	2.63 (0.70)
happy	0.18 (0.46)	0.20 (0.48)	0.09 (0.20)
sad	0.09 (0.31)	0.57 (0.56)	0.39 (0.48)
other	0.37 (0.73)	0.59 (0.90)	0.50 (1.0)
Happy			
angry	0.02 (0.09)	0.05 (0.21)	0.05 (0.16)
happy	1.84 (1.2)	2.96 (0.65)	3.05 (0.67)
sad	0.05 (0.16)	0.23 (0.46)	0.23 (0.42)
other	0.46 (0.80)	0.78 (0.91)	0.82 (1.0)
Sad			
angry	0.13 (0.32)	0.54 (0.58)	0.46 (0.61)
happy	0.14 (0.43)	0.25 (0.67)	0.21 (0.52)
sad	1.43 (1.2)	2.95 (0.63)	2.84 (0.76)
other	0.33 (0.71)	0.52 (0.95)	0.52 (0.87)
Peaceful			
angry	0.05 (0.21)	0.04 (0.13)	0.02 (0.09)
happy	0.86 (0.90)	1.41 (1.1)	1.14 (0.96)
sad	0.13 (0.29)	0.43 (0.66)	0.25 (0.29)
other	1.52 (1.1)	2.11 (1.1)	2.46 (1.5)

[a] Note: the following presentation order differs from the presentation order in the experiment

Self report

Highly significant task and emotion effects for the four self-report scales (angry, happy, sad, other) and significant interactions between emotion and task for the angry, happy and sad scales emerged in univariate analyses of variance ($P < 0.001$ in all cases). The univariate F-tests showed no significant difference between the Feel and the Feel-and-Show conditions except for the sad scale ($F(1,27) = 4.80$, $P < 0.037$). The self-report data provide an additional manipulation check. As expected, the target emotion received the highest ratings for all three tasks. (In the case of peacefulness the scale 'other' yielded the highest ratings). That is, subjects reported to have felt the emotions they were asked to generate (see Table I).

It is interesting to note that subjects reported having felt the emotions they were asked to pose, since they were instructed to suppress feeling in the Show task. However, the self-reports on all four scales are significantly higher in the Feel and the Feel-and-Show conditions than in the Show condition.

Perceived task difficulty

An analysis of variance of the difficulty ratings yielded main effects for task ($F(2,22) = 8.63$, $P < 0.01$) and emotion ($F(3,21) = 11.79$, $P < 0.001$) and a significant task by emotion interaction ($F(6,18) = 3.33$, $P < 0.05$). There was no significant main effect for repetition nor for any interactions with repetition. Within-subjects a priori contrasts were performed to assess differences in the perceived difficulty of the tasks. The univariate F-test shows a significant difference between the Feel and the Feel-and-Show conditions ($F(1,23) = 5.59$, $P < 0.05$). Encouraging the subjects to show facial expression in the latter condition reduced the perceived difficulty of generating an emotion. In addition, feeling an emotion and feeling while expressing are perceived as significantly more difficult than just showing an emotional expression ($F(1,23) = 14.64$, $P < 0.001$). The task by emotion interaction seems to be caused by a differential effect of the Show condition on the display of anger versus the display of peacefulness; whereas it is easier to show anger than to generate it, it is more difficult to show peacefulness than to generate it ($F(1,23) = 13.86$, $P < 0.001$). The relative difficulty of the peacefulness display may be caused by the lack of a prototypical peaceful expression that can be easily posed.

The significant difference in difficulty between tasks is evidence for the facilitative effect of facial expression on generating an emotion. We had expected that subjects would set a criterion level corresponding to the experienced emotion, so that the augmenting effect of adding facial expression would make the task easier. As expected, the self-report data, like that for heart rate, showed no significant difference between the Feel and Feel-and-Show conditions, but it was easier for the subject to express and feel an emotion than just to feel that emotion.

TABLE II

Means and standard deviations for self-reports of task difficulty by emotion and elicitation condition [a]

Condition	*Show*	*Feel*	*Feel-and-Show*
Emotion			
Angry			
trial 1	1.71 (1.55)	2.83 (1.74)	2.63 (1.38)
trial 2	1.42 (1.02)	2.75 (1.36)	2.33 (1.20)
Happy			
trial 1	0.75 (1.03)	1.42 (1.50)	1.46 (1.53)
trial 2	0.83 (0.82)	1.71 (1.60)	1.33 (1.05)
Sad			
trial 1	1.83 (1.24)	2.54 (1.50)	2.08 (1.77)
trial 2	1.79 (1.50)	1.88 (1.39)	1.96 (1.33)
Peaceful			
trial 1	1.42 (1.06)	1.42 (1.14)	1.08 (1.32)
trial 2	1.08 (1.10)	1.50 (1.56)	1.21 (1.18)

[a] Note: the following presentation order differs from the presentation order in the experiment

One might argue that the perceived difficulty ratings were subject to demand effects. However, it is not obvious in which direction such an effect should go. The instructions did not mention possible differences in difficulty between the task. The way the tasks were presented, introducing first the Feel condition, then the Show condition and then a combination of the two, might have suggested to the subjects that the Feel-and-Show condition should be more difficult than the single tasks. The pattern of results does not support this notion (see Table II). Further, an inspection of the perceived difficulty ratings also shows that the tasks do not become easier with repetition. On the contrary, the second (repeated) Feel condition was not easier than either the first Feel or the first Feel-and-Show condition.

Button-press latency

Inspection of the latency data revealed a high correlation between the means and their variances. Therefore, the following analyses were

TABLE III

Means and standard deviations of latency times (log-score) [a]

Condition	*Show*	*Feel*	*Feel-and-Show*
Emotion			
Angry			
trial 1	1.17 (0.26)	1.87 (0.34)	1.66 (0.29)
trial 2	1.01 (0.40)	1.50 (0.43)	1.49 (0.35)
Happy			
trial 1	1.10 (0.32)	1.68 (0.42)	1.57 (0.32)
trial 2	0.96 (0.32)	1.44 (0.43)	1.34 (0.41)
Sad			
trial 1	1.29 (0.28)	1.79 (0.37)	1.69 (0.32)
trial 2	1.12 (0.38)	1.53 (0.37)	1.44 (0.39)
Peaceful			
trial 1	1.23 (0.27)	1.65 (0.43)	1.61 (0.28)
trial 2	1.06 (0.36)	1.45 (0.44)	1.42 (0.43)

[a)] Note: the following presentation order differs from the presentation order in the experiment

conducted using logarithmically transformed values (Winer, 1962). A task × emotion × repetition analysis of variance showed significant task and emotion effects ($P < 0.001$) as well as an interaction ($P < 0.023$). There was a main effect for repetition, but no interactions. The latencies were generally shorter in the second half of the experiment, with a similar reduction in latency for all three tasks (see Table III).

As the order of tasks was fixed for both repetitions, task effect and order are confounded, the fixed order was deemed necessary in order to minimize priming effects in the first feel condition. It is therefore difficult to demonstrate, on the basis of latency alone, that the decrease in latency from the Feel condition to the Feel-and-Show condition is caused by the facilitative effects of facial expression and not by a simple practise effect. The two repetitions followed each other. If the decrease in latency time for the Feel-and-Show condition is due solely to a practise effect one would expect a linear trend reflected in the difficulty ratings. However, as mentioned above, the perceived difficulty ratings for the tasks show that they do not become easier with repetition. Even though the self-report of difficulty is a cruder measure than latency, we feel that the differences in reaction time between the Feel and the Feel-and-Show condition can be attributed to a difference in the underlying tasks. Since the decrease in latency holds for all three tasks in the second repetition, one can assume that the sequence effect is a general training effect, which influences all tasks, rather than a change in the accessibility of affective imagery. An overall facilitation of all three tasks would not refute the augmenting effects of expressive behavior in the Feel-and-Show task.

Summary

Consistent patterns across emotions were found for the three tasks. The two conditions involving the self-generation of an emotion (Feel and Feel-and-Show) were characterized by a high level of self-reported emotional feeling. The two conditions involving voluntary facial expressions (Show and Feel-and-Show) were marked by high levels of facial EMG activity, and the muscle patterns were consistent with the emotions that were both requested and reported. Heart rate distinguished between the Feel and the Feel-and-Show conditions on one hand and the Show condition on the other.

Qualitatively distinct reactions were found for the four self-generated emotions, as reflected by the self-report, autonomic and EMG measures. Facial EMG revealed tensional patterns that distinguished not only between negative and positive emotions, but also between emotions within the same valence.

The Show condition was characterized by short button-press latency times, and the Feel and Feel-and-Show conditions produced relatively long latency times, but importantly, with the Feel condition showing longer latencies than the Feel-and-Show condition. The latency data were consistent with the notion that the addition of facial expression facilitates the self-generation of emotion, as predicted by the monotonicity version of the FFH. Post hoc analyses suggest that the differences found in the latency times due to task cannot be attributed simply to a practise effect with a fixed order.

DISCUSSION

The results of this study support the monotonicity version of the facial feedback hypothesis, which claims that there is a positive, monotonic and causal relationship between the expression of an emotion and its perceived intensity. The mean latency times showed that subjects reached their subjectively determined criterion level for the presence of a moderately intense emotion faster when they not only experienced the emotion but also showed the congruent facial expression. While it could be argued that self-reports or even autonomic data are influenced by experimental demand, this is unlikely in the case of button-press latency times, because the measure is indirect and was taken without the subjects being aware that latency was measured.

Specifically, the comparison between the Feel and Feel-and-Show conditions yields the expected support for the monotonicity hypothesis. It was anticipated that the period from the start of the task to the button-press would be shorter in the Feel-and-Show condition, as compared to the Feel condition, due to the facilitative contribution of the facial expression on the self-generation of emotion. One might argue, given that most studies on the FFH have used verbal self-report as the primary dependent measure, that in accordance with the monotonicity hypothesis subjects should also report a higher level of the target emotion. However, in the paradigm employed here, verbal self-report data were not expected to differ, because we assumed that subjects would set a criterion level of subjective experience in the Feel and would press the button in the Feel-and-Show condition once this same level was reached. The data support this notion. Izard (1990) pointed out recently that a critical requirement for the ecological validity of a FFH study is that subjects experience a self-managed emotion. The setting of a subjective criterion level of emotional experience by the subjects can be interpreted as indicating that the self-generation procedure induces a self managed emotional state, thus meeting this condition for an adequate test of the hypothesis.

The findings of the present study are also consistent with the sufficiency version of the facial feedback hypothesis, which claims that the production of the facial expression of an emotion is sufficient by itself to cause the emotion to be elicited. The self-report data show that subjects experienced the emotions they were asked to pose to a substantial degree in the Show condition. This is the case even though the instructions for this task strongly demanded that subjects not feel the emotion! The pattern for heart rate changes across the four emotions suggests that the reactions for the Show condition were largely the same as for the Feel condition. As the muscular effort due to the expression of emotion was more pronounced in the Show condition, it is unlikely that the observed autonomic changes are caused by muscular effort alone. It seems justifiable to suggest that the similarity in the autonomic pattern for the Feel and the Show conditions is due to the same underlying affective state; in one case the subjects were explicitly asked to feel the emotion; in the other case the emotion was indirectly evoked, as predicted by the sufficiency hypothesis.

Nevertheless, this can not be seen as a stringent test for the sufficiency hypothesis. For example, it is plausible that the previous experience with the self-generation task in the Feel condition resulted in cognitive priming. That is, posing the emotional expression may have triggered the recall of mental images with associated subjective feelings. The subject does not necessarily have to be aware of this, but instead it could be mediated by automatic processes (e.g., Leventhal, 1984a, 1984b). The mediating processes of the sufficiency hypothesis have never been explicitly stated. Therefore, a recall process such as the one described above, triggered by facial expression alone, could be a legitimate instance of the processes suggested by the sufficiency hypothesis.

Overall, the present study found evidence for the monotonicity version, and tentative evidence for the sufficiency version, of the facial feedback hypothesis, not only regarding a positive/negative dimension but also between emotions of the same valence. The emotions of the same valence employed in the present study differed in level of activation and in facial expression. Following the argument outlined by Winton (1986) that previous investigations of the FFH have been restricted to two emotions of different valence, thereby limiting the generalizability of their results to the dimensional level, we suggest that future research makes use of more emotions within the same valence and level of activation, such as anger, disgust and fear. In addition, one of the key issues in understanding the causal role of facial expression for the internal state of the individual, as well as for social functioning (e.g., acquisition of display rules), lies in taking the developmental aspect more into account (see also Izard, 1990). Studies with different age groups, particularly during childhood are urgently needed to address this issue.

As a methodological outcome, the results of this study indicate that the 'self-generation' method is a viable tool for the induction of emotions in the laboratory. Specific emotions were induced, as shown by the self-report data, and the analysis of the facial EMG data reveals that these subjective feelings were accompanied by appropriate facial expressions. Autonomic reactions distinguishing between the four different emotions were also found. The method of subject-cued, self-generated emotions appears to be more effective in producing autonomic and facial reactions than the more traditional approach using mental imagery alone. This may be because the subjects did not have to disclose the details of their imagery and could therefore use more effective, private scenarios.

One might also speculate about the role of the subject-cuing vs. external control by the experimenter. It has been shown that the belief of being in control reduces stress in an experimental setting (e.g., Stoyva and Anderson, 1982). We assume that by letting subjects set the criterion level of success when generating an emotion, they felt more in control, thereby making the task less threatening since they could establish the degree to which they re-experienced the emotional event. In particular, this should make the self-generation of negative emotions easier. Moreover, it is reasonable to assume that external constraints on the imagery process may be considered disruptive by subjects, and the emphasis on script-like descriptions of situations or reactions might be more restraining than the broader instruction to 'generate an emotion.'

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