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Peripheral feedback effects of facial expressions, bodily postures, and vocal expressions on emotional feelings

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The purpose of this study was to examine the feedback effects of three modalities of emotional expression on emotional experience. Facial expressions, bodily postures, and vocal expressions of anger, sadness, fear, and happiness were manipulated under disguised conditions in a sample of 52 undergraduate students. After each manipulation, participants rated their feelings of anger, sadness, fear, happiness, disgust, and surprise on 11-point scales. Results indicated that: (1) facial expressions and bodily postures tended to produce specific, categorical effects on emotional feelings (the effects of vocal expressions were inconsistent); (2) the magnitudes of effects produced by facial expressions tended to be stronger than those of bodily postures, which tended to exceed those of vocal expressions; and (3) responsiveness to self-produced cues of emotion was consistent across the three modalities of expression.

Changes in our emotional behaviour produce corresponding changes in our emotional experiences, at least for some of us. The seeds of this idea can be traced back to the work of Hegel (1830/1971), through Darwin (1872/1998), to the theories of James (1890/1981) and Tomkins (1964/1995). Both James and Tomkins proposed that the proximal cause of our emotional experience is our own bodily activity. For James, emotional experience could be elicited by a number of different bodily responses, both internal and peripheral. Here is an example of how he described the production of a sad, or ''melancholy,'' feeling: ''... sit all day in a moping posture, sigh, and reply to everything with a dismal voice, and your melancholy lingers''; and to produce its antithesis, ''real cheerfulness ... Smooth the brow, brighten the eye, contract the dorsal rather than the ventral aspect of the frame, and speak in a major key, pass the genial

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compliment, and your heart must be frigid indeed if it do not gradually thaw!'' (James, 1890/1981, pp. 1077–1078).

For Tomkins, emotional experience was elicited primarily by facial and vocal responses. In his earlier writing, Tomkins focused on the face: ''... the face expresses affect, both to others and to the self via feedback, which is more rapid and more complex than any stimulation of which the slower moving visceral organs are capable'' (Tomkins & McCarter, 1964/1995, p. 218). Later, he ''emphasized the face and voice as the major loci of the critical feedback which was experienced as affect'' (Tomkins, 1978/1995, p. 89) and contended that: ''The contraction of no other set of muscles in the body had *any* apparent motivational properties. Thus, if I were angry, I might clench my fist and hit someone, but if I simply clenched my fist, this would in no way guarantee I would become angry'' (Tomkins, 1978/1995, p. 90, emphasis in the original).

Both James' and Tomkins' theories are cited as sources of the ''facial feedback hypothesis'' (McIntosh, 1996). In tests of this hypothesis, facial muscles are manipulated to produce discernable emotional expressions that, in turn, produce changes in emotional feelings matching the expressions. The ''facial feedback effect'' has been replicated many times (reviewed most recently by Soussignan, 2002; also see earlier reviews by Cornelius, 1996, and by McIntosh, 1996). Although critics (e.g., Winton, 1986) have argued that the feedback effect may be caused by experimental demand, the results of studies in which disguised procedures have been used (e.g., Larsen, Kasimatis, & Frey, 1993; Strack, Martin, & Stepper, 1988) have produced results similar to those in which the procedures' purpose has not been hidden. Confidence in the finding is such that the research method has been used by investigators to examine emotional abnormalities related to clinical disorders, including schizophrenia and depression (Flack, Laird, & Cavallaro, 1999a) and premenstrual syndrome (Schnall, Abrahamson, & Laird, 2002). The causal link between expression and experience has also been included within some neuroscience perspectives on emotion (Damasio, 1999; LeDoux, 1996), and cited in textbooks on introductory psychology (Feldman, 2002; Myers, 2004).

Tomkins' influence may account for the relative paucity of research on the effects of other types of emotional behaviours, such as bodily postures and vocal expressions, on emotional feelings. Although much more limited, the available evidence on the effects of manipulated bodily postures (Duclos et al., 1989; Flack, Laird, & Cavallaro, 1999b; Riskind & Gotay, 1982; Schnall & Laird, 2003; Stepper & Strack, 1993) and of vocal expressions (Hatfield, Hsee, Costello, Weisman, & Denney, 1995; Siegman, Anderson, & Berger, 1990; Siegman & Boyle, 1993) also demonstrates a feedback effect consistent with the effects of facial expressions. Since the production of these behaviours, too, lead to changes in emotional feelings, the broader notion of a ''peripheral'' feedback hypothesis seems warranted.

Parameters of peripheral feedback effects

Many of the most basic parameters of the peripheral feedback effect have not yet been replicated, and some have yet to be addressed at all. One important parameter of the effect is its specificity. As Winton (1986) has pointed out, most studies of facial feedback have produced evidence that expressions cause feelings of the same dimension or valence (i.e., pleasant vs. unpleasant), but not of the same category (e.g., angry expressions cause greater feelings of anger than do expressions of sadness or fear) of emotion. The issue of effect specificity has been addressed explicitly in three studies of facial expressions and bodily postures (Duclos et al., 1989; Flack et al., 1999a, study 1; Flack et al., 1999b), and in one study of vocal expressions (Hatfield et al., 1995). Each of these studies demonstrated effects that were largely, although not exclusively, specific to individual emotional feelings. Greater magnitudes of felt anger, for example, tend to be reported following manipulations of an angry facial expression, as compared with ratings of felt anger caused by sad, fearful, or happy expressions. But the mean ratings of anger following sad, fearful, and happy expressions are not zero; there seems to be a small, general effect of expressions on felt emotional arousal, as well as some ''bleeding'' of the effect by valence (Flack et al., 1999b). The general effect by valence is exemplified by the finding that some expressions bearing physical similarities tend to elicit feelings that are similar as well. For example, Flack et al. (1999a, study 1; Flack et al., 1999b) reported that facial expressions of anger produced not only increases in feelings of anger, but also increases in feelings of disgust. Likewise, in the same study, the facial expression of disgust also produced elevations of felt disgust and anger. A similar pattern was found in these studies for the effects of the fear expression, which has produced elevations not only of felt fear, but also of felt surprise (of course, this effect seems to cut across valences, at least to the extent that surprise is not necessarily an unpleasant emotion). Thus, the first aim of the present research was to re-examine the effects of facial expressions, bodily postures, and vocal expressions for categorically specific effects on emotional feelings.

A second parameter that has not been adequately addressed is the relative impact of different modalities of expression, including facial expression, bodily posture, and vocal expression, on emotional experience. In fact, multiple modalities of expression have been examined using within-subjects designs in only five studies (Duclos et al., 1989; Duclos & Laird, 2001; Flack et al., 1999a, Study 1; Flack et al., 1999b; Schnall & Laird, 2003). Although both expressions and postures of anger, sadness, fear, or happiness tended to cause emotional feelings matching each expression or posture in these studies, differences in the magnitudes of expression and posture effects were not tested; no comparisons of the effects of facial expressions or postures with those of vocal expressions have appeared in the literature. Perusal of the results of statistical planned comparisons in the Flack et al. studies (1999a, study 1; Flack et al., 1999b) reveal

something of a mixed bag, despite the use of identical procedures. On the one hand, results from the first of these studies (1999a, study 1) demonstrated magnitudes of *t* for facial expression effects that were approximately twice those of posture effects (in cases of mean ratings of feelings matching expressions and postures of anger, sadness, and happiness, and mean ratings of disgust feelings in the angry expression and posture, and mean ratings of surprise feelings in the fear expression and posture; the reverse was true for the effects of the fear expression and posture on mean ratings of felt fear). On the other hand, the second of these studies (Flack et al., 1999b) produced greater magnitudes of *t* for bodily postures of anger and sadness than those found in the first study, effects that, in the second study, were comparable in magnitude to those of angry and sad facial expressions. The pattern of differences in the effects of the fear and happy expressions and postures on mean ratings of fear and happiness were similar in the two studies, as were the effects of the fear expression and posture on feelings of surprise; the effects of the angry expression and posture on disgust feelings were similar to each other, however, in the second study. Accordingly, the second purpose of the present study was to test for differences among the relative magnitudes of emotional feelings produced by the three modalities of expression which have been examined only separately in previous studies.

A third important but understudied parameter of the peripheral feedback effect is the degree to which responsiveness to one's own emotional behaviour is consistent across types of expression. Consistency of responsiveness across expression modality has been addressed directly in only one previous study (Flack et al., 1999b), the results of which demonstrated positive correlations of moderate magnitudes between ratings of feelings matching manipulated facial expressions and bodily postures. The patterns of correlations conformed to a valence-based pattern, such that ratings of emotions matching unpleasant expressions and postures were all moderately associated with each other, but far less so with ratings of happiness during happy expressions and postures. The magnitudes of correlations between ratings of feelings in matching expressions and postures ranged from .42 (for ratings of sadness in the sad expression and posture) to .67 (for ratings of anger in the angry expression and posture). Since correlations of moderate magnitude require variation within constituent sets of scores, these findings likely reflect consistent variation in participants' responses to the expression and posture manipulations. Laird and colleagues have reported evidence of such variation by demonstrating reliable individual differences in the extent to which people are responsive to their own self-produced cues of emotion (e.g., Duclos & Laird, 2001; Duncan & Laird, 1977; Laird et al., 1994). Some people seem to be moderately responsive to their own expressive behaviours, whereas others tend to be significantly less so, or even completely nonresponsive (presumably, those who are less, or not at all responsive to their own emotional behaviour rely primarily on external, situational cues to determine how they are feeling; Laird, 1984). Since responsiveness to the effects of

facial expressions is consistent with responsiveness to the effects of bodily postures, it seems reasonable to expect similar consistencies in responsiveness among facial expressions, bodily postures, and vocal expressions. Testing this idea was the third goal of the present research.

The present research

In the present research, facial expressions, bodily postures, and vocal expressions of anger, sadness, fear, and happiness were manipulated, after each of which participants rated their feelings of anger, sadness, fear, happiness, disgust, and surprise. The following hypotheses were tested using a within-subjects design. First, facial expressions, bodily postures, and vocal expressions were all expected to produce specific, categorical effects on emotional feelings. Second, feedback from ones own muscular changes might be expected to produce a greater impact on felt experience than feedback from sounds produced by one's own vocalisations. Furthermore, the apparently greater variety and specificity of combinations of facial musculature might be expected to produce stronger feedback effects than those caused by the more gross muscle movements involved in bodily postures. Therefore, facial expressions were expected to produce greater magnitudes of self-rated emotional feelings than bodily postures, and bodily postures were expected to produce greater magnitudes of self-rated emotional feelings than vocal expressions. Third, self-ratings of feelings matching manipulated facial expressions, bodily postures, and vocal expressions were expected to be positively and moderately correlated.

METHOD

Participants

The participants in this study were 52 undergraduate students (32 women and 20 men) who volunteered for this study in order to earn credit toward a research requirement in their introductory psychology course.

Procedures

The procedures used in this study were adapted, in part, from those developed by Duclos et al. (1989), Flack et al. (1999b), and Siegman and Boyle (1993). Participants were told that the purpose of the study was to examine the effects of different kinds of muscle movements and vocalisations on psychophysiological responses. They were also told that the study required the monitoring of changes in their emotional feelings because, ostensibly, such changes ''could have an impact on the relationship between movement or vocalising and psychophysiological responses''. This explanation of the purpose of the study was designed to disguise the fact that the investigators were testing relationships between expressive behaviour and emotional feeling. Participants were informed that

they would be asked to move different muscles in their face, and in the rest of their body, and to read lists of words out loud. They were told that their compliance with the instructions for each of these tasks would be monitored by means of a video camera and monitor; that their psychophysiological responses would be measured by means of a noninvasive, fingertip electrode, attached to the index finger of their nondominant hand; and that they would provide information on any changes in their emotional feelings by means of a form containing six 11-point rating scales (one each for anger, sadness, fear, happiness, disgust, and surprise), directly following each movement or vocalising task. Following this explanation, participants gave their informed consent.

Participants were seated in a straight-backed, comfortable chair with armrests, facing a video camera, in a laboratory room approximately 12 feet × 15 feet in size. The dummy finger electrode was applied snugly to the index finger of the nondominant hand by means of a Velcro strip. Participants were shown that the electrode was attached to a small amplifier, itself attached to a personal computer, and that movement of their nondominant hand produced movement on a graph displayed on the computer monitor. The monitor was then turned away, so that participants could not see it during the experimental tasks. The research assistant sat behind and out of the view of participants, in order to reduce potential experimenter effects, but could see the participants on the video monitor, and was close enough to give verbal instructions.

Prior to each experimental task, participants were told to relax the muscles in their faces and bodies. After indicating that they had done so, participants were then given the instructions for producing each expression. They were told to maintain their facial or bodily muscles in the instructed positions for a period of 10 s. In order to produce vocal expressions, participants were given cards containing lists of nonemotional words (e.g., ''and'', ''or'', ''but'') that they read out loud. Each list contained the same words, the number of which was based on pilot testing, so that each list took approximately 10 s to read out loud at a moderate pace. The sets of instructions for producing the four facial expressions, bodily postures, and vocal expressions are given below.

Instructions for producing facial expressions

Anger. Push your eyebrows together and down. Clench your teeth tightly, and push your lips together.

Sadness. Relax your eyebrows, so that they drop down toward your cheeks. With your mouth closed, push your lower lip up lightly.

Fear. Raise your eyebrows, and open your eyes as widely as possible. Move your whole head back, so that your chin is tucked in a little. Let your mouth relax and hang open a little.

Happiness. Draw the corners of your mouth up and back, letting your mouth open a little.

Instructions for producing bodily postures

Anger. Put your feet flat on the floor, directly below your knees, and put your forearms and elbows on the arms of the chair. Now clench your fists tightly, and lean your upper body slightly forward.

Sadness. Sit back in your chair, resting your back comfortably against the back of the chair, and draw your feet loosely in under the chair. You should feel no tension in your legs or feet. Now fold your hands in your lap, just loosely cupping one hand in the other. Drop your head, letting your rib cage fall, and letting the rest of your body go limp. You should feel just a slight tension up the back of your neck and across your shoulder blades.

Fear. Scoot to the front edge of your chair, and draw your feet together and underneath the chair. Now turn your upper body toward the right, twisting a little at the waist, but keeping your head facing forward. Now dip your right shoulder a bit, and lean your upper body slightly backward. Raise your hands to about mouth level, arms bent at the elbows, and palms facing forward.

Happy. Sit up as straight as you can. Put your hands at the ends of the armrests, and make sure that your legs are straight in front of you, with your knees bent, and feet right below your knees.

Instructions for producing vocal expressions

Angry. Read this list of words as quickly and loudly as you can.

Sadness. Read this list of words as slowly and softly as you can.

Fear. Read this list of words as quickly and softly as you can.

Happiness. Read this list of words at moderate tempo and volume.

The order of groupings of manipulated facial expressions, bodily postures, and vocal expressions was kept constant but rotated, so that each grouping occurred in the same position the same number of times across participants. The order of individual expression tasks was also kept constant within each grouping by modality, so that each expression occurred in the same position the same number of times across participants. Four expressions within each of the three modalities resulted in a total of 12 tasks.

After the last expression manipulation was completed, participants were asked to fill out a questionnaire, in which they indicated their understanding of

the potential purposes of the experimental procedures. For purposes of subsequent statistical analysis, they were assigned to one of three groups on the basis of their answers: (1) repetition of the investigators' initial explanation only; (2) some indication that the manipulations were intended to produce emotional expressions, but no indication that the expressions caused changes in self-rated emotional feelings; or (3) some indication that the manipulations were intended to produce emotional expressions, and that the expressions were the cause of changes in self-rated emotional feelings.

RESULTS

Order and gender effects

Following the approach used by Flack et al. (1999b), omnibus repeated-measures multivariate analyses of variance (RM-MANOVAs) with Greenhouse-Geisser corrections were used to examine the central interactions of facial expression × rating, bodily posture × rating, and vocal expression × rating, and the separate three-way interactions with task order and gender. Effects of the manipulations on self-rated feelings were indicated by statistically significant interactions in all three cases: facial expression × rating, $F(4, 538, 154.307) = 13.38$, $p < .001$, bodily posture × rating, $F(3, 591, 125.683) = 12.33$, $p < .001$, and vocal expression × rating, $F(5, 669, 198.431) = 3.78$, $p < .01$. None of the three-way interactions with task order or gender were statistically significant: facial expression × rating × order, $F(9, 077, 154.307) = 0.53$, $p = .856$, facial expression × rating × gender, $F(4, 538, 154.307) = 0.83$, $p = .520$, bodily posture × rating × order $F(7, 182, 125.683) = 0.58$, $p = .776$, bodily posture × rating × gender $F(3, 591, 125.683) = 0.80$, $p = .515$, vocal expression × rating × order, $F(11, 339, 198.431) = 0.98$, $p = .468$, and vocal expression × rating × gender, $F(5, 669, 198.431) = 0.47$, $p = .819$.

Categorical effects

Planned comparisons (Kirk, 1982) were used to test for expected differences between the mean rating of a feeling matching a manipulated expression or posture, and the mean of the ratings of the same feeling across nonmatching expressions or postures (all using two-tailed tests of statistical significance) . For example, the mean rating of angry feelings during the angry facial expression was compared with the mean of anger ratings across the sad, fearful, and happy facial expressions. Residual comparisons were also computed within each set of feelings ratings.

Facial expression effects. The mean ratings for each of the six feelings across each of the four expressions and the results of the planned comparisons are contained in Table 1. The expected patterns were observed in five out of the

TABLE 1
Mean ratings and (standard deviations) of feelings across conditions of facial expression (n = 51)[a]

Rating	*Expression*				
	ANG *M* (*SD*)	*SAD* *M* (*SD*)	*AFR* *M* (*SD*)	*HAP* *M* (*SD*)	t[b]
ANG	2.69 (2.88)	0.45 (1.22)	0.67 (1.34)[c]	0.16 (0.58)	5.14***
SAD	0.35 (1.06)	2.41 (2.80)	0.35 (0.91)	0.43 (1.22)	4.83***
AFR	0.20 (0.80)	0.35 (0.96)	1.02 (1.63)	0.41 (1.12)	2.50*
HAP	0.51 (1.39)	0.65 (1.79)	0.96 (1.89)[c]	2.31 (2.50)	4.21***
DIS	1.71 (2.40)	1.12 (1.99)	1.57 (2.53)[c]	0.75 (1.96)	1.24
SUR	0.41 (1.30)	0.29 (0.94)	1.75 (2.42)	1.06 (1.95)[c]	2.83**

[a] One participant did not complete the facial expression tasks.

[b] t represents the difference between the mean rating of the feeling matching a given facial expression with the mean of the ratings of the same feeling across nonmatching facial expressions.

[c] represents the statistically significant ($p < .05$) positive result of a residual comparison.

*$p < .05$; **$p < .01$; ***$p < .001$; all two-tailed.

six comparisons: the mean ratings of anger, sadness, fear, and happiness were all highest in their respective facial expressions. In addition, the mean rating of surprise was highest in the fear expression. The exception occurred in ratings of disgust, in which the mean rating of disgust during the angry expression failed to exceed the mean of disgust ratings across the remaining three expressions. Residual comparisons revealed the following statistically significant differences (all at ps < .05): the mean rating of anger during the fear expression exceeded the mean of the anger ratings during the sad and happy expressions; the mean rating of happiness during the fear expression was greater than the mean of the happy ratings during the angry and sad expressions; the mean rating of disgust during the fear expression was greater than the mean of the disgust ratings during sad and happy expressions; and the mean rating of surprise during the happy expression was greater than the mean of the surprise ratings in the angry and sad expressions.

Bodily posture effects. The same patterns were observed in the mean ratings of feelings produced by manipulated bodily postures. The mean ratings for each of the six feelings across each of the four postures and the results of the planned comparisons are given in Table 2. Expected patterns were found in five out of the six comparisons: the mean ratings of anger, sadness, fear, and happiness were all highest in their respective bodily postures. The mean rating of surprise was also highest in the fear expression. Again, the exception occurred in ratings of disgust, in which the mean rating of disgust during the angry expression was

TABLE 2
Mean ratings and (standard deviations) of feelings across conditions of bodily posture (n = 52)

Rating	*Expression*				
	ANG *M* (*SD*)	*SAD* *M* (*SD*)	*AFR* *M* (*SD*)	*HAP* *M* (*SD*)	*t*[a]
ANG	1.96 (2.54)	0.42 (1.18)	0.40 (1.09)	0.25 (0.97)	4.21***
SAD	0.15 (0.64)	1.81 (2.48)	0.29 (1.00)	0.33 (0.86)	4.31***
AFR	0.19 (0.66)	0.65 (1.49)[b]	1.10 (1.91)	0.19 (0.69)	2.45*
HAP	0.54 (1.70)	0.65 (1.71)	0.89 (2.01)	1.40 (2.26)	2.54*
DIS	1.15 (2.11)	0.81 (1.95)	0.81 (1.88)	0.58 (1.49)	1.27
SUR	0.21 (0.78)	0.12 (0.58)	1.25 (2.30)	0.46 (1.16)	2.83**

[a] t represents the difference between the mean rating of the feeling matching a given bodily posture with the mean of the ratings of the same feeling across nonmatching bodily postures.
[b] represents the statistically significant ($p < .05$) positive result of a residual comparison.
*$p < .05$; **$p < .01$; ***$p < .001$; all two-tailed.

not significantly greater than the mean of disgust ratings across the three remaining expressions. The only significant result among the residual comparisons revealed that the mean rating of fear during the sad posture was greater than the mean of the fear ratings during the angry and happy postures (at $p < .05$).

Vocal expression effects. In contrast to the effects of facial expressions and bodily postures, the effects of vocal expressions on self-rated feelings were much more inconsistent. The mean ratings of each of the six feelings across each of the four vocal expressions and the results of the planned comparisons are included in Table 3. Expected patterns were found in only two of the six comparisons: The mean ratings of anger and sadness were highest in their respective vocal expressions. However, the mean ratings of fear and happiness during their respective vocal expressions failed to exceed significantly the means of the same feelings across nonfearful and nonhappy expressions. In addition, the mean rating of disgust was not higher in the angry expression as compared with the remaining expressions, and the same was true for the mean rating of surprise in the fear expression. Residual comparisons indicated that the mean rating of sadness in the fear vocal expression was greater than the mean of sad ratings in the angry and happy vocal expressions, and that the mean rating of sadness during the happy vocal expression was greater than the mean rating of sadness during the angry vocal expression (both at $p < .05$).

TABLE 3
Mean ratings of feeling across conditions of vocal expression (n = 52)

	Expression				
Rating	*ANG* *M* (*SD*)	*SAD* *M* (*SD*)	*AFR* *M* (*SD*)	*HAP* *M* (*SD*)	t^a
ANG	1.10 (1.60)	0.42 (1.14)	0.46 (1.34)	0.35 (1.06)	2.56*
SAD	0.10 (0.60)[c]	1.06 (1.75)	0.62 (1.40)[b]	0.29 (0.72)	2.57*
AFR	0.65 (1.80)	0.35 (1.05)	0.60 (1.46)	0.23 (0.96)	0.76
HAP	1.25 (2.20)	1.08 (2.09)	1.19 (2.36)	1.54 (2.66)	1.16
DIS	1.06 (1.83)	0.81 (1.60)	0.85 (1.79)	1.00 (2.29)	0.58
SUR	0.89 (1.87)	0.33 (0.88)	0.64 (1.36)	0.64 (2.02)	0.06

[a] t represents the difference between the mean rating of the feeling matching a given vocal expression with the mean of the ratings of the same feeling across nonmatching vocal expressions.
[b] represents the statistically significant ($p < .05$) positive result of a residual comparison.
[c] represents the statistically significant ($p < .05$) negative result of a residual comparison.
*$p < .05$, all two-tailed.

Magnitudes of effects

Another set of planned comparisons was conducted in order to test the hypothesis that the magnitudes of effects of facial expressions would exceed those of bodily postures, and that the magnitudes of effects of bodily postures would exceed those of vocal expressions (again using two-tailed tests). The indices of magnitude chosen for these comparisons were the ratings of feelings matching each *facial expression*, *bodily posture*, and *vocal expression* (e.g., the mean rating of anger during the angry facial expression, the mean rating of sadness during the sad posture, the mean rating of fear during the fearful vocal expression), plus the ratings of disgust during the anger expressions and posture, and the ratings of surprise during the fear expressions and posture. The results of these three sets of comparisons are contained in Table 4. Mean ratings of anger and happiness during their respective facial expressions, and the mean rating of disgust during the angry expression, exceeded mean ratings of the same feelings during their respective bodily postures (a statistical trend toward the same difference was found for mean ratings of sadness). The mean ratings of anger and sadness during their respective bodily postures, and the mean rating of surprise during the fear posture, were greater than the mean ratings of the same feelings during their respective vocal expressions (a statistical trend toward the same difference was found for mean ratings of fear). And mean ratings of anger, sadness, and fear in their respective facial expressions, and the mean ratings of disgust during the angry expression and surprise during the fear expression, exceeded the mean ratings of the same feelings during their respective vocal expressions.

TABLE 4
Mean ratings of feelings matching facial expressions, bodily postures, and vocal expressions (all two-tailed tests)

Rating group	*Condition*		
	Facial expression *M* (*SD*)	*Bodily posture* *M* (*SD*)	*Vocal expression* *M* (*SD*)
ANG	2.69 (2.88)[a]	1.96 (2.54)[b]	1.10 (1.60)[c]
SAD	2.41 (2.80)	1.81 (2.48)[b]	1.06 (1.75)[c]
AFR	1.02 (1.63)	1.10 (1.91)	0.60 (1.46)[c]
HAP	2.31 (2.50)[a]	1.40 (2.26)	1.54 (2.66)
DIS	1.71 (2.40)[a]	1.15 (2.11)	1.06 (1.83)[c]
SUR	1.75 (2.42)	1.25 (2.30)[b]	0.64 (1.36)[c]

[a] Facial expression and bodily posture means differ significantly at a minimum of $p < .05$.
[b] Bodily posture and vocal expression means differ significantly at a minimum of $p < .05$.
[c] Facial expression and vocal expression means differ significantly at a minimum of $p < .05$.

Correlations

Pearson correlations were used to test for predicted positive relationships of moderate magnitude across responses to facial expressions, bodily postures, and vocal expressions (again using two-tailed tests). Correlations were analysed among all of the ratings of feelings matching each expression or posture (e.g., rating of anger during the angry facial expression, rating of anger during the angry bodily posture, and rating of anger during the angry vocal expression). The results of these analyses are contained in Table 5, divided into three sections; the first for correlations between ratings matching facial expressions and bodily postures, the second for correlations between ratings matching facial expressions and vocal expressions, and the third for correlations between ratings matching bodily postures and vocal expressions. With one exception, ratings of a given feeling matching an expression in one modality were correlated moderately and positively with ratings of the same feeling matching expressions in the other two modalities. Thus, ratings of anger during the angry facial expression were correlated significantly and positively with ratings of anger during the angry bodily posture. The same was true for ratings of sadness, fear, and happiness in their respective facial expressions and bodily postures. Likewise, correlations between ratings matching bodily postures and vocal expressions of the same emotions were also correlated moderately and positively. Correlations between ratings matching facial expressions and vocal expressions were also significant and positive, with the exception of the relationship between happy feelings in the happy facial expression and happy feelings in the happy bodily posture. Furthermore, ratings of unpleasant feelings in general tended to

TABLE 5
Correlations among ratings of the same feelings in matching facial expressions, bodily postures, and vocal expressions

	Facial expression (n = 51)			
Posture	*ANG*	*SAD*	*AFR*	*HAP*
ANG	.66**	.60**	.52**	.57**
SAD	.69**	.60**	.59**	.48**
AFR	.62**	.60**	.45**	.36**
HAP	.27	.24	.14	.34*
	Facial expression (n = 51)			
Vocal	*ANG*	*SAD*	*AFR*	*HAP*
ANG	.36**	.27	.36**	.05
SAD	.53**	.48**	.15	.18
AFR	.50**	.44**	.54**	.23
HAP	.09	.03	−.04	.18
	Bodily posture (n = 52)			
Vocal	*ANG*	*SAD*	*AFR*	*HAP*
ANG	.54**	.39**	.19	.09
SAD	.54**	.61**	.48**	.31*
AFR	.60**	.58**	.48**	.41**
HAP	−.01	.03	.01	.50**

*$p < .05$; **$p < .01$; all two-tailed.

be significantly and positively correlated with each other in all three matrices, while the relationships between unpleasant feelings and happy feelings were less consistent and, in most cases, negligible and nonsignificant.

Task awareness

Two of the three-way interactions with understanding of the purpose of the manipulations were statistically significant: facial expression × rating × understanding, $F(9, 077, 154.307 = 2.57$, $p < .01$, bodily posture × rating × understanding, $F(7, 182, 125.683 = 2.62$, $p < .05$, and vocal expression × rating × understanding $F(11, 339, 198.431) = 1.23$, $p = .268$. Frequency analyses revealed that 16 participants (30.8% of the sample) gave no indication of awareness, 20 (38.5%) indicated awareness that they were adopting expressions during at least some of the manipulations, but no awareness that these caused changes in their feelings, and the remaining 16 (30.8%) indicated both an

awareness that they were adopting expressions and that the expressions caused changes in their feelings. Pearson correlations between level of awareness and responsiveness to the manipulations, the latter indexed by the mean ratings of feelings matching each of the facial expressions, bodily postures, and vocal expressions (e.g., the mean rating of angry feelings during the angry facial expression), ranged from .33 to .40. The R^2 values thus ranged from .11 to .16, indicating that the effect of awareness accounted for 11% to 16% of the variance in the ratings of feelings chosen to represent the magnitudes of expression and posture effects.

DISCUSSION

Categorical effects

Consistent with the first hypothesis, category-specific effects were found in four out of the six sets of feelings ratings in both the facial expression and bodily posture conditions. Ratings of felt anger, sadness, fear, and happiness were each greatest during their respective facial expressions and bodily postures. In addition, ratings of surprise were highest during the fear facial expression and bodily posture, as demonstrated previously by Flack et al. (1999b). Although not statistically significant, the observed patterns of mean ratings of disgust during both the facial expression and bodily posture trials were also consistent with the hypothesized pattern, and with those found by Flack et al. (1999b). As noted earlier, elevations of disgust feelings during an angry expression, and of surprise during a fear expression, are probably caused by the physical similarities within both sets of emotions (Russell & Bullock, 1985). Such similarities are also consistent with Plutchik's (2000) multidimensional model of emotion. Although relatively few in number, the significant results of residual comparisons among ratings across the facial expressions are consistent with differences in level of arousal and valence. Thus, for example, the higher rating of anger during the fear expression, as compared with ratings of anger during the sad and happy expressions, is consistent with the notion that anger and fear are both relatively high arousal emotions with negative valences. Residual results for ratings of disgust followed a similar pattern, as did those for ratings of surprise, although the latter at least arguably shares a positive valence with happiness. Since this is the fourth study to demonstrate effect specificity for facial expressions and bodily postures, it seems safe to conclude that the effects of these two expressive modalities are categorical, and not merely dimensional, at least for the set of emotions addressed in this study.

Unexpectedly, statistically significant categorical effects were found in only two of the six sets of ratings caused by manipulated vocal expressions. Although not statistically significant, the observed pattern of mean ratings of happy feelings was consistent with the hypothesised result. However, the patterns of mean ratings of fear, disgust, and surprise all failed to conform to expectations.

The failure to demonstrate clear categorical effects for at least half of the vocal expressions may have been due to the absence of additional cues required to produce more realistic vocalisations of emotion. Hatfield et al. (1995, experiment 2) manipulated a greater number of vocal qualities (including rhythm, intonation, and pausing), using sound production without any verbal content, and observed category-specific effects for both pleasant vocalisations (joy and love) and for unpleasant vocalisations (anger and sadness), although the effects were more distinct in the latter cases. Clearly, further research is needed to determine the number of vocal parameters required to distinguish adequately among the effects of both pleasant and unpleasant emotional vocalisations on subsequent emotional feelings.

Magnitudes of effects

The results of tests comparing the relative magnitudes of facial expressions, bodily postures, and vocal expressions were mostly consistent with expected differences. In three out of six cases, facial expressions caused significantly greater ratings of matching or similar feelings (anger, happiness, and disgust during the angry facial expression) than did bodily postures. A statistical trend toward the same pattern was found for ratings of sadness in the facial expression and bodily posture, and observed differences between ratings of surprise during the fearful facial expression and bodily posture were both in the hypothesised direction. Facial expressions also caused significantly higher ratings than vocal expressions in five out of the six cases (anger, sadness, fear, disgust during the angry facial expression, surprise during the fear facial expression). The effects of the bodily postures were significantly greater than those of the vocal expressions in three of the six cases (anger, sadness, and surprise during the fear expression), with a statistical trend toward the expected result in ratings of fear.

Thus, at least as they were manipulated in this study, facial expressions appear to produce the strongest impact on subsequent emotional feelings, vocal expressions the weakest impact, and bodily postures fall in between the two. This is one possibility, consistent with the notion that muscular feedback is stronger or more apparent than auditory feedback in producing emotional feelings. Another is that our manipulation modalities may have been differentially evocative because of differences in their quality. In particular, the instructions used to produce vocal expressions, although based on those used by Siegman and colleagues (Siegman et al., 1990; Siegman & Boyle, 1993), may not have reflected adequately the multifaceted nature of vocal emotional expressions (e.g., Johnston & Scherer, 2000). Perusal of the mean ratings of feelings matching vocal expressions in the present study and those observed by Hatfield et al. (1995) (11-point scales were used in both studies) indicate that the manipulation of vocalisation features in addition to volume and speed seem to cause greater magnitudes of feelings than those found in the present study. For

example, mean ratings of anger during the angry vocal expressions were 2.05 and 1.10, for sadness 2.34 and 1.06, and for fear 1.37 and 0.60, in Hatfield et al. and the present study, respectively. Substituting Hatfield's results for those of the present study, the impact of facial expressions and vocal expressions seems to be pretty even. Further head-to-head comparisons of different modalities of expression, using more multifaceted manipulations of vocal expressions, are needed to decide this issue.

As in all such studies, the magnitudes of the effects of separate self-produced cues of emotion, tend to be low, averaging about 2.5 to 3.5 on 11-point scales. The relatively small magnitudes of these effects may be due to a number of factors. One such factor is the likely presence of individual differences in responsiveness to self-produced cues of emotion (e.g., Duclos & Laird, 2001). Such differences were masked in the present study by not distinguishing between groups of participants who were more or less responsive to the manipulations. Another factor is that, in separating and isolating the effects of facial expressions, bodily postures, and vocal expressions, investigators introduce conditions that are unlikely to occur in the world outside the laboratory. Emotional responses in the real world tend to include simultaneous expressions across these and other modalities (e.g., gestures). As matching expressions from more than one modality are combined, their effects appear to be additive, as compared with the effects of isolated, individual expressions (Flack et al., 1999a), although these findings await replication. Even if replicated, the feelings produced by combinations of expressions do not tend to exceed the midpoint of the rating scales used to measure them. Our failure to produce emotional experiences that exceed mild-to-moderate levels of intensity is also likely due to the typical experimental setting used in this research. Participants in such studies have little reason, aside from the feedback produced by their expressive behaviour, to experience emotional reactions. With no other sources of emotion elicitation aside from expressive behaviour (which is unlikely to be the only such source in the vast majority of emotional episodes), it is not surprising that we produce only small magnitudes of emotional feelings.

Consistency in responsiveness

Consistency of response to self-produced cues of emotion across modalities of expression was also expected, and this prediction was supported by the results of correlational analyses. As was the case in the only previous work examining correlations between the effects of facial expressions and bodily postures (Flack et al., 1999b), the patterns of correlations in the present study demonstrated consistency of response across modalities of expression, including vocalisation. Ratings of the same feelings matching facial expressions and bodily postures, those matching facial expressions and vocal expressions, and those matching bodily postures and vocal expressions, were, with a single exception, moderately

and positively correlated. The exception occurred in the lack of significant association between ratings of happiness in the facial and vocal expressions of happiness. In addition, although positive and statistically significant, the correlation between ratings of happiness in the happy facial expression and in the happy posture was somewhat lower than those among the unpleasant feelings during matching, unpleasant facial expressions and postures. The posture of happiness, as constructed in this and previous studies, has had a somewhat checkered career, demonstrating the expected effects in some investigations (Flack et al., 1999b), but not in others (Flack et al., 1999a, study 1), unlike the consistent effects of facial expressions and bodily postures of anger, sadness, and fear (and facial expressions of happiness). Either we have yet to produce a manipulation that reliably mimics the posture of happiness, or there is no such posture.

Experimental demand and individual differences

A potentially troubling result was uncovered in the omnibus analyses addressing the impact of participants' awareness of the purpose of the manipulations on the expression effects. Awareness interacted significantly with the expression × rating effect during both the facial expression and bodily posture trials (but not in the vocal expression trials). Thus, a role for experimental demand cannot be ruled out in the results of this study. Equally plausible, however, is the alternative explanation that those participants who ''caught on'' to the expression-experience link in this study were among those who were most strongly affected by manipulations of their own emotional behaviour. An individual who experiences a fairly strong jag of anger after being instructed, unknowingly, to scowl, seems more likely to develop a subsequent awareness of the purpose of the instruction than someone who experiences little or no anger at all. And the greater the number of such manipulations in any given investigation, the more likely such individuals would seem to catch on to their purpose.

In previous studies, experimental demand was controlled in one of two ways; either by disguising the manipulations (e.g., Strack, Martin, & Stepper, 1988), or by excluding the data from participants who revealed awareness of the purposes of expression tasks on postexperimental questionnaires (e.g., Duclos et al., 1989). Although still an open issue, the results of research to date indicate that experimental demand is unlikely to account for the peripheral feedback effect (Duclos & Laird, 2001; Schnall & Laird, 2003). Furthermore, although investigators have been appropriately conservative in discarding data from participants who reveal their awareness, the result may underestimate the effects of peripheral feedback, particularly in those who tend to be more responsive to such feedback. Such individual differences in responsiveness to self-produced cues of emotion have only recently been the subjects of detailed analysis (Duclos & Laird, 2001; Schnall & Laird, 2003). Much more work is needed to

understand these differences and their implications, especially with respect to the mechanisms of emotional experience in those who are less responsive to self-produced cues. Presumably, individuals who are less responsive to peripheral feedback cues are more responsive to emotional cues available from the external environment (Laird, 1984), although this is yet to be demonstrated.

In conclusion, the results of the present research indicate that facial expressions and bodily postures tend to produce specific, categorical effects on emotional feelings (and that at least some vocal expressions do as well), that the magnitudes of effects caused by facial expressions tend to exceed those of bodily postures (and perhaps those of vocal expressions), and that these effects are consistent for the same individuals across all three modalities of expression.

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