Emotional Suppression: Physiology, Self-Report, and Expressive Behavior

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This study examined the effects of *emotional suppression*, a form of emotion regulation defined as the conscious inhibition of emotional expressive behavior while emotionally aroused. Ss (43 men and 42 women) watched a short disgust-eliciting film while their behavioral, physiological, and subjective responses were recorded. Ss were told to watch the film (no suppression condition) or to watch the film while behaving "in such a way that a person watching you would not know you were feeling anything" (suppression condition). Suppression reduced expressive behavior and produced a mixed physiological state characterized by decreased somatic activity and decreased heart rate, along with increased blinking and indications of increased sympathetic nervous system activity (in other cardiovascular measures and in electrodermal responding). Suppression had no impact on the subjective experience of emotion. There were no sex differences in the effects of suppression.

Little is known about what happens when people regulate their emotions. In this article, we investigate one kind of emotion regulation, namely, emotional suppression.

Emotion and Emotion Regulation

Adopting a discrete emotions perspective (e.g., Arnold, 1960; Ekman, Friesen, & Ellsworth, 1982; Frijda, 1986; Izard, 1971, 1977; Levenson, 1988; Plutchik, 1980; Tomkins, 1962, 1963, 1984), we assume that emotions are biologically based reactions that organize an individual's responses to important events. We further assume that these reactions unfold over a relatively brief time course (seconds, not hours), are malleable (showing variability, rather than reflexlike stereotypy), and have components in the domains of physiological response, subjective experience, and expressive behavior.

Emotion regulation may be defined as the manipulation in self or other of (a) emotion antecedents or (b) one or more of the physiological, subjective, or behavioral components of the emotional response. Examples of different kinds of emotion regulation include avoiding a conversation that would make one angry (regulation of emotion antecedents in self), telling a joke (regulation of emotion antecedents in other), exaggerating one's sadness at another's ill fortune (regulation of emotional responses in self), or telling a child not to act like a crybaby (regulation of emotional responses in other). In this article, we consider just one of these many kinds of emotion regulation, namely, *emotional suppression,* which we define to be the conscious inhibition of one's own emotional expressive behavior while emotionally aroused.

Emotional Suppression

Despite the commonness of emotional suppression, there is little agreement as to its effects. Some researchers (e.g., Darwin, 1872; Gellhorn, 1964; Izard, 1971; James, 1884; Tomkins, 1984) assert that expressive behavior is so important to an emotional response that the other aspects of an emotion (subjective experience and physiological response) are greatly diminished if its behavioral expression is stifled. This view is consistent with the folk admonition to count to 10 before reacting when one is angry so that the anger will dissipate (Tavris, 1984).

Other researchers (e.g., Cannon, 1927; Jones, 1935) disagree, arguing that the inhibition of expressive behavior leads to increases in the other aspects of an emotional response. Advocates of this position also may claim to have common sense on their side, as it is often said that bottling up an emotion will only mean that it will find another outlet (Marshall, 1972).

Surprisingly, very few studies have directly examined what happens to other aspects of emotional responding when subjects consciously inhibit the behavioral signs of emotion while emotionally aroused, and among those that have, fewer still have assessed physiological responding. There are, however, two large literatures on the more general topic of the relation between expression and physiology, one concerned with *characteristic expressive styles* and the other concerned with *manipulated emotional expressivity,* which are widely cited in discussions of emotion regulation. We now turn to these literatures to derive predictions as to what might happen to other aspects of the emotional response (especially physiological responding) when subjects suppress the visible signs of emotion.

Characteristic Expressive Styles

Internalizers and Externalizers

A sizable literature suggests that individuals differ as to whether they are emotionally expressive (externalizers) or emotionally unexpressive (internalizers). Implicit in this literature is the assumption that these expressive differences represent enduring characteristics, an assumption that with few exceptions (e.g., Notarius & Levenson, 1979) has generally gone untested.

Fifty years of research in this tradition has shown that emotionally unexpressive adults and children are more physiologically reactive to a variety of emotional stimuli than are expressive subjects (Buck, 1979; Field & Walden, 1982; Funkenstein, King, & Drolette, 1954; Jones, 1935, 1950, 1960; Notarius & Levenson, 1979).

This negative correlation between behavioral and physiological responses usually has been explained using a *hydraulic* model, which suggests that when expressive signs of emotion are inhibited they are discharged through other channels. In a recent article, Cacioppo et al. (1992) pointed out that this model is not directly tested by these kinds of studies and offered an alternative explanation—also untested—based on individual differences in the "gain" of physiological and expressive channels.

For expressive style to be relevant to emotional suppression, it must be assumed that characteristically unexpressive individuals are actually inhibiting emotional expression. If this assumption is made, then the findings from this literature would be consistent with a prediction that emotional suppression should lead to heightened physiological reactivity.

Emotions and Health

A related literature builds on the venerable idea that people who chronically inhibit their emotions may be more prone to disease than those who are emotionally expressive (Alexander, 1939; Freud, 1961). In recent years, there have been empirical reports of an association between the inhibition of anger and hostility on the one hand and essential hypertension and coronary heart disease on the other (e.g., Appel, Holroyd, & Gorkin, 1983; Diamond, 1982; Harburg et al., 1973; Holroyd & Gorkin, 1983; MacDougall, Dembroski, Dimsdale, & Hackett, 1985; also see Engebretson, Matthews, & Scheier, 1989), and others have suggested that emotional inhibition may be linked to cancer onset and progression (Gross, 1989; Temoshok, 1987).

We consider this literature to be most consistent with a prediction that emotional suppression should lead to heightened physiological reactivity, assuming that the link between emotional inhibition and disease end states is heightened physiological reactivity (a common postulate in studies of physiological reactivity and disease: e.g., Holroyd & Gorkin, 1983; Krantz & Manuck, 1984; MacDougall, Dembroski, & Krantz, 1981; Steptoe, 1981).

Summary

These two literatures concerned with characteristic expressive styles are generally supportive of a negative relation between emotional expression and other aspects of emotional responding. We consider them to be most consistent with the hypothesis that emotional suppression should lead to greater physiological responding.

Manipulated Emotional Expressivity

A number of studies have experimentally manipulated emotional expressive behavior and examined other components of the emotional response. Although such studies would seem to provide exactly the kind of experimental test of the effects of emotional suppression that we seek, most have failed to provide such a direct test because they (a) did not arouse emotion independently of facial manipulation, (b) did not have subjects inhibit emotion, or (c) did not measure physiology.

Manipulated Facial Action in the Absence of Emotion Elicitor

In this paradigm, subjects simply configure their facial muscles to make emotion-relevant facial expressions. Results of these studies indicate that voluntarily adopting the facial expressions associated with discrete emotions seems to elicit both subjective emotional feelings (Duclos et al., 1989; Duncan & Laird, 1977, 1980; Laird, 1974, Experiment 1; Levenson, Ekman, & Friesen, 1990; Rhodewalt & Comer, 1979; but not McCaul, Holmes, & Solomon, 1982) and physiological reactions (Ekman, Levenson, & Friesen, 1983; Levenson, Carstensen, Friesen, & Ekman, 1991; Levenson et al., 1990; Levenson, Ekman, Heider, & Friesen, 1992; McCaul et al., 1982) appropriate to those expressions.

In terms of their direct relevance to emotional suppression, these studies neither aroused emotion independently of facial manipulation nor had subjects inhibit emotion.

Manipulated Facial Action in the Presence of Emotion Elicitor

In this paradigm, subjects configure their facial muscles to make emotion-relevant facial expressions in the presence of an emotion elicitor (e.g., slides or films). Studies using this paradigm have shown that producing emotion-appropriate expressive behavior leads to greater self-reports of emotion (Kraut, 1982; Laird, 1974, Experiment 2; Rutledge & Hupka, 1985; but not Tourangeau & Ellsworth, 1979). To our knowledge, there have been only two reports in which this paradigm was used to examine the effects of inhibiting expressive behavior, and each found that inhibiting amusement expressive behavior decreased amusement self-reports (McCanne & Anderson, 1987; Strack, Martin, & Stepper, 1988).

In terms of their direct relevance to emotional suppression, these studies did not measure physiology and, with two exceptions, did not have subjects inhibit emotion.

Modulated Spontaneous Facial Expression in the Presence of Emotion Elicitor

In this paradigm, subjects are asked explicitly to modulate (e.g., exaggerate or diminish) spontaneously occurring facial expressive behaviors that have been generated by an emotion elicitor. In contrast with the previous studies in which static facial displays are created, this paradigm requires that subjects consciously modulate their ongoing involuntary expressive reactions.

Leventhal and Mace (1970) found that female elementary school children reported less favorable attitudes toward a humorous film when instructed to inhibit their responses than

when instructed to exaggerate (boys showed the opposite pattern). Physiological responding was not measured.

Several studies using this paradigm had subjects inhibit expression and also measured physiology, thus potentially providing a test of emotional suppression as we have defined it. Lanzetta and co-workers found that subjects had smaller skin conductance responses and lower reports of pain when asked to hide their reactions to electric shocks than when asked to exaggerate (Colby, Lanzetta, & Kleck, 1977; Lanzetta, Cartwright-Smith, & Kleck, 1976). Compared with subjects who responded spontaneously, Bush, Barr, McHugo, and Lanzetta (1989) found that subjects instructed to inhibit their expressive behavior had similar heart rates but lower self-reports of amusement during a filmed comedy routine. Zuckerman, Klorman, Larrance, and Spiegel (1981) found that subjects instructed to respond with neutral facial expressions to pleasant and unpleasant films had lesser increases in physiological arousal than did subjects instructed to respond naturally or to exaggerate their responses.

Summary

Although only a few studies in the preceding section provided the kind of direct test we consider necessary, they and the other studies of manipulated expressivity we reviewed are generally supportive of a positive relation between emotional expression and other aspects of the emotional response. Thus, in contrast with the literature on individual differences in emotional characteristic expressive styles, we consider the literature on manipulated emotional expressivity to be most consistent with the hypothesis that emotional suppression should lead to lesser subjective experience and physiological responding.

Sex Differences

There have been reports of sex differences in several aspects of emotional responding, including degree of expressivity (women are more expressive: e.g., Buck, Baron, & Barrette, 1982; Buck, Miller, & Caul, 1974; Fujita, Harper, & Wiens, 1980; Gallagher & Shuntich, 1981; Hall, 1979) and success at interpreting others' emotional expressions (women are more successful: e.g., Hall, 1978; Zuckerman et al., 1976). In the literature relevant to emotional suppression, however, sex differences have not always been considered. Even when studies included both male and female subjects, some did not report analyzing sex differences (e.g., Strack et al., 1988), whereas others actually partialed out the effects of sex (e.g., Zuckerman et al., 1981). It thus seems reasonable to investigate sex differences in the effects of emotional suppression (Buck, 1981).

The Present Research

In the present research, we explored the effects of emotional suppression by having subjects inhibit spontaneous facial expressions in the presence of an external emotion elicitor. We chose this paradigm because we thought it provided a good analog to the everyday situation in which a person becomes emotionally aroused (e.g., angry at a boss) and consciously attempts to inhibit his or her emotional expressive behavior.

Subjects were randomly assigned to one of two conditions. In the suppression condition, subjects were instructed to attempt to suppress all visible signs of emotion while watching a film known to elicit disgust. In the no suppression condition, subjects simply watched the same film. To begin to understand the temporal course of emotional suppression, subjects' responses were measured continuously as the suppression instructions were administered, during the film, and during a 1-min post-film period.

Overview

This article reports two studies that were identical in every respect but for the fact that the first used a sample of men, whereas the second used a sample of women. These studies were conducted approximately 18 months apart because practical considerations (e.g., subject availability, laboratory resources, and funding patterns) made it unfeasible to conduct one large study.

Study 1

Method

Subjects

Forty-three male undergraduates came to the Berkeley Psychophysiology Laboratory for individual sessions.[1] The subjects were 18 to 23 years old ($M = 19.3$), and their ethnic identification (44% Asian, 35% White, 7% Black, and 14% other) approximated the demographics of the student population at the University of California, Berkeley. Subjects fulfilled a requirement of an introductory psychology course by participating in this study.

Stimulus Films

Three silent films developed by P. Ekman and W. Friesen of the University of California, San Francisco (see Ekman, Friesen, & O'Sullivan, 1988) were pretested by us in group settings to determine the emotion self-reports they elicited. One film showed flowers in a park on a sunny day (neutral film) and was 113 s in length. It elicited emotion self-reports that were similar to baseline. The other two films showed medical procedures. The first showed the treatment of burn victims (burn film) and was 55 s long. The second showed a close-up of the amputation of an arm (amputation film) and was 64 s long. These two films elicited equivalent levels of self-reported disgust, with little report of other emotions.

Procedure

On arrival, subjects were seated in a comfortable chair in a well lit 3 m × 6 m room. The experimenter (James J. Gross) informed them that we were "interested in learning more about emotion" and that their reactions would be videotaped. Physiological sensors (see below) were attached, and subjects completed several self-report instruments (including demographic questions and a questionnaire on present mood).

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[1] A total of 47 subjects were run. Of these, 4 were excluded from our analyses: (a) 3 because of equipment failure (2 in the no suppression condition and 1 in the suppression condition) and (b) 1 because of extreme agitation (suppression condition). This left 43 subjects.

After completing the questionnaires, subjects were told that they would be shown several short films. The films were shown on a 27-in. color television monitor at a distance of 1.75 m from the subject.[2]

The first trial began when subjects were told that the television screen would be blank for about a minute and that this time should be used to "clear your mind of all thoughts, feelings, and memories" (all instructions were prerecorded). After this 1-min baseline period, subjects received the following instructions: "We will now be showing you a short film clip. It is important to us that you watch the film clip carefully, but if you find the film too distressing, just say 'stop.' " These instructions were followed by the neutral film, and after the film there was a 1-min postfilm period. Subjects then completed a self-report inventory (described below) to assess their emotional reactions during the neutral film.

The second trial began with the same 1-min baseline procedure. Subjects were given the foregoing instructions a second time and then watched the burn film. After the film, there was a 1-min postfilm period, and then subjects completed a self-report inventory to assess their emotional reactions during the burn film.

The third trial began with the same 1-min baseline procedure. Subjects then received one of two sets of instructions, as determined by their random assignment to one of two conditions (no suppression or suppression). For subjects in the no suppression condition (n = 22), the foregoing instructions were repeated. Subjects in the suppression condition (n = 21), however, received the following instructions:

> We will now be showing you a short film clip. It is important to us that you watch the film clip carefully, but if you find the film too distressing, just say "stop." This time, if you have any feelings as you watch the film clip, please try your best not to let those feelings show. In other words, as you watch the film clip, try to behave in such a way that a person watching you would not know you were feeling anything. Watch the film clip carefully, but please try to behave so that someone watching you would not know that you are feeling anything at all.[3]

Subjects then watched the amputation film, which was followed by a 1-min postfilm period. After the postfilm period, subjects completed a self-report inventory (described below) to assess their emotional reactions during the amputation film.

To increase statistical power, we decided not to counterbalance film order. All subjects watched the neutral film, the burn film, and then the amputation film. The decision not to counterbalance film order seemed acceptable given that (a) the neutral film was used to accustom subjects to the laboratory, (b) the burn film was used to confirm that subjects in the two experimental conditions did not differ in their responses to a disgust film before the instructional manipulation, and (c) the central question as to the effects of the suppression instructions during the amputation film constituted a between-groups comparison.

Apparatus

Audiovisual. A remotely controlled high-resolution color video camera placed behind darkened glass in a bookshelf was used to unobtrusively record subjects' facial behavior and upper body movement.

Self-report. After viewing each film, subjects indicated their emotional responses to the film by using a self-report inventory consisting of 16 terms: *amusement, anger, arousal, confusion, contempt, contentment, disgust, embarrassment, fear, happiness, interest, pain, relief, sadness, surprise,* and *tension.* Subjects were asked to rate the greatest amount of each emotion they had felt during the film, using an anchored 9-point Likert scale (0 = *none* and 8 = *the most in my life*) that was adapted from Ekman, Friesen, and Ancoli (1980).

Physiological. Continuous recordings were made using a 12-channel Grass Model 7 polygraph, which was connected to a DEC LSI-11/73 microcomputer. Nine measures were obtained: (a) Heart rate; Beckman miniature electrodes with Redux paste were placed in a bipolar configuration on opposite sides of the subject's chest. The interbeat interval was calculated as the interval (in ms) between successive R waves. (b) Skin conductance level: A constant-voltage device was used to pass a small voltage between Beckman regular electrodes (using an electrolyte of sodium chloride in unibase) attached to the palmar surface of the middle phalanges of the first and third fingers of the nondominant hand. (c) Finger temperature: A thermistor attached to the palmar surface of the distal phalange of the fourth finger recorded temperature in degrees Fahrenheit. (d) Finger pulse amplitude: A UFI photoplethysmograph recorded the amplitude of blood volume in the finger using a photocell taped to the distal phalange of the second finger of the nondominant hand. (e) Pulse transmission time to the finger: The time interval (in ms) was measured between the R wave of the electrocardiogram (EKG) and the upstroke of the peripheral pulse at the finger site. (f) Pulse transmission time to the ear: A UFI photoplethysmograph attached to the right earlobe recorded the volume of blood in the ear. The time interval (in ms) was measured between the R wave of the EKG and the upstroke of peripheral pulse at the ear site. (g) Respiration period: A pneumatic bellows was stretched around the thoracic region, and the intercycle interval was measured (in ms) between successive inspirations. (h) Respiration depth: The point of maximum inspiration minus the point of maximum expiration was determined from the respiratory tracing. (i) General somatic activity: An electromechanical transducer attached to the platform under the subject's chair generated an electrical signal proportional to the amount of movement in any direction.

Physiological measures were monitored continuously using an on-line data acquisition software package developed in our laboratory. This software computes second-by-second averages for each measure. These measures were carefully selected so as to provide a broad index of the activity of five physiological systems especially important to emotional responding: cardiac (a, e, and f), vascular (c, d, e, and f), electrodermal (b), respiratory (g and h), and striate muscle (i).

Data Reduction

Behavior. Subjects' behavioral responses were coded using a system developed for this study, which consisted of 11 codes: (a) alertness, (b) blinks, (c) body movement, (d) disgust, (e) face touching, (f) happiness, (g) looking around the room, (h) mouth movement, (i) overall facial movement, (j) smiles, and (k) yawns. Behavioral responses of anger, fear, sadness, and surprise were also coded, but because the base rates for these emotions were too low to allow adequate reliability, these codes were dropped. Of the codes that were retained, one was a dichotomous measure (face touching), three were frequency measures (blinks, smiles, and yawns: These were converted to events per minute

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[2] The first 9 subjects in Study 1 were shown films on a 13-in. television. These subjects were distributed evenly between the instructional groups (5 in the no suppression condition and 4 in the suppression condition). Analyses revealed no differences between these two screen size conditions on physiological, self-report, or behavioral measures; thus, the data were collapsed across the two screen sizes.

[3] Although these instructions were developed independently, they resemble instructions used in a study in which subjects attempted to diminish the startle response to a gunshot stimulus (Ekman, Friesen, & Simons, 1985).

for analysis), and the rest were continuous measures whose values represented an aggregate of intensity, duration, and frequency of response.

Two female coders (who were unaware of subjects' experimental conditions) scored the prefilm, film, and postfilm periods. Reliabilities were derived by having the two coders independently score all periods for 9 subjects. Interrater reliability for the dichotomous code (face touching) was high (Cohen's kappa = .94), as were reliabilities for the other codes (mean Pearson r = .81, range .66 for alertness to .90 for blinks).

Physiology. Second-by-second values for each of the physiological variables were initially averaged for each of three epochs: the 1-min prefilm period, the entire film, and the 1-min postfilm period.

Study 2

Method

Subjects

Forty-two female undergraduates came to the Berkeley Psychophysiology Laboratory for individual sessions.[4] The subjects were 17 to 23 years old (M = 19.2), and their ethnic identification was mixed (31% Asian, 31% White, 14% Black, and 24% other). Subjects fulfilled a requirement of an introductory psychology course by participating in this study.

Procedure

The experimenter, stimulus films, procedure, and apparatus were the same as in Study 1. Twenty-one women were randomly assigned to each of the two experimental conditions (no suppression and suppression).

Data Reduction

Data reduction procedures were identical to those used in Study 1. For the behavioral data, two female coders (one of whom had also coded the behavioral data for Study 1) scored prefilm, film, and postfilm periods. Reliabilities were derived by having the two coders independently score all periods for 9 subjects. Interrater reliability for the dichotomous code (face touching) was high (Cohen's kappa = .88), as were reliabilities for the other codes (mean Pearson r = .86, range .79 for overall facial movement to .92 for disgust).

Results

The male and female samples did not differ in terms of age, $t(83)$ = 0.41, *ns*, or ethnicity, χ^2 (3, N = 84) = 2.82, *ns*. Given this comparability, as well as the equivalence of procedures across these two studies, the data were combined in a single analysis, with gender treated as a between-subjects factor.

Efficacy of Stimulus Films

Previous group testing of the burn and amputation films indicated that they elicited self-reports of disgust. To confirm that the burn and amputation films had elicited disgust in the present sample, we examined subjects' self-report, behavioral, and physiological responses to these films. Because half of the subjects viewed the amputation film under the suppression instructions, which were likely to influence these responses, we assessed the effectiveness of the amputation film as a disgust

elicitor by only considering data from subjects in the no suppression condition.

Self-report. Subjects (a) reported greater disgust during the burn and amputation films than during the neutral film and (b) reported feeling more disgust than any other emotion during the burn and amputation films.

Behavioral. Subjects were coded as showing more disgust expressive behavior during the burn and amputation films than during the neutral film.

Physiological. Although we have not yet established the nature of emotion-specific autonomic activity using film stimuli, the direction of subjects' physiological changes during the burn and amputation films was consistent with our previous reports of the physiological changes that accompany disgust when elicited by directed facial actions or emotional imagery. These include decreased heart rate (Ekman et al., 1983; Levenson et al., 1990; Levenson et al., 1991), increased skin conductance (Levenson et al., 1990), and decreased finger pulse amplitude (Levenson, Ekman, Heider, & Friesen, 1992).

Analytic Strategy for Evaluating Effects of Suppression Manipulation

The initial disgust-eliciting film (i.e., the burn film), which all subjects viewed under the same instructions to simply watch the film, provided an opportunity to evaluate the effectiveness of our random assignment of subjects to experimental conditions. Overall multivariate analyses of variance (MANOVAs; for the behavioral, self-report, and physiological domains) failed to reveal any differences between suppression and no suppression subjects during this film, indicating that our random assignment had been successful.

Our basic analytic strategy involved comparing suppression subjects' responses to the amputation film with no suppression subjects' responses to the amputation film. Given the number of dependent measures and the exploratory nature of this work, we decided to conduct three overall MANOVAs (one on all behavioral measures, one on all physiological measures, and one on all self-report measures) to assess whether there were general effects of the suppression instructions before proceeding with univariate analyses (see Huberty & Morris, 1989, for a discussion of the efficacy of this use of MANOVA).

Behavioral. For each of the behavioral variables, we computed change scores by subtracting prefilm period averages from amputation film period averages and amputation postfilm period averages. We then conducted an overall $2 \times 2 \times 2$ MANOVA (Sex $\times$ Condition [suppression vs. no suppression] $\times$ Time [film vs. postfilm], with time as a within-subjects factor) with all 11 behavioral variables, followed by similarly structured univariate analyses of variance (ANOVAs) for each of the variables.

Physiological. An initial examination of the second-by-sec-

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[4] A total of 49 subjects were run in Study 2. Of these, 7 were excluded from our analyses: (a) 1 because of equipment failure (in the no suppression condition), and (b) 6 requested to stop the amputation film (5 in the no suppression condition and 1 in the suppression condition). This left 42 subjects.

ond physiological data (see Figures 3–5) revealed several differences between conditions that appeared before the start of the film, during the administration of the suppression instructions. If we only analyzed film and postfilm periods, these differences would be missed. For this reason, we added the instructional period to the analysis, computing change scores by subtracting prefilm levels from the instructional, film, and postfilm averages. We then conducted an overall $2 \times 2 \times 3$ MANOVA (Sex $\times$ Condition [suppression vs. no suppression] $\times$ Time [instructions, film, and postfilm], with time as a within-subjects factor) with all nine physiological variables, followed by similarly structured univariate ANOVAs for each of the variables.[5]

Self-report. Self-report variables were collected for the film period only. For this reason, we could not compute change scores as we had for behavioral and physiological variables. We thus conducted an overall 2×2 MANOVA (Sex $\times$ Condition [suppression vs. no suppression]) with all 16 self-report variables, followed by similarly structured univariate ANOVAs for each of the variables.

Suppression and Expressive Behavior

The overall MANOVA for the behavioral variables revealed a condition effect, $F(11, 71) = 2.53$, $p < .01$, indicating that the suppression instructions had an overall effect on subjects' expressive behavior. Univariate analyses revealed that subjects in the suppression condition had smaller increases in disgust behavior than subjects in the no suppression condition (mean change in disgust behavior: suppression = 0.26, no suppression = 1.22), condition $F(1, 81) = 12.33$, $p < .01$. For overall facial movement, a Condition $\times$ Time interaction, $F(1, 81) = 4.90$, $p < .05$, revealed that suppression subjects showed smaller increases in overall facial movement than did no suppression subjects during the film period (mean change in overall facial movement: suppression = −0.24, no suppression = 0.56), $t(81) = −2.33$, $p < .05$, but not during the postfilm period (mean change in overall facial movement: suppression = 0.57, no suppression = 0.67), $t(81) = −0.29$. Suppression subjects were less likely to touch their face during the film period than were no suppression subjects (percentage of subjects who touched their face: suppression = 9.5%, no suppression = 27.9%, $z = −2.17$, $p < .05$). There was no difference during the postfilm period (percentage of subjects who touched their face: suppression = 33.3%, no suppression = 44.2%, $z = −1.03$). For body movement, there was a Condition $\times$ Time interaction, $F(1, 81) = 4.72$, $p < .05$; t tests revealed that suppression subjects were rated as showing greater decreases in body movement than no suppression subjects both during the film period (mean change in body movement: suppression = −1.69, no suppression = −0.21), $t(81) = −4.12$, $p < .001$, and the postfilm period (mean change in body movement: suppression = −0.02, no suppression = 0.74), $t(81) = −2.11$, $p < .05$. Subjects also showed greater increases in blinking in the suppression condition than in the no suppression condition (mean change in blinking: suppression = 4.14, no suppression = −0.11), condition $F(1, 81) = 5.99$, $p < .05$. The suppression instructions had no discernible effects on the remaining behavioral variables (alertness, happiness,

looking around the room, mouth movement, smiles, and yawns). The behavioral effects of the suppression instructions are shown in Figure 1.

Although the behavioral data suggest that the suppression instructions were effective, it should be noted that the elimination of expressive behavior was not complete. Subjects in the suppression condition were still coded as showing greater increases in disgust expressive behavior in response to the amputation film than in response to the neutral film (mean change in disgust behavior: amputation film = 0.26, neutral film = 0.00), paired-samples $t(41) = 2.52$, $p < .05$.

There were no sex differences in the effects of the suppression manipulation on any of these behavioral measures in either multivariate or univariate analyses: none of the Sex $\times$ Condition or Sex $\times$ Condition $\times$ Time effects were significant.

Suppression and Self-Report

The overall MANOVA for the self-report variables did not reveal any effects involving condition, suggesting that the suppression instructions did not have an overall effect on emotion self-reports. We conducted exploratory univariate tests to assess the possibility that the suppression instructions had more limited effects. The only effect was a condition main effect for contempt, $F(1, 81) = 5.53$, $p < .05$, with suppression subjects reporting feeling greater contempt than no suppression subjects (mean contempt: suppression = 1.45, no suppression = 0.61). Emotion self-reports for the amputation film are depicted in Figure 2.

There were no sex differences in the effects of the suppression manipulation on any self-report measures in either multivariate or univariate analyses: none of the Sex $\times$ Condition effects were significant.

Suppression and Physiology

The overall MANOVA for the physiological variables revealed condition, $F(9, 64) = 2.98$, $p < .01$, and Condition $\times$ Time, $F(18, 55) = 3.33$, $p < .001$, effects, suggesting that the suppression instructions had an overall effect on subjects' physiological responses. The results of univariate tests are described below; means and standard errors for all physiological variables are presented in Table 1.

Somatic activity.[6] For somatic activity, there was a Condition $\times$ Time interaction, $F(2, 71) = 8.30$, $p < .01$. Follow-up t tests indicated that suppression subjects showed greater de-

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[5] An evaluation of the law of initial values, which holds that physiological change scores tend to be negatively correlated with baseline scores, indicated that this law held for finger pulse amplitude, respiration depth, and respiration period. These variables were therefore analyzed using the prefilm baseline values as covariates.

[6] During the course of Study 1, it was necessary to replace both activity and finger pulse amplitude apparatus. Because no simple conversion was possible between data obtained before and after the apparatus change, the most conservative approach was taken: 9 men whose data were obtained before the change of equipment (5 in the no suppression condition and 4 in the suppression condition) were dropped from activity and finger pulse amplitude analyses.
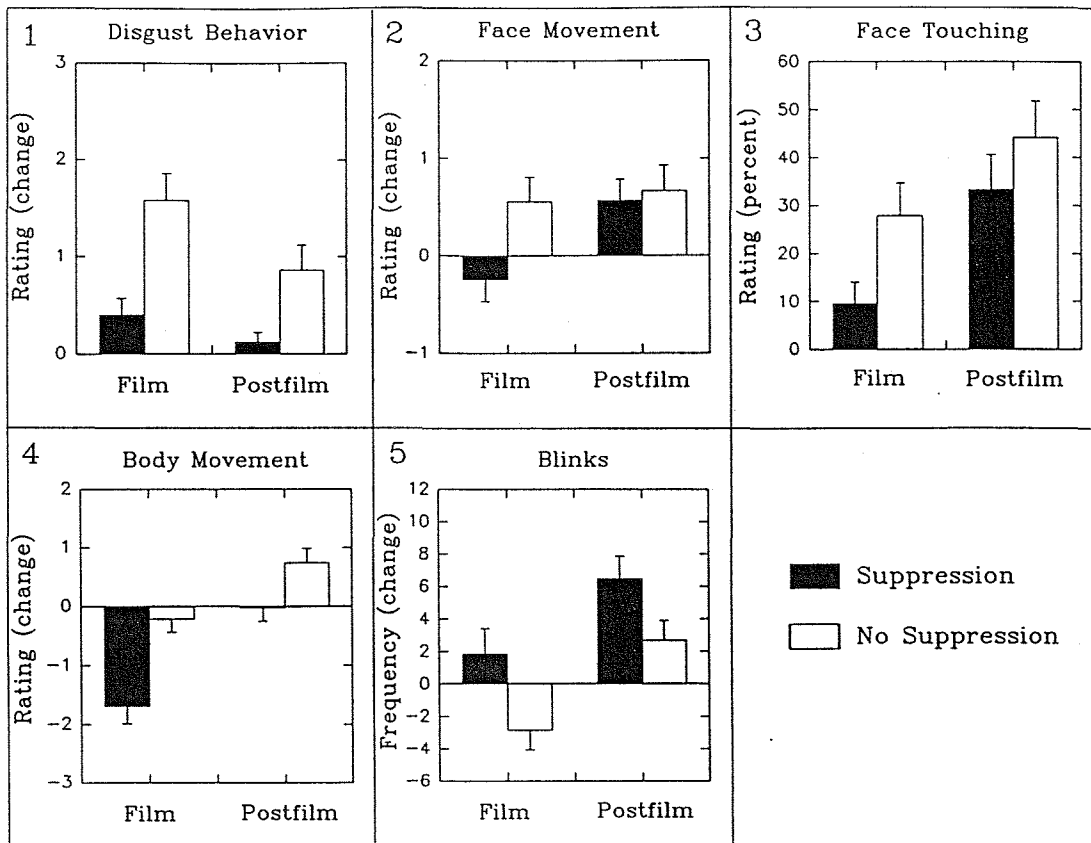
Figure 1. Panel 1: Ratings of disgust expressive behavior (change from prefilm baseline) for amputation film and postfilm periods, with standard errors of the mean. (Panel 2: Ratings of overall facial movement [change from prefilm baseline] for amputation film and postfilm periods, with standard errors of the mean. Panel 3: Ratings of face touching [percentage of subjects who touched their face] for amputation film and postfilm periods, with standard errors of the mean. Panel 4: Ratings of body movement [change from prefilm baseline] for amputation film and postfilm periods, with standard errors of the mean. Panel 5: Frequency of blinks [change from prefilm baseline] for amputation film and postfilm periods, with standard errors of the mean.)

creases in somatic activity than did no suppression subjects during the film period (mean change in activity: suppression = -0.13, no suppression = 0.06), $t(72) = -3.32$, $p < .01$, and postfilm period (mean change in activity: suppression = 0.00, no suppression = 0.17), $t(72) = -2.97$, $p < .01$, but not during the instructional period (mean change in activity: suppression = 0.10, no suppression = 0.08), $t(72) = 0.35$. Second-by-second data for somatic activity are presented in Figure 3.

Heart rate. For heart rate, there was a Condition × Time interaction, $F(2, 80) = 10.07$, $p < .001$. Follow-up t tests indicated that suppression subjects showed greater decreases in heart rate than did no suppression subjects during the film period (mean change in interbeat interval: suppression = 42.90, no suppression = 5.09), $t(81) = 2.64$, $p < .05$, and postfilm period (mean change in interbeat interval: suppression = 32.89, no suppression = -2.76), $t(81) = 2.49$, $p < .05$, but not during the instructional period (mean change in interbeat interval: suppression = -34.10, no suppression = -19.59), $t(81) = -1.01$. Second-by-second data for interbeat interval are presented in Figure 3.

Finger pulse amplitude (see footnote 6). Suppression sub-

jects showed greater decreases in finger pulse amplitude than did no suppression subjects (mean change in finger pulse amplitude: suppression = -3.38, no suppression = -1.06), Condition $F(1, 71) = 12.04$, $p < .01$. Second-by-second data for finger pulse amplitude are presented in Figure 4.

Pulse transmission time to the finger. For pulse transmission time to the finger, there was a Condition × Time interaction, $F(2, 80) = 6.93$, $p < .01$. Follow-up t tests indicated that suppression subjects showed greater decreases in pulse transmission time to the finger than did no suppression subjects during the postfilm period (mean change in pulse transmission time to the finger: suppression = -8.13, no suppression = 0.77), $t(81) = -2.13$, $p < .05$. There were no reliable differences in pulse transmission time to the finger between the two conditions during the instructional period (mean change in pulse transmission time to the finger: suppression = 9.28, no suppression = 2.39), $t(81) = 1.65$, or during the film period (mean change in pulse transmission time to the finger: suppression = 6.64, no suppression = 8.16), $t(81) = -0.36$. Second-by-second data for pulse transmission time to the finger are presented in Figure 4.
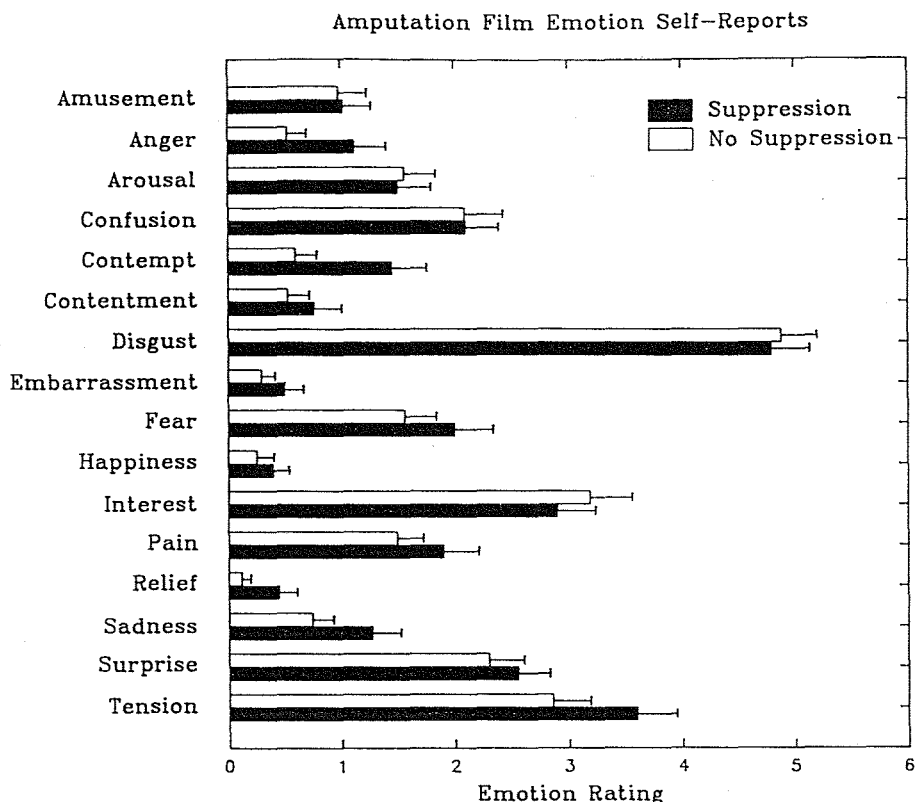
Amputation Film Emotion Self-Reports

Figure 2. Emotion self-reports by condition for the amputation film, with standard errors of the mean.

Skin conductance. Subjects in the suppression condition showed greater increases in skin conductance than did subjects in the no suppression condition (mean change in skin conductance: suppression = 0.86, no suppression = 0.33), condition $F(1, 81) = 6.19, p < .05$. Second-by-second data for skin conductance are presented in Figure 5.

Other measures. There were no effects of the suppression manipulation on finger temperature, respiration period, or respiration depth.

Sex differences. For pulse transmission time to the ear, there was a Sex × Condition interaction, $F(1, 81) = 4.02, p < .05$. Follow-up t tests indicated that none of the pairwise comparisons were significant. The effects of the suppression instructions on physiological responses did not differ for men and women for all other variables.

Additional analyses concerning the instructional period. To ensure that adding the instructional period to our planned analyses did not produce spurious results, we conducted a set of 2 × 2 × 2 ANOVAs (Sex × Condition [suppression vs no suppression] × Time [film vs. postfilm]) in which the instructional period was omitted. The results of these analyses were essentially identical to those reported previously (with the exception that the Sex × Condition effect for pulse transmission time to the ear dropped below significance, $F[1, 81] = 3.61, ns$).

To clarify whether the suppression instructions had effects during the film period over and above the effects evident during the instructional period, we conducted a 2 × 2 multivariate analysis of covariance (Sex × Condition [suppression vs. no suppression]) with all nine physiological variables' film period

values, using instructional period values as covariates. This analysis revealed a condition effect, $F(9, 55) = 4.84, p < .001$, with univariate effects for somatic activity, interbeat interval, and pulse transmission time to the finger. A parallel analysis with just the eight autonomic variables (all variables except somatic activity) also revealed a condition effect, $F(8, 57) = 3.85, p < .01$, with univariate effects for interbeat interval and pulse transmission time to the finger. From these analyses we conclude that the suppression instructions had effects during the film above and beyond those that were found in the period before the film.

Protection Against Type I Error

To understand the consequences of emotional suppression more fully, we adopted a multimethod approach, with measures obtained in the domains of subjective experience, behavior, and physiology. Although this approach has certain advantages, it also runs the risk of increased experimentwise error due to multiple significance tests. There are many approaches to the control of experimentwise error but little agreement as to which approach is best in the context of a two-group study with multiple dependent measures.

We had adopted a typical hierarchical strategy in which we first conducted MANOVAs, then ANOVAs, and then multiple comparisons; however, the efficacy of omnibus MANOVAs for controlling Type I error has recently been called into question (Huberty & Morris, 1989). In the present study, it was clear that the effects of suppression were too numerous to be accounted

Table 1

Mean Change From Prefilm Period and Standard Errors for Physiological Variables During the Amputation Film Trial Instructional, Film, and Postfilm Periods

| | Instructions | | | | Film | | | | Postfilm | | | |
| | No suppression | | Suppression | | No suppression | | Suppression | | No suppression | | Suppression | |
Condition	M	SE	M	SE	M	SE	M	SE	M	SE	M	SE
ACT												
Men	0.07	0.02	0.13	0.06	0.04	0.06	−0.15	0.06	0.22	0.07	−0.01	0.08
Women	0.09	0.04	0.09	0.06	0.08	0.08	−0.11	0.04	0.13	0.06	0.00	0.05
All	0.08	0.02	0.10	0.04	0.06	0.05	−0.13	0.03	0.17	0.04	0.00	0.04
IBI												
Men	−22.38	8.21	−46.53	9.55	−8.76	31.50	51.98	13.94	−22.30	13.68	24.48	13.04
Women	−16.67	5.81	−21.67	8.65	19.60	15.09	33.81	14.15	17.70	8.61	41.30	9.15
All	−19.59	5.03	−34.10	6.65	5.09	17.65	42.90	9.91	−2.76	8.64	32.89	7.98
FPA												
Men	−0.61	0.86	−2.11	1.16	−1.73	1.02	−4.49	2.02	−0.02	0.56	−2.69	1.60
Women	−1.05	0.44	−3.37	0.71	−2.44	0.67	−5.77	1.07	−0.33	0.71	−1.69	1.02
All	−0.85	0.45	−2.80	0.65	−2.12	0.58	−5.20	1.07	−0.19	0.46	−2.14	0.90
PTTF												
Men	0.49	2.11	5.87	6.10	6.00	2.85	−0.47	7.94	0.96	2.17	−12.20	6.79
Women	4.38	2.14	12.68	2.59	10.42	3.39	13.76	3.69	0.56	2.71	−4.05	2.33
All	2.39	1.52	9.28	3.31	8.16	2.21	6.64	4.46	0.77	1.71	−8.13	3.60
SCL												
Men	0.00	0.07	0.45	0.13	0.66	0.33	0.99	0.24	0.37	0.22	0.38	0.13
Women	0.02	0.10	0.53	0.22	0.88	0.44	1.75	0.39	0.04	0.23	1.02	0.28
All	0.01	0.06	0.49	0.13	0.77	0.27	1.37	0.23	0.21	0.16	0.70	0.16
PTTE												
Men	−0.41	0.65	1.89	0.89	−2.18	2.37	−1.50	1.70	−3.49	2.13	−0.01	1.72
Women	0.32	1.62	−0.71	0.74	0.51	2.87	−5.38	1.64	0.67	2.97	−4.77	1.36
All	−0.05	0.85	0.59	0.61	−0.87	1.85	−3.44	1.20	−1.45	1.82	−2.39	1.15
TEM												
Men	0.02	0.11	−0.09	0.12	−0.28	0.19	−0.53	0.17	−0.34	0.23	−0.72	0.23
Women	0.01	0.13	−0.03	0.16	−0.32	0.20	−0.65	0.24	−0.71	0.25	−1.10	0.26
All	0.01	0.08	−0.06	0.10	−0.30	0.14	−0.59	0.14	−0.52	0.17	−0.91	0.17
RP												
Men	−316.23	207.26	−865.07	224.59	−495.99	205.37	−604.32	229.39	−404.72	172.33	−550.60	204.85
Women	−177.71	94.43	−216.80	191.72	−137.99	180.37	−35.57	138.78	18.08	122.90	0.47	133.35
All	−248.58	114.79	−540.93	154.37	−325.51	138.83	−326.89	141.27	−203.39	111.31	−281.79	129.48
RD												
Men	−35.98	35.55	−17.44	23.94	−57.52	29.05	−80.16	24.34	9.25	37.22	−54.69	29.27
Women	20.80	13.59	1.80	12.79	12.98	17.47	24.78	26.89	34.40	15.14	30.73	24.39
All	−8.25	19.63	−7.82	13.49	−23.13	17.83	−27.69	19.77	21.51	20.29	−11.98	20.01

Note. ACT = general somatic activity; IBI = interbeat interval; FPA = finger pulse amplitude; PTTF = pulse transmission time to the finger; SCL = skin conductance level; PTTE = pulse transmission time to the ear; TEM = finger temperature; RP = respiration period; RD = respiration depth.

for merely by chance; 6 of 8 tests (75%) involving behavioral variables and 7 of 11 tests (64%) involving physiological variables were significant. Nonetheless, we assessed the effects of using the modified Bonferroni procedure (Keppel, 1982) as an alternative approach to experimentwise error protection. Setting a familywise error rate of .20 for each class of dependent variables (behavioral, self-report, and physiological), we found that 4 out of the 14 reported differences between suppression and no suppression subjects would no longer be significant at the adjusted alpha levels. These were (a) pulse transmission time to the finger during the postfilm period, (b) behavioral ratings of face movement during the film period, (c) behavioral ratings of body movement during the postfilm period, and (d) self-reports of contempt during the film period.

These changes would not appreciably alter the overall pattern of results nor their interpretation. Thus, we feel confident that our findings are not the consequence of increased Type I error associated with using a multimethod approach.

General Discussion

What happens when one consciously suppresses an emotional response? Does emotional suppression restore calm, or does inhibiting emotional expressive behavior lead to greater arousal? In this study, we addressed this question by instructing subjects to inhibit their expressive behavior as they watched a film known primarily to elicit the emotion of disgust.
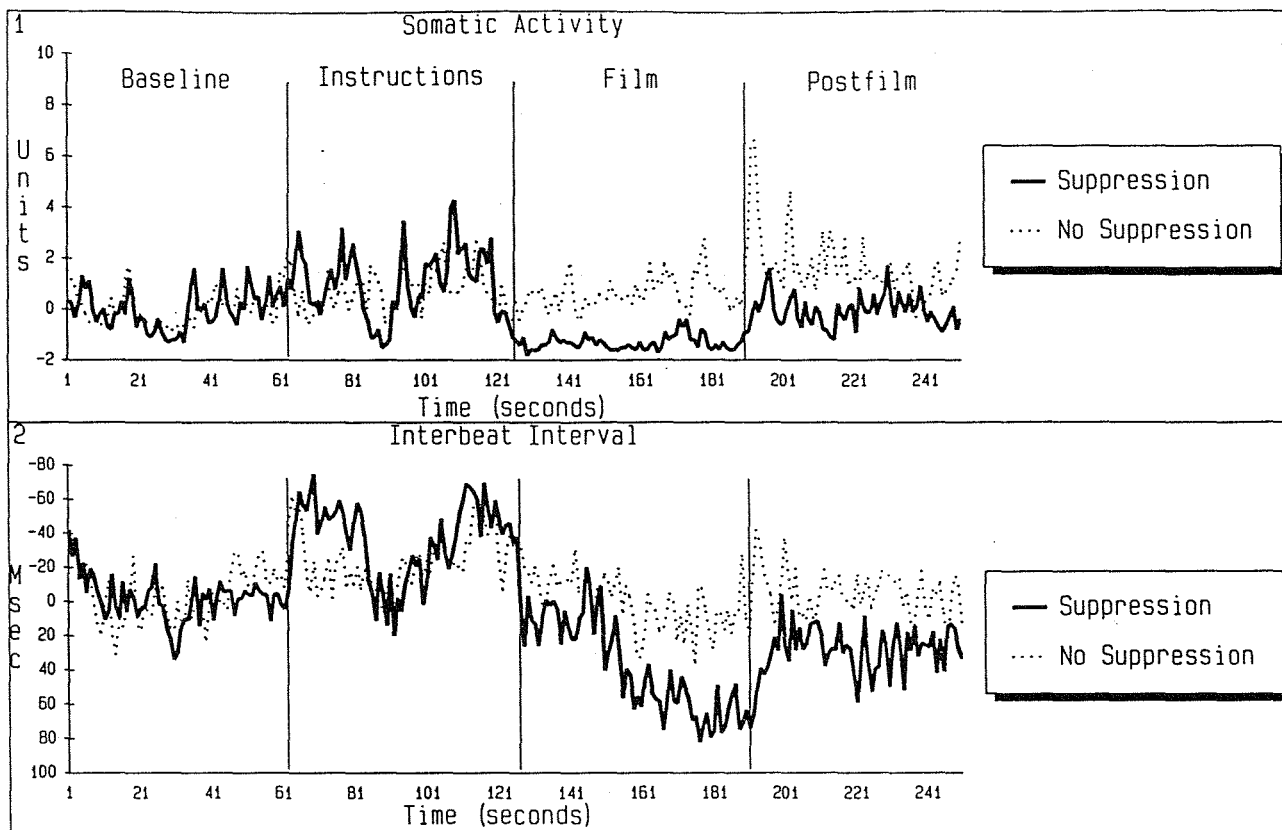
Figure 3. Panel 1: Second-by-second scores (change from prefilm baseline) for somatic activity during the amputation film. (Panel 2: Second-by-second scores [change from prefilm baseline] for interbeat interval during the amputation film. Note that in both panels, the ordinate's scale is such that increased arousal [i.e., increases in somatic activity and decreases in interbeat interval] is upward.)

Effects of Suppression

Behavioral and physiological measures showed clear effects of the suppression instructions; emotion self-reports did not. These effects did not differ by sex.

Behavior

In terms of expressive behavior, suppression instructions led to decreased disgust expressive behavior, decreased facial movement, decreased face touching, and increased blinking. Coders' ratings also indicated decreased body movement, which was confirmed by decreases in the physiological measure of somatic activity. Together, these findings suggest that subjects were able to comply with the instructions to inhibit their expressive behavior and that in doing so, they also limited their general somatic activity. Although most of our behavioral findings only served to confirm the efficacy of our manipulation, suppression subjects' increases in blinking can be considered a sign of greater arousal (Stern & Dunham, 1990; Stern, Walrath, & Goldstein, 1984).

Self-Report

In the self-report domain, suppression instructions had no overall effect on emotion self-reports, and, more specifically, had no effect on disgust self-reports. However, exploratory anal-

yses revealed a main effect of the suppression instructions on self-reports of contempt. Although we suspect that this finding may be due to chance (as there were 16 emotion self-reports), it is interesting to note that suppression of disgust led to increased reports of contempt, an emotion that bears marked similarities to disgust.

Physiology

Physiologically, in addition to greater decreases in somatic activity, the concomitants of the suppression of disgust were greater increases in skin conductance, greater decreases in finger pulse amplitude, more pronounced shortening of pulse transmission times to the finger, and greater decreases in heart rate. The greater increases in skin conductance, greater decreases in finger pulse amplitude, and more pronounced shortening of pulse transmission times to the finger are all signs of greater sympathetic nervous system activation. Like the increases in blinking, these findings favor the view that emotional suppression leads to increased arousal.

If Suppression Is Arousing, Why Was There Heart Rate Deceleration?

Unlike the findings for blinking, skin conductance, finger pulse amplitude, and pulse transmission time to the finger, the finding that suppression subjects evidenced greater heart rate
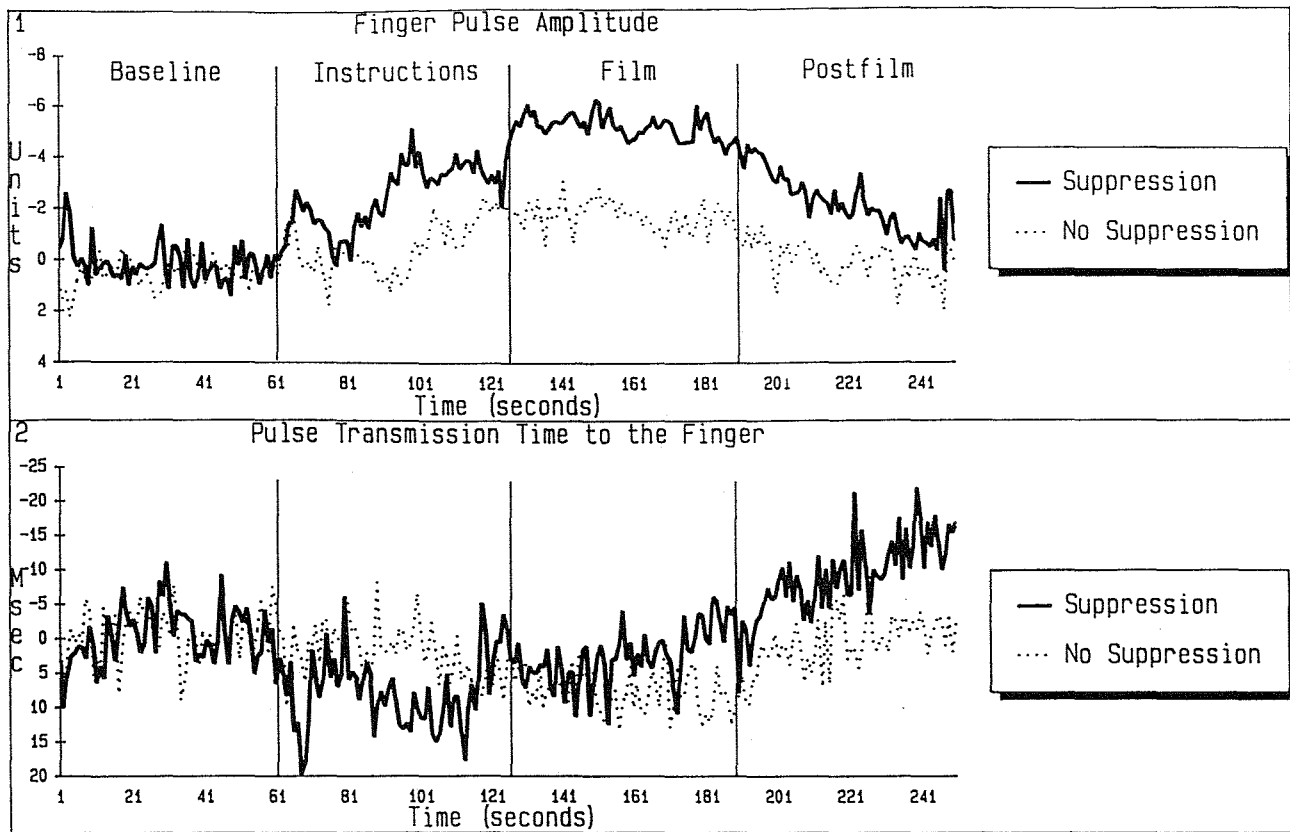
Figure 4. Panel 1: Second-by-second scores (change from prefilm baseline) for finger pulse amplitude during the amputation film. (Panel 2: Second-by-second scores [change from prefilm baseline] for pulse transmission time to the finger during the amputation film. Note that in both panels, the ordinate's scale is such that increased arousal [i.e., decreases in finger pulse amplitude and decreases in pulse transmission time to the finger] is upward.)

deceleration than did no suppression subjects seems at odds with the view that suppression is arousing. Given that increases in heart rate would usually be associated with increases in arousal, our heart rate findings seem to indicate that suppression subjects were less aroused than no suppression subjects.

There seem to be at least two explanations for this discrepant heart rate finding. The first highlights suppression subjects' decreases in somatic activity, whereas the second requires us to consider the possibility that the physiological effects of emotional suppression may be emotion specific.
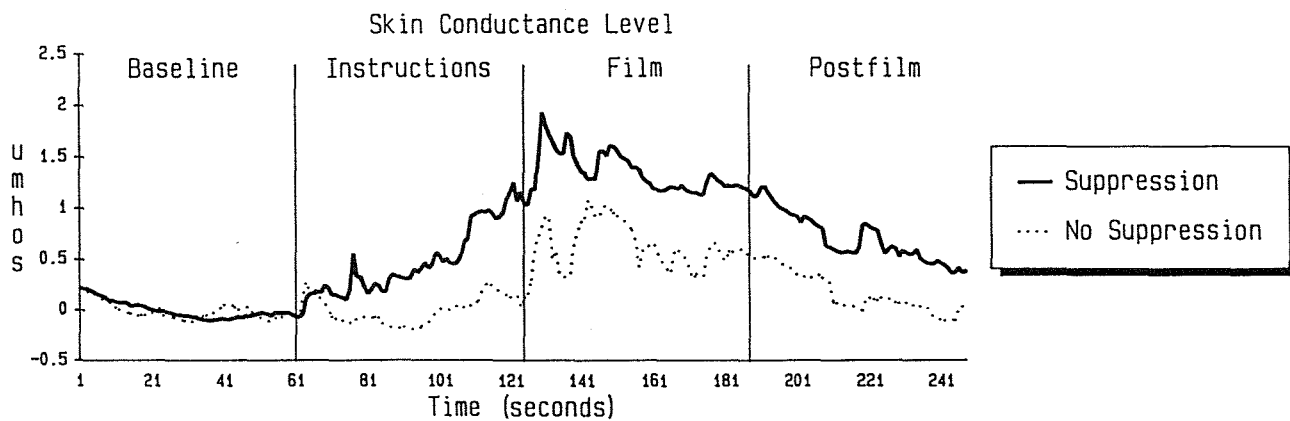

Figure 5. Second-by-second scores (change from prefilm baseline) for skin conductance level during the amputation film. (Note that the ordinate's scale is such that increased arousal [i.e., increases in skin conductance level] is upward.)

Cardiac-Somatic Coupling

Given suppression subjects' more pronounced decreases in somatic activity than no suppression subjects', it could be argued that suppression subjects' greater heart rate deceleration was due not to lesser sympathetic arousal but rather to reduced levels of bodily activity, which is known to be productive of decreases in heart rate (e.g., Obrist, 1981; Vander, Sherman, & Luciano, 1990). Because much of the coupling between somatic activity and heart rate is vagally mediated (Obrist, 1981), decreases in heart rate secondary to a reduction in somatic activity could certainly coexist with concomitant sympathetic nervous system activation of vascular and electrodermal systems.

Emotion-Specific Autonomic Activity

A second possible explanation of the heart rate finding leads us to consider the possibility that suppression might have emotion-specific effects. In our earlier work using directed facial actions and imagery as emotion elicitors, we have focused on a distinguishing autonomic feature of disgust, that is, its association with lower levels of heart rate compared with other negative emotions such as anger, fear, and sadness (Ekman et al., 1983; Levenson, 1992; Levenson et al., 1991; Levenson et al., 1990). However, there are other autonomic changes that occur in disgust that are similar to those occurring in other negative emotions. These include increases in skin conductance (Levenson et al., 1990) and decreases in finger pulse amplitude (Levenson, Ekman, Heider, & Friesen, 1992). Thus, with the exception of the shortening of pulse transmission time to the finger, all of the significant cardiovascular (i.e., vasoconstriction and heart rate slowing) and electrodermal (i.e., increased skin conductance) effects of inhibiting disgust expressive behavior in the present study could be accounted for by asserting that the suppression of disgust leads to greater "disgustlike" physiological responding.

Choosing Between Alternative Explanations

Because the present study involved the suppression of only one emotion (disgust), we cannot choose between the competing cardiac–somatic coupling and emotion-specific autonomic activity explanations of the observed heart rate deceleration. The viability of the emotion-specific interpretation might be established, however, if it were demonstrated that the suppression of anger, fear, or sadness (emotions associated with increased heart rate) produced heart rate acceleration, despite a suppression-induced reduction in somatic activity. On the other hand, if the suppression of these emotions produced the same pattern of heart rate deceleration as did suppression of disgust in the present study, the cardiac–somatic coupling explanation would be supported. We plan to evaluate these possibilities in a future study.

The Time Course of Instructional Effects

Although previous studies using this paradigm have only examined the effects of suppression instructions during the emotional elicitation itself, we thought it important to examine the temporal parameters of emotional suppression starting with the instructions and continuing through the film and postfilm periods. Using these data, we were able to consider the onset, duration, and offset characteristics of the physiological effects of emotional suppression.

An examination of the second-by-second plots of the data (see Figures 3–5) reveals intriguing temporal differences in the onset of the physiological response to suppression. Recall that there were effects involving condition for five physiological variables: general somatic activity, heart rate, finger pulse amplitude, pulse transmission time to the finger, and skin conductance. For finger pulse amplitude and skin conductance, the effects of our suppression manipulation started before the film began, first appearing during the instructional period. In contrast, measures of activity and heart rate did not begin to differentiate conditions until the film started. Finally, for pulse transmission time to the finger, the effects of suppression began to emerge during the film but reversed in direction after the film.

At this juncture, we cannot say with certainty what these onset differences mean. We would speculate that the prefilm differences in finger pulse amplitude and skin conductance reflect a preparation to suppress, an effect of subjects' "bracing" themselves for the upcoming emotional stimulus. It will be important in future work to explore further the nature of this preparatory activation, perhaps by examining the effects of suppression instructions that are followed by an emotionally neutral film, to see if early activation still obtains and if it is limited to these two physiological functions, both of which are mediated solely by the sympathetic branch of the autonomic nervous system.

Another interesting temporal feature of these findings was that the manipulation's effects seemed to continue even after the amputation film had ended. In the physiological realm, each of the five physiological variables that was affected by the suppression instructions during the film also was affected during the postfilm period. In the behavioral realm, condition main effects for disgust expressive behavior, body movement, and blinking all suggest that the effects of emotional suppression continued throughout the postfilm period.

Is Emotional Suppression Per Se the Active Ingredient?

We have suggested that it was the suppression of disgust expressive behavior that produced the observed pattern of physiological changes. However, because we were attempting to model emotional suppression as it often occurs in everyday life—when one person attempts to inhibit his or her emotional expressive behavior while interacting with (and being observed by) another—it could be argued that the key ingredient in the suppression instructions was not the requirement to inhibit expressive behavior but rather the suggestion that the subject would be observed by another person. Social presence, both real and imagined, clearly has an impact and may even alter the person's physiological state (e.g., Cacioppo, Rourke, Marshall-Goodell, Tassinary, & Baron, 1990; Zajonc, 1965). Although all subjects in the present study knew that they were being videotaped, the suppression instructions might have served to make this fact more salient for subjects in the suppression condition.

Albeit feasible, the available empirical evidence does not favor this interpretation. Whereas Kleck et al. (1976) reported that subjects who were observed while waiting for a shock had less expressive behavior than controls who were not observed (which would be consistent with the effects of our suppression instructions), subjects in their study who were observed also had less physiological responding as measured by skin conductance level (which is the opposite of our findings).

Another interpretation of these results is that it was the performance of a task (i.e., suppressing emotion while carefully watching the film) and task-related factors such as concern with task performance that produced suppression condition subjects' greater arousal. In dealing with this possibility, we would suggest that the suppression condition fairly represented the nature of suppression in everyday life, for when people try to regulate their emotions they (a) attend to the environment, (b) attempt to manage their responses, and (c) monitor their success at emotion regulation. We are comfortable with the notion that suppression is a task that involves real work and that the observed physiological activation associated with suppression may reflect the additional metabolic demands occasioned by that work.

An important question to ask, which we cannot answer using the data from the present study, is whether the physiological activation associated with the work of emotional suppression is different in type or amount from that brought about by other forms of inhibition (e.g., thought suppression, Wegner, Shortt, Blake, & Page, 1990) or, more generally, other kinds of mental work. In this regard there are certain similarities between our findings and Fowles's (1980) three arousal model, which provides a very general view of behavioral activation and inhibition. Our finding that emotional suppression produced increased skin conductance responding is consistent with Fowles's view that electrodermal activation is associated with activation of the behavioral inhibition system. Our finding that emotional suppression produced decreased heart rate is consistent with Fowles's view that cardiovascular deactivation is associated with deactivation of the behavioral activation system. Although we hypothesize that there are physiological differences between emotional and other types of inhibition, as well as differences between emotional suppression and other kinds of mental work, this question clearly requires further study.

Sex Differences in Emotional Suppression

The behavioral, subjective, and physiological effects of emotional suppression did not appear to differ by sex. There are two factors, however, that could have influenced this finding. First, we studied men and women in separate experiments separated by a period of 18 months, and it is possible that some unknown factor related to this time difference could have obscured true sex differences. Second, as reported in footnotes 1 and 4, 6 of our female subjects discontinued their participation in this study, whereas none of our male subjects did so, χ^2 (1, $N = 90$) = 3.90, $p < .05$; it is unknown whether sex effects would have emerged had these 6 women completed the study.

Nonetheless, our failure to find sex differences in the effects of emotional suppression is consistent with our previous findings insofar as sex differences are virtually absent in basic emotional processes (e.g., emotion-specific physiological activity in Levenson et al., 1991; Levenson et al., 1990; empathic accuracy and associated physiological responding in Levenson & Ruef, 1992; effects of alcohol on emotional and physiological responses to stress in Levenson, Oyama, & Meek, 1987; voluntary control of heart rate in Levenson & Ditto, 1981). We have found sex differences to be much more likely to be present in more complex interpersonal contexts (e.g., marital interaction in Levenson & Gottman, 1985; Levenson, Carstensen, & Gottman, 1992; Gottman & Levenson, 1988, 1992).

Methodological Considerations

Several design features of this study merit comment.

Why Study Disgust?

We chose to study suppression using a film that primarily elicits a single emotion—disgust—because (a) disgust is relatively easy to elicit in the laboratory in an ethical and controlled fashion, (b) most theorists agree that disgust is an emotion (Rozin & Fallon, 1987; but see Tomkins, 1963), (c) disgust is associated with a distinct facial expression (Ekman, Sorensen, & Friesen, 1969), and (d) compared with other negative emotions such as anger, fear, and sadness, disgust may be associated with a different cardiovascular response, namely, relative heart rate deceleration (Ekman et al., 1983; Levenson, 1992; Levenson et al., 1991; Levenson et al., 1990; Levenson, Ekman, Heider, Friesen, 1992).

Why Tell Subjects Only to Inhibit Visible Signs of Emotion and not Subjective Emotional Experience as Well?

We chose to model a common emotion-regulation situation, perhaps the modal situation, in which the goal is to hide visible signs that would indicate what one is feeling. One advantage of this operationalization is that it is relatively easy to determine whether the experimental manipulation was successful (by measuring subjects' emotional expressive behavior). In contrast, knowing whether someone was successful in inhibiting subjective emotional experience is much more difficult, given the possible distortion of self-report due to demand characteristics. As indicated in the introduction to this article, there are many forms of emotion regulation; the generality of our findings across modes of emotion regulation remains to be determined.

Why Tell Subjects to Inhibit all Visible Signs of Emotion Rather Than Just Disgust?

We chose to instruct subjects to suppress all visible signs of emotion, rather than just disgust expressive behaviors, for several reasons: (a) to avoid having subjects anticipate the specific emotional quality of the film, (b) to avoid introducing a demand characteristic for a specific emotion that could compromise the self-report data, and (c) to have an instruction that could be used unchanged in future studies of suppression using

other emotions. One unwelcome consequence of this decision was that we could not separate the effects of suppressing disgust from those of suppressing emotion in general. Because the film we used primarily elicited disgust, we consider it most parsimonious to interpret our findings in terms of the effects of suppressing disgust, but it is certainly possible that other instructional variants would have yielded other results.

Why Use a Between-Subjects Design, if Emotional Suppression Is a Within-Subjects Phenomenon?

Because we randomly assigned subjects to our two experimental conditions, we could assume that subjects' responses in the absence of differing instructions would have been equivalent across conditions. For this reason, we were able to interpret differences between suppression and no suppression subjects as being the result of emotional suppression.

It could be argued, however, that emotional suppression is best thought of as a within-subjects process and that the effects of emotional suppression are best revealed by a within-subjects design in which responses obtained from a person in the presence of suppression are compared with responses from that same person obtained in its absence (Buck, 1980). To assess the possibility that a within-subjects approach might reveal something different from our between-subjects approach, we conducted a parallel set of analyses using response to the burn film as a covariate (given that all subjects viewed this film without instructions to suppress, it effectively provided a within-subjects control).

These covariance analyses revealed a highly similar pattern of findings. The only change for behavioral variables was that the condition effect for blinks dropped below significance, $F(1, 80) = 3.80$, ns. For self-report variables, the condition effect for contempt was no longer evident, but a condition effect for self-reported relief emerged, $F(1, 77) = 4.03$, $p < .05$, indicating that suppression condition subjects experienced greater relief than did no suppression condition subjects (mean relief: suppression = 0.45, no suppression = 0.12). There were no changes for physiological variables.

Implications for the Relation Between Expression and Physiology

Our results indicate that emotional suppression produces a mixed pattern of physiological changes. Increased blinking, increased skin conductance level, decreased finger pulse amplitude, and decreased pulse transmission time to the finger (the latter three indicating increased sympathetic nervous system activation) suggest that suppression produces increased arousal. Decreased somatic nervous system activity and decreased heart rate (the latter indicating increased parasympathetic drive to the heart, decreased sympathetic drive to the heart, or both) suggest that suppression produces decreased arousal.

These findings suggest that simple models of emotional suppression that are based on uniform, unidirectional changes in physiological activity are not adequate. The findings also call into question models of the general relation between expression

and physiology that are predicted on unidirectional changes in sympathetic nervous system outflow (e.g., Cacioppo et al., 1992).

We turn now to a consideration of how these findings relate to the existing literatures on the relation between expression and physiology.

Studies of Characteristic Expressive Styles

With the notable exception of heart rate, our physiological findings are consistent with studies of internalizers and externalizers that have shown that internalizing (i.e., unexpressive) subjects are more physiologically reactive to emotion-eliciting stimuli than are externalizing (i.e., expressive) subjects (e.g., Buck, 1979; Jones, 1935, 1950, 1960; Notarius & Levenson, 1979). This suggests the possibility that internalizers habitually use emotion-regulation strategies similar to those experimentally induced in the present study.

Although the health consequences of emotional suppression were not directly assessed, suppression subjects' lesser general somatic activity, coupled with their greater skin conductance response, is consistent with Pennebaker's work on behavioral inhibition, in which behavioral inhibition has been associated with increased electrodermal responding and poorer health outcomes (Pennebaker & Beall, 1986; Pennebaker & Chew, 1985; Pennebaker, Hughes, & O'Heeron, 1987; Pennebaker, Kiecolt-Glaser, & Glaser, 1988a, 1988b).

Studies of Manipulated Emotional Expressivity

At first glance, the present results appear to be at odds with studies that have explicitly manipulated emotional expressivity (e.g., Buck, 1980; Laird, 1974; Lanzetta et al., 1976; Levenson et al., 1991; Levenson et al., 1990; Zuckerman et al., 1981). Taken as a whole, the manipulated expressivity literature suggests that emotion-specific activity of the facial muscles should be positively correlated with the other components of an emotional response, a suggestion that is contradicted by our findings.

This contradiction might be partially resolved by considering that this literature obscures important differences in the processes that underlie emotional expression and emotional suppression. The great majority of these studies have shown that making an emotion-relevant facial expression is associated with emotion-relevant physiology and subjective experience (Duclos et al., 1989; Duncan & Laird, 1977, 1980; Ekman et al., 1983; Kraut, 1982; Laird, 1974; Levenson et al., 1991; Levenson, 1990; Levenson, Ekman, Heider & Friesen, 1992; McCaul et al., 1982; Rhodewalt & Comer, 1979; Rutledge & Hupka, 1985), not that the inhibition of expressive behavior provoked by an external emotional stimulus is associated with a decrement in physiological responding or subjective experience. This suggests caution in assuming that emotional suppression and emotional expression are endpoints of the same continuum.

As indicated in the introduction to this article, few studies have actually considered emotional suppression, and fewer still have examined the physiological effects of inhibiting expressive behavior when emotionally aroused. In contrast with our findings, those studies that have examined the physiological effects

of emotional suppression have failed to find increased physiological reactivity: (a) Inhibiting pain behavior was associated with decreased skin conductance reactivity (Colby et al., 1977; Lanzetta et al., 1976), (b) inhibiting amusement behavior had no effect on heart rate (Bush et al., 1989), (c) responding to pleasant and unpleasant films with neutral facial expressions was associated with decreased physiological reactivity (Zuckerman et al., 1981).

We cannot know with certainty why the conclusions reached in these studies were discrepant with ours. Certainly there were important methodological differences. For example, most of these studies examined the suppression of amusement or pain expressive behavior, which may have different consequences from the suppression of disgust. In the one study that appears to have examined the suppression of disgust expressive behavior (Zuckerman et al., 1981), data were analyzed by collapsing across both positive and negative films, and a composite measure of physiological arousal was used (including blood volume, skin conductance, and heart rate), which may have obscured important differences in the effects of emotional suppression on each of these physiological variables. These methodological differences notwithstanding, questions clearly remain about the generality of our findings. We plan to explore this issue in future studies.

Conclusion

This study examined the effects of consciously inhibiting emotional expressive behaviors elicited by a disgusting film. Physiologically, suppression led to a mixed state in which signs of greater arousal, including increases in blinking and in certain sympathetically mediated electrodermal and cardiovascular responses, were found along with signs of lesser arousal, including decreases in somatic activity and in heart rate. In terms of subjective experience, suppression had no effects on self-reports of disgust. Additional research will be needed to illuminate further the nature of emotional suppression and to distinguish its effects from those of other forms of emotion regulation—processes that are at once so common and so little understood.

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