Journal of Personality and Social Psychology
1979, Vol. 37, No. 7, 1204–1210

Expressive Tendencies and Physiological Response to Stress

Clifford I. Notarius
Catholic University of America

Robert W. Levenson
Indiana University

This study assessed the effects of natural expressive tendencies on physiological response to stress. Male undergraduates were unobtrusively observed while watching a stressor videotape. On the basis of the subjects' facial responsiveness to the film, a group of 23 natural expressers and 22 natural inhibitors were selected and exposed to a threat of shock situation during which heart rate, respiration rate, skin conductance, and facial expressions were monitored. In accord with the discharge model of emotion, natural inhibitors were less facially expressive and more physiologically reactive to the shock threat than were natural expressers. The results also demonstrated that overt expressivity is stable over time and situation. On personality measures, natural expressers scored significantly higher on Mehrabian's empathic tendency scale, thus supporting the efficacy of this paper-and-pencil instrument as a measure of nonverbal responsiveness. The two groups did not differ on measures of self-esteem, introversion–extraversion, or locus of control. The results are discussed in terms of the discharge model as a descriptive metaphor and not a causal theory.

Understanding the relationship between overt emotional expression and physiological response is necessary for a comprehensive theory of emotion as well as for an adequate conceptualization of behavior change following any of several expressive therapies (Nichols & Zax, 1977). Facial display is one component of emotional expression that has been shown to influence both physiological reaction patterns and the subjective experience of emotion (e.g., Izard, 1978; Laird, 1974). Although there is agreement that facial display is an important component of emotional response, there is conflicting evidence about whether facial display attenuates (Buck, Miller, & Caul, 1974; Buck, Savin, Miller, & Caul, 1972; Lanzetta & Kleck, 1970) or augments (Lanzetta, Cartwright-Smith, & Kleck, 1976) physiological response to emotionally arousing situations.

Lanzetta and Kleck (1970), Buck et al. (1972), and Buck et al. (1974) used an encoding/decoding paradigm to study the relationship between facial displays of emotion and physiological response to arousing situations. In these studies, a sender subject was exposed to an emotionally arousing event while an observer subject watched the subject's face on a video monitor and attempted to decode the sender's expression. The sender's skin conductance or heart rate or both were monitored throughout the stimulus presentation. The results of these studies indicated that the observer subjects were most accurate at decoding the facial expressions of sender subjects who were least physiologically reactive to the eliciting stimuli; conversely, observer subjects were least accurate at decoding the facial expressions of sender subjects who were most physiologically reactive. The results of these studies, which imply that reduced decoding accuracy was due to relatively fewer facial expressions, have been interpreted as support for

This article is based on data collected as part of the first author's doctoral dissertation.

The authors would like to thank Chrys Ruybal, Kitty Kane, and Michael Reed for serving as coders, and Alyne Robin and George Doxas for serving as experimenters. Howard J. Markman provided valuable comments on an earlier draft of this article.

Requests for reprints should be sent to Clifford I. Notarius, Department of Psychology, Catholic University of America, Washington, D.C. 20064.

the discharge model of emotion according to which facial expressions are associated with attenuated physiological response to emotional stimuli.

Unfortunately, the encoding/decoding paradigm does not provide a strong empirical test of the discharge model. In the studies that used this paradigm, the assessment of overt expressivity was dependent on the measure of decoding accuracy and the implication that this measure reflects overt expressivity. A more direct test of the relationship between facial expressiveness and physiological reactivity would be to place subjects in an arousing situation with trained raters recording the extent of their facial expressiveness. This methodology would enable an objective assessment of a subject's tendency to facially display a response to an emotionally arousing situation. Comparison of the objectively rated facial display data with recorded physiological response data would allow a test of the discharge model in situations in which natural response tendencies would most likely be evidenced.

An alternative approach is possible in which an attempt is made to directly manipulate the extent of facial responsiveness. Lanzetta et al. (1976) tested the discharge model in a well-designed study incorporating experimentally manipulated facial displays and independent assessment of expressivity during exposure to electric shock. Lanzetta et al. instructed subjects to either pose an intense expressive reaction or to pose no reaction to electric shock and found that subjects who were instructed to pose no reaction were significantly less *physiologically* reactive to the shock than subjects who had posed an intense reaction. These results are opposite to predictions based on the discharge model. Lanzetta et al. interpreted their results as support for proprioceptive feedback models of emotion (Gellhorn, 1964; Izard, 1971).

The discrepancy between Lanzetta et al.'s (1976) findings and previous support for the discharge model (Block, 1957; Buck et al., 1974; Buck et al., 1972; Jones, 1950; Lanzetta et al., 1970; Learmonth, Ackerly, & Kaplan, 1959) may stem from differences across studies in the operationalization of emotional expressivity. With the exception of Lanzetta et al.'s (1976) study, all previous investigations that found support for the discharge model allowed subjects access to their natural emotional responses during exposure to an eliciting situation. Thus, as Lanzetta et al. suggest, short-term, experimentally manipulated control of emotional expression may lead to a positive relationship between facial expression and physiological reactivity, whereas natural response patterns may be characterized by the discharge model.

One possible mediator of this short-term, positive relationship may be patterns of general somatic activity that are activated by instructions to "be responsive." To the extent that subjects become more physically active, one would expect such activity to be accompanied by increases in heart rate and skin conductance. Conversely, if instructions to hide responses produce a decline in somatic activity and a more general state of relaxation, decreases in cardiac and electrodermal activity might follow. In any event, it seems likely that results derived from experiments that involve natural expressive tendencies will differ from the results obtained from direct manipulation of expressivity, insofar as the two methodologies reveal different aspects of the relationship between facial expressivity and physiological responsiveness.

The purpose of the present study was to determine the relationship between facial displays of emotion and physiological reactivity to stress in subjects whose natural expressive styles were unconstrained. The experimental design incorporated a behavioral coding of facial expressivity (Mehrabian, 1972) and multiple measures of physiological reactivity (heart rate, respiration rate, and skin conductance). Based on the consistency of findings from studies in which subjects were allowed their natural emotional responses, it was predicted that natural expressers would be less physiologically reactive to an emotionally arousing situation than natural inhibitors.

A secondary purpose of the study was to explore personality correlates of expressive tendencies. Buck et al. (1974) reported that expressers were higher in self-esteem and were more extraverted than inhibitors. In the present study, subjects were assessed on self-esteem, introversion–extraversion, and empathic tendency.

Method

Subject Selection

To test the experimental hypotheses, it was necessary to preselect a group of natural inhibitors (persons who show little or no facial responsivity to an emotional situation) and a group of subjects who were natural expressers (people who show high levels of facial responsivity to an emotional situation). Seventy-six male undergraduates enrolled in introductory psychology classes were recruited for the preselection phase of the experiment; they were fulfilling a course requirement.

To establish natural expressive tendencies, subjects were shown an industrial accident film that had been demonstrated to be emotionally arousing (Lazarus, Opton, Nomikos & Rankin, 1965). The subjects were told that they would view a brief film and then be asked to complete several questionnaries. The questionnaires were Mehrabian's empathic tendency scale, Eysenck's Introversion–Extraversion Scale, Rotter's Locus of Control Scale, and Janis and Field's Self-Esteem Inventory.

Subjects viewed the industrial accident film in groups of four to six while three coders (two undergraduates and the first author) observed through a one-way mirror. Throughout the film, coders counted the number of facial expressions occurring in 30-sec time periods and entered this number on a coding sheet. Criteria for determining the occurrence of a facial expression were based on a procedure described by Mehrabian (1972). Using this procedure, changes from a neutral display to a nonneutral display and back to a neutral display constituted one facial expression. Gestural behaviors, such as slight movements of the eyebrows or touching the face with the hand, were not counted as facial expressions. Although more elaborate qualitative coding schemes exist for classifying facial displays in terms of discrete emotional states (Ekman & Friesen, 1975), it was decided to use a relatively simple quantitative coding system in this study to determine if a general relationship between natural facial expressiveness and physiological reactivity could be detected using a stress paradigm.

In addition to recording the number of facial expressions, coders assigned a subjective rating on a 10-point scale to each subject after the film, with 0 indicating little overt expressivity and 10 indicating a high level of expressivity. For all groups of four to six subjects, each coder observed three subjects, thus generating three independent codings of at least one subject during each screening of the film. This coding overlap permitted continuous reliability estimates throughout the subject selection procedure. Correlations between observers' codings averaged .88 (range, .79 to .95 for the number of expressions) and averaged .91 for the subjective index (range, .85 to .95).

Subjects who received a behavioral rating of 9 expressions or more and a subjective rating of 5 or more were classified as natural expressers, whereas subjects receiving a behavioral rating of 3 expressions or less and a subjective rating of 1 or less were classified as natural inhibitors. On this basis, 23 natural inhibitors and 22 natural expressers were selected for continuation in the experiment.

Procedure

A single laboratory appointment was arranged for each of the 45 subjects selected for continuation in the experiment. As each subject arrived at the laboratory, he was seated in a comfortable chair in front of a video monitor and an unobtrusively placed video camera. The subject was told that he would be viewing a film on the monitor and that the experimenters were interested in people's physiological reactions to the film. Physiological sensing devices to detect heart rate, respiration rate, and skin conductance were then attached to the subject, and he was told that the experimenter (one of two research assistants blind to the experimental hypotheses) was going to set up the film and check to see that the physiological recording equipment was working properly.

Just prior to leaving the subject, the experimenter informed the subject that he would soon see a "digital voltmeter" displayed on the monitor via a closed circuit TV camera placed in the adjoining room. The subject was told that the "voltmeter" indicated the voltage flowing through his body as measured by a clip (actually a ground clip) attached to his ear. The experimenter explained that the meter had an internal circuit to sense rapid increases in voltage and that if the internal circuit was activated, "9999" would begin to flash as a warning that a dangerously high level of voltage was present and that a strong shock could result. The subject was then asked to monitor the voltmeter and to signal the experimenter immediately if 9999 began to flash by ringing a buzzer conveniently placed to the subject's right. The experimenter asked if the subject had any questions and then left, telling the subject that he had to check the recording equipment.

In reality, the monitor displayed a videotape that was identical for all subjects and on which was recorded a small digital light display of four numbers. The preprogrammed display presented "0000" for 4 min, leading to small increases over the next 30 sec until 9999 began to flash on and off for 1 min. The flashing display of 9999 constituted the threat of shock. As soon as the subject signaled the onset of 9999, the experimenter began to jiggle the wires in the adjoining room as if to attempt to locate the "problem." A loud thump on the wall was produced to accompany the return of 0000 to the video monitor; then 0000 remained on the monitor for 4.5 min (the poststimulus period). The experimenter entered the subject room and apologized for the flashing 9999 by explaining that this was the first time this had happened, that the cause was located and corrected, and that the subject was in no danger. The subject was then shown a second stressor film and exposed to an additional arousing situation before being debriefed.[1]

[1] Only data gathered in response to the threat of shock are reported. Although all subjects watched the film and were exposed to a third eliciting situation, it

Monitoring physiological responses. Skin conductance was measured by passing a constant voltage between two Beckman electrodes placed on the volar surfaces of the middle segments of two fingers of the right hand. Heart rate was recorded bipolarly using Beckman surface electrodes. Respiration rate was assessed by stretching a mercury strain gauge 10 inches (25.4 cm) in length above the subject's waist. Physiological signals were passed through a Grass Model 7 polygraph and routed through the analog-to-digital converter of a PDP-11 computer for on-line processing.

Monitoring facial expressivity. Facial expressivity was coded by the same coders using a similar procedure to that used in the preselection of subjects, with the exception that only one coder rated each subject.[2] The coder watched the subject's face on a closed-circuit video monitor located in a separate room and pressed a button for the duration of each nonneutral facial display. In the case of expressions maintained over 5 sec, the computer automatically counted an additional expression. Coders were blind as to which group the subject was assigned.

Videotape functions. The videotape served two functions, (a) to present the threat of shock stimulus to the subject and (b) to signal the end of the trial periods to the computer. An inaudible signal (17,000 kHz) placed on the videotape at spaced intervals (30 sec during stimulus presentations and 90 sec during baseline periods) momentarily closed a decoding switch, signaling the computer to begin a new trial period. The videotape continued for the duration of the experiment to ensure identical timing of the experiment for each subject.

Dependent measures. The computer was used to obtain the following dependent variables: (a) heart rate (interbeat interval)—time, in msec, between heart beats; (b) respiration rate (intercycle interval)—time, in msec, between inspiration and expiration cycles; (c) skin conductance—skin conductance, in micromhos; and (d) facial expression—the number of facial expressions coded.

Results and Discussion

Physiological reactivity was assessed by comparing average responses occurring in a 4.5-minute prestimulus period with average responses occurring in a 1-minute stimulus period. A 4.5-minute poststimulus period was compared with the prestimulus period to determine the extent of return to resting levels following exposure to an emotionally arousing situation. Dependent variables were entered into a Groups × Trials repeated measures analysis of variance with two groups (natural inhibitors and natural expressers) and three trials (prestimulus, stimulus, and poststimulus). Planned comparisons by t test were used to test specific reaction patterns of natural expressers and natural inhibitors.

Due to equipment malfunction, heart rate data were lost for one natural inhibitor across all stimulus periods, respiration rate data were lost for one natural expresser during the stimulus period, and skin conductance data were lost for one natural expresser across all stimulus periods and for one natural expresser during the prestimulus period. The remaining available data from these subjects were included in the analyses.

Stability of the inhibitor–expresser dimension. The preselection of subjects was intended to yield two groups of subjects who differed in the tendency to display facial expressions in response to emotionally arousing situations. In the absence of evidence concerning the stability of the tendency towards overt facial displays of emotion, it was hoped that a selection procedure based on behavioral observations of expressions in response to a stressor situation would be most likely to reliably identify the two groups. Examination of the mean number of facial expressions displayed in response to the threat of shock stimulus indicated that natural expressers averaged significantly more facial expressions than did natural inhibitors, $t(86) = 2.53$, $p < .025$; the mean numbers of expressions were 1.34 and .87, respectively. This result confirms the preselection classification of subjects and demonstrates stability of expressive tendencies across two independent situations (film and threat of shock) and across time (approximately 9 weeks separated the preselection film and the threat of shock situations).

Assessment of the arousing situation. Since the threat of shock was a novel stressor, it was important to determine whether subjects found the situation arousing. A significant trials effect

was decided that the within-subject design used in this study did not permit valid interpretation of the physiological data gathered following the threat of shock.

[2] Even though several months had passed since the preselection phase of the experiment, every attempt was made to ensure that a given subject's facial expressions were coded by a different rater in the preselection and laboratory phases of the research. Use of separate groups of coders in both phases of the study and having two coders per subject in the laboratory phase (to allow continuation of reliability monitoring) would be desirable in future work.

Table 1
Physiological Reactivity Patterns for Inhibitors and Expressers

Subjects	Measure	Prestimulus	Shock threat	Poststimulus
Inhibitors	Heart rate[a]	865	818*	882
	Respiration rate[b]	3648	3298*	3621
	Skin conductance (micromhos)	12.7	16.6*	15.7*
Expressers	Heart rate[a]	823	820	838
	Respiration rate[b]	3593	3530	3687
	Skin conductance (micromhos)	10.8	14.5*	12.9*

[a] Time in msec between heart beats.
[b] Time in msec between inspiration and expiration cycles.
* Significantly different from prestimulus level ($p < .001$).

was found on all dependent measures, indicating that the threat of shock was a physiologically arousing situation; for facial expression, $F(2, 86) = 35.12$, $p < .001$; for heart rate, $F(2, 84) = 11.21$, $p < .001$; for respiration rate, $F(2, 85) = 10.61$, $p < .001$; and for skin conductance, $F(2, 83) = 49.49$, $p < .001$. Anecdotal data gathered during the debriefing also indicated that the subjects found the situation arousing and believable. One subject, for example, related, "When the nines began to flash I really thought I was in for it."

Reactivity patterns in natural expressers and natural inhibitors. On measures of heart rate and respiration rate, natural expressers were less reactive to the threat of shock stimulus than were natural inhibitors. Natural inhibitors showed a significant heart rate increase, $t(84) = 3.76$, $p < .001$, and a significant respiration rate increase, $t(85) = 4.34$, $p < .001$, from the prestimulus to the stimulus period, whereas natural expressers showed no significant change from prestimulus levels in heart rate, $t(84) = .28$, *ns*, or respiration rate, $t(85) = .78$, *ns*. During the poststimulus period, heart rate and respiration rate of both groups returned to prestimulus levels. Heart rate and respiration rate means are presented in Table 1. These results are consistent with the discharge model.

Analysis of the skin conductance measure indicated that both groups were similarily reactive to the threat of shock; natural inhibitors showed a significant increase in skin conductance from prestimulus levels, $t(83) = 7.11$, $p < .001$, as did natural expressers, $t(83) = 6.67$, $p < .001$. During the poststimulus period, each group maintained a significantly higher skin conductance level relative to the prestimulus period, $t(83) = 5.49$, $p < .001$, for natural inhibitors; $t(83) = 3.89$, $p < .001$, for natural expressers. Skin conductance means are presented in Table 1. Skin conductance reactivity patterns did not discriminate natural expressers from natural inhibitors, as would be predicted on the basis of the discharge model.

Resting levels of natural inhibitors and natural expressers. Although reactivity patterns from the prestimulus to the stimulus period are the critical test of the discharge model, baseline differences occurring in the prestimulus period were also assessed. Natural expressers displayed a faster heart rate during the prestimulus period than did natural inhibitors, $t(84) = 3.35$, $p < .001$; whereas natural inhibitors displayed a significantly higher skin conductance level than did natural expressers, $t(83) = 3.49$, $p < .001$. The two groups did not display any prestimulus respiration rate differences, $t(85) = .68$, *ns*.

These baseline differences, observed in subjects who had just entered the laboratory and who were told only to monitor a "voltmeter," were unexpected. Furthermore, the pattern of the baseline differences indicated that one group was not simply more aroused to the general laboratory situation than the other group, since heart rate was elevated for natural expressers whereas skin conductance was elevated for natural inhibitors. These findings, together with the lack of correspondence between skin conductance reactivity and heart rate and respiration rate reactivity, suggest that expressive tendencies may be associated with differences in individual physiological response stereotypy (Roessler & Engel, 1974) between expressers and inhibitors. This interpretation is offered tentatively, pending replication and extension of the results.

Personality correlates of expressive tendencies. Natural expressers were shown to be significantly more empathic on Mehrabian's empathic tendency questionnaire than were natural inhibitors, $F(1, 43) = 5.37$, $p < .025$. In a series of studies, Mehrabian (1972) presented evidence that overt responsiveness is the primary characteristic of subjects who score high on this questionnarie. Thus, the empathic tendency questionnaire appears to have discriminative validity.

The two groups did not significantly differ on measures of introversion–extraversion, self-esteem, or locus of control. These results are contrary to the findings of Buck et al. (1974).

Conclusion

The results of the present study are consistent with the discharge model; expressive subjects were significantly less physiologically reactive to an emotional stressor than were nonexpressive subjects. Furthermore, the stability of the inhibitor–expresser dimension over time and situation suggests an enduring attribute of affective style. However, it would be inappropriate, on the basis of these data, to conclude that facial expression functions as a causal agent in determining the parameters of physiological response to stress. More appropriate experimental designs for examining the causal relationship in which expressiveness is directly manipulated (e.g., Lanzetta et al., 1976) have produced results that are discrepant with the discharge model. This discrepancy between the results of studies in which subjects were allowed their natural response patterns and those in which subjects were asked to control their emotional expression underscores the fact that the discharge model is a descriptive metaphor for clinical and empirical findings that expressive individuals are less physiologically reactive to stress than are natural inhibitors. The fact that facial expressions are not mediating the relationship between expressivity and physiological reactivity leads to speculation concerning a third factor or factors that are responsible for the observed relationship.

Speculatively, the causal factors mediating the observed relationships between expressivity and physiological reactivity may involve the subject's cognitive appraisal of the eliciting situations. Given personality differences between expressive and inhibited subjects (Block, 1957; Jones, 1950; Learmonth et al., 1959), it would not be unexpected to find characteristic differences between the groups in the cognitive processes that function to shape an emotional response out of an environmental stressor. According to Lazarus, Averill, and Opton (1970), the outcome of these cognitive, subjective processes is an appraisal of the eliciting situation (along such dimensions as perceived danger, threat, or security) that determines a complex emotional response, which includes both overt expression and physiological response. Prestimulus differences in physiological levels observed in the present study may reflect the operation of differential appraisal from the moment the subjects entered the laboratory environment.

Attempts to refine our understanding of the determinants of different physiological reactivity patterns between expressive and nonexpressive individuals, whether or not cognitive appraisal is the primary mediator, must acknowledge the influence of several factors that have yet to be addressed. The first of these is the possible role of stimulus specificity. Although the facial responses in the present study were similar for the accident film and the threat of shock, it is conceivable that other stimuli might produce different patterns of facial and physiological response. In this respect, it would be important to examine stressors of a more interpersonal nature as well as situations in which positive affect is elicited. Second, continued research must recognize that natural expressive tendencies cannot be equated with instructionally manipulated displays of emotion. Short-term control of expression does not seem to be the equivalent of an expressive response from an individual's natural repertoire. Third, a more qualitative coding of facial expressiveness would be useful in determining whether the discharge model is uncritical as to the nature of facial display or whether such dimensions as appropriateness of affect, duration of display, or specific emotion displayed improve the predictive power of the model. Finally, further refinements in the scope of physiological response analysis may be important. Although it is generally agreed that monitoring one physiological system (e.g., skin conductance) is insufficient for adequately assessing physiological response, there is less consensus as to how data from multiple physiological systems should be handled in light of such factors as stimulus specificity and individual response stereotypy, which may strongly influence the nature of interrelationships among facial and physiological indices of expressivity.

References

Block, J. A study of affective responsiveness in a lie-detection situation. *Journal of Abnormal and Social Psychology*, 1957, *55*, 11–15.

Buck, R. W., Miller, R. E., & Caul, W. F. Sex, personality, and physiological variables in the communication of affect via facial expression. *Journal of Personality and Social Psychology*, 1974, *30*, 587–596.

Buck, R. W., Savin, V. J., Miller, R. E., & Caul, W. F. Communication of affect through facial expressions in humans. *Journal of Personality and Social Psychology*, 1972, *23*, 362–371.

Ekman, P., & Friesen, W. V. *Unmasking the face*. Englewood Cliffs, N.J.: Prentice-Hall, 1975.

Gellhorn, E. Motion and emotion: The role of proprioception in the physiology and pathology of emotions. *Psychological Review*, 1964, *71*, 457–472.

Izard, C. E. *The face of emotion*. New York: Appleton-Century-Crofts, 1971.

Izard, C. E. *Human emotions*. New York: Plenum Press, 1978.

Jones, H. E. The study of patterns of emotional expression. In M. L. Reymert (Ed.), *Feelings and emotions*. New York: McGraw-Hill, 1950.

Laird, J. D. Self-attribution of emotion: The effects of expressive behavior on the quality of emotional experience. *Journal of Personality and Social Psychology*, 1974, *29*, 475–486.

Lanzetta, J. T., & Kleck, R. E. Encoding and decoding of nonverbal affect in humans. *Journal of Personality and Social Psychology*, 1970, *16*, 12–19.

Lanzetta, J. T., Cartwright-Smith, J., & Kleck, R. E. Effects of nonverbal dissimulation on emotional experience and autonomic arousal. *Journal of Personality and Social Psychology*, 1976, *33*, 354–370.

Lazarus, R. S., Averill, J. R., & Opton, E. M. Towards a cognitive theory of emotion. In M. A. Arnold (Ed.), *Feelings and emotions*. New York: Academic Press, 1970.

Lazarus, R. S., Opton, E. M., Nomikos, M. S., & Rankin, N. O. The principle of short circuiting of threat: Further evidence. *Journal of Personality*, 1965, *33*, 622–635.

Learmonth, G. J., Ackerly, W., & Kaplan, M. Relationships between palmar skin potential during stress and personality variables. *Psychosomatic Medicine*, 1959, *21*, 150–157.

Mehrabian, A. *Nonverbal communication*. Chicago: Aldine, 1972.

Nichols, M., & Zax, M. *Catharsis in psychotherapy*. New York: Gardner Press, 1977.

Roessler, R., & Engel, B. T. The current status of the concepts of physiological response specificity and activation. *International Journal of Psychiatry in Medicine*, 1974, *5*, 359–366.

Received August 11, 1978 ■