Journal of Experimental Psychology:
Human Perception and Performance
1981, Vol. 7, No. 2, 333-341

0096-1523/81/0702-0333$00.75

Lateral Asymmetry in the Expression of Cognition and Emotion

John T. Cacioppo
University of Iowa

Richard E. Petty
University of Missouri, Columbia

Portrait photographs were taken of actors facing a one-way mirror. Consciously shaped facial expressions of sadness and thoughtfulness were obtained from actors as they viewed themselves in a mirror, spontaneous expressions of sadness and thoughtfulness were obtained when actors looked up while reading emotional and technical passages, and a neutral expression was obtained as actors stared expressionlessly into the mirror. Raters subsequently judged the expressiveness of right-side, left-side, and original orientation composites of each of the portrait photographs. Their ratings revealed lateral asymmetry in the expressive movements of the face. The nature of the asymmetry was affected by whether the expression was of emotion or cognition and by whether the expression was shaped consciously or spontaneously. These results are explained by a model in which the expressive movements of each side of the face are controlled by the efferentiation from the contralateral hemisphere.

Research on the expression of cognition and emotion has found the human face to be replete with information, though much of it is transient and covert (Cacioppo & Petty, 1979a, 1979b). Identifiable emotional processes have been linked to distinctive patterns of muscular activity in the face (Ekman & Friesen, 1975; Izard, 1971; Schwartz, 1975). Similarly, electromyographic studies of cognitive processes have uncovered intimate expressive movements within the speech musculature during the silent performance of verbal-analytic tasks (Garrity, 1977; McGuigan, 1978). As is the case for emotional processing, the nature of the cognitive processing influences the pattern of expressiveness by the face. For instance, the extent of speech muscle activation is affected by the depth-of-processing during the task (Cacioppo & Petty, 1979c, in press), whereas the patterning *within* the speech musculature varies as a function of the phonetic attributes of the information being processed (McGuigan & Winstead, 1974).

Nevertheless, these distinctive facial patterns for cognition and emotion may be but part of the story. For some time it has been suggested that the face is physiognomically asymmetric (Wolff, 1933, 1943). Experimental evidence strongly supporting this contention was provided recently by Sackeim and Gur (1978). They obtained several prototypical photographs of the six primary emotions (happiness, surprise, fear, sadness, anger, and disgust—cf. Ekman & Friesen, 1975) and constructed right-side, left-side, and original-orientation composites of each. Subjects then rated the expressiveness of each photograph. Sackeim and Gur found that left- as compared to right-side composites were judged as more intense expressions of negative emotions. This physiognomic asymmetry was attributed to contralateral hemispheric control of expressive movements in the face.

Several interesting questions remain regarding the lateral asymmetry of expressiveness in the human face. First, considerable research has demonstrated differential hemispheric involvement in tasks, with right-handed men typically displaying right-hemispheric dominance during spatial–emotional

This research was supported in part by University of Iowa Grant G-603 and National Science Foundation Grant BNS 80-23589.

We are grateful to Ken McAlpine and Kevin Smith for their assistance during the preparation of the photographs and collection of the data, to Ellen B. Ryan for her suggestions and support, and to two anonymous reviewers for their comments regarding an earlier draft of this article.

Requests for reprints should be sent to John T. Cacioppo, Department of Psychology, University of Iowa, Iowa City, Iowa 52242 or to Richard E. Petty, Department of Psychology, University of Missouri, Columbia, Missouri 65211.

tasks but left-hemispheric dominance during verbal–analytic tasks (Dimond & Beaumont, 1974; Donchin, Kutas, & McCarthy, 1977; Milner, 1971; Schwartz, Davidson, & Maer, 1975). If there is contralateral hemispheric control predominating in the expressive movements of the face, then facial expressions should be accentuated in left- relative to right-side composites for emotions, but right- rather than left-side composites should evince greater expressiveness for facial portraits depicting "thoughtfulness," such as that portrayed by Rodin in his classic sculpture, "The Thinker." Sackeim and Gur (1978) provided evidence for the first half of this hypothesis, but their data do not address the second portion of it. A major aim of the present study, then, is to test this full hypothesis.[1]

Second, Wolff (1933, 1943) suggested that the right side of the face was more "public" and consciously controlled in its expressiveness than the left side of the face, which he describes as "private" and more spontaneous in its expressive movements. This suggestion, which has never been tested empirically to our knowledge, is examined in the present study by obtaining photographs of actors from behind a one-way mirror. Consciously shaped expressions were secured by instructing actors from a local theater group to view themselves in the mirror and display their best (public) expression of sadness and thoughtfulness. Relatively spontaneous expressions were obtained by asking actors to read a sad or technical passage while looking up at the mirror occasionally as if speaking to an audience. If Wolff's suggestion is correct, then we should find (a) exaggerated facial expressions in right- compared to left-side composites for the poses that are consciously formed and (b) accentuated expressiveness in left- rather than right-side composites for spontaneous expressions.[2]

Third, there is a real possibility that both of these hypotheses are correct. For instance, Wolff's assertion about the asymmetric expression of emotion was supported by Sackeim and Gur (1978). Furthermore, Wolff's speculations about the right side of the face being more consciously controlled than the left, together with the notions of contralateral hemispheric control of asymmetric facial expressions, are compatible with research on differential hemispheric functioning, which indicates that the left side of the brain is involved in conscious processes more than the right side of the brain (Gazzaniga & LeDoux, 1978; Sperry, Gazzaniga, & Bogen, 1969). If both hypotheses are borne out in the present study, however, their simultaneous operation may mask the two-way interaction that each predicts.

Fortunately, research on cerebral asymmetry has demonstrated that a simple additive model accurately accounts for the effects of task requirements on hemispheric involvement (cf. Kinsbourne, 1978; Schwartz et al., 1975). This additive model allows us to predict in advance how the experimental factors affect asymmetry in facial expressions should both of the above hypothesized processes operate. Specifically, the operation of contralateral hemispheric control over facial expressiveness in the manner outlined in the two hypotheses above should produce a three-way interaction: Voluntarily posed expressions of thoughtfulness should invoke expressiveness that is especially apparent in right-side composites, whereas voluntarily posed expressions of sadness should yield expressiveness that appears similarly in right- and left-side composites. Conversely, spontaneous expressions of thoughtfulness should evince expressiveness that is similar in right-

[1] We investigated physiognomical asymmetry in the human face by examining the expressions of "sadness" and "thoughtfulness." With affect and, possibly, content of thought differing between these types of expression, it is not possible to pinpoint exactly the cause of any observed differences. On the other hand, this approach provides an initial test of the hypothesis that the right and left sides of the face differ in the nature of their expressiveness of cognition and emotion.

[2] Sackeim and Gur (1978) used posed expressions of emotions, which at first might appear relevant to the first part of this hypothesis. However, the photographs they used were selected from photographs that possessed a particularly high degree of specificity and clarity of emotional expression (Ekman & Friesen, 1975). These poses might be more similar to the spontaneous emotional expressions in which Ekman and Friesen were interested than to the controlled expressions about which Wolff (1943) spoke.

and left-side composites, whereas spontaneous expressions of sadness should create expressive movements that are especially graphic in left-side composites.

Method

Subjects and Design

Fifty undergraduate introductory psychology students served as raters in a 3 (type of composite: right-side, original orientation, vs. left-side) × 2 (type of expression: sadness vs. thoughtfulness) × 2 (spontaneity of expression: voluntarily posed vs. spontaneous) + 3 (external control: right-side, original orientation, and left-side composite of neutral expression) within-subjects design. Groups of 20, 19, and 11 raters independently judged each of the slides. The order of the slide presentations was varied randomly across groups. Raters earned extra credit by their participation.

Materials

Twenty black-and-white portrait photographs of four professional actors who volunteered their time were obtained in preliminary sessions. All four actors were right-handed men. The actors were placed in front of a one-way mirror and were asked to read a passage from a mathematics textbook, read a passage about the father's funeral in *Death of a Salesman*, feign an expression of someone lost in grief, feign an expression of someone lost in thought on a difficult problem, and display a neutral expression by relaxing and not thinking. The order in which actors performed these tasks varied, and actors were unaware of the experimental hypotheses.

Portraits of the actors were shot through the one-way mirror using a 35-mm camera. Three 8 in. × 10 in. (20.3 cm × 25.4 cm) glossies, two in the original and one in the reversal orientation, were made for each of the 20 photographs obtained in the preliminary session. One of the original prints and the reversed print were cut vertically through the midline of the face, and composites of the right and left sides of the face were constructed (cf. Sackeim & Gur, 1978). Thirty-five millimeter slides were made for each of the original-orientation, right-side, and left-side composites.

Procedure

Raters were seated in the center section of an auditorium and completed two 7-point scales (ranging from extremely nonemotional, to extremely emotional, not intense, to very intense) for each of the 60 photographs presented.[3] Raters were told that they would be viewing a number of portrait photographs. The raters were instructed to view each until it was removed, at which time they should rate the expressiveness of the face in the photograph, using the appropriate pair of scales provided. The auditorium then was darkened, and each slide was presented for 10 sec followed by at 10-sec presentation of a blank slide. The blank slide provided enough illumination in the auditorium for raters to see and use their rating scales.

Results

Mean ratings of expressiveness were computed for each slide averaging across scales and posers to obtain stable judgments regarding the facial expressions to test the hypothesis that the right and left sides of the face differ in their expressiveness. A 3 × 2 × 2 analysis of variance was performed on these mean ratings, which are displayed in Figure 1. Significant main effects were found for spontaneity of expression, $F(1, 49) = 13.09$, $p < .001$, type of expression, $F(1, 49) = 35.53$, $p < .001$, and composite, $F(2, 98) = 10.47$, $p < .01$. The portraits of the voluntarily posed faces ($M = 4.22$) were rated as more expressive than were the portraits of the spontaneous faces ($M = 4.02$); sad faces ($M = 4.26$) were rated as more expressive than were thoughtful faces ($M = 3.98$); and right-side composites were rated as the most expressive ($M = 4.22$), whereas original-orientation composites were rated as least expressive ($M = 4.02$).

These main effects were qualified by significant two-way interactions. Wolff (1943) hypothesized that public expressions are most apparent on the right side of the face, whereas private expressions are most apparent on the left. The present analysis obtained support for this hypothesis: A significant Composite × Spontaneity of Expression interaction, $F(2, 98) = 20.47$, $p < .001$, indicated that voluntarily shaped expressions were more evident in right- than left-side composites, whereas spontaneous expressions were more apparent in left- than right-side composites (see Figure 1).

Second, a marginally significant Composite × Type of Expression interaction was obtained, $F(2, 98) = 2.74$, $p < .10$, which reflected the predicted discrimination across the two sides of the face in the expression of thoughtfulness and sadness. Briefly, the

[3] These measures were selected after preliminary work suggested that they reflected the general expressiveness displayed in portrait photographs. The ratings were averaged across scales to obtain a measure of general expressiveness.

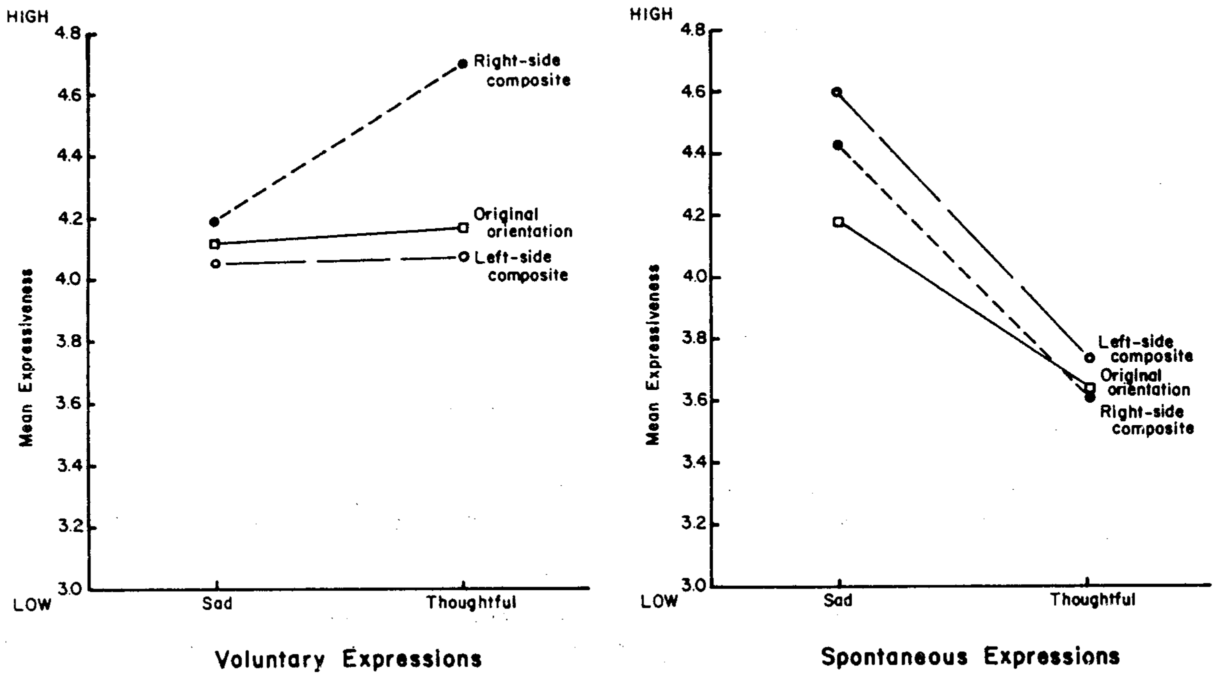

Figure 1. Expressiveness of the face as a function of the type of composite and the type and spontaneity of expression.

ordering of the means constituting the interaction indicated that sadness was displayed more expressively on left- than right-side composites, whereas thoughtfulness was evinced more expressively on right- than left-side composites. Thus, evidence in the form of the predicted two-way interactions was found for the two major hypotheses of the present study. The Composite × Type of Expression interaction just described replicates and extends Sackeim and Gur's (1978) study of facial asymmetry. In addition, the Composite × Spontaneity interaction described above provides evidence for the first time for Wolff's speculations regarding facial asymmetry in public versus private expressions.

We cautioned that should both hypotheses be accurate, there might be an attenuation of the two-way interactions, since the factors of type and spontaneity of expression in some instances place contradicting demands and in some instances place facilitating demands on asymmetrical hemispheric involvement. Consistent with this reasoning, we obtained a Type × Spontaneity of Expression interaction, $F(1, 49) = 57.54, p < .001$, a weaker than expected Composite × Type of Expression interaction (see above), and a three-way interaction $F(2, 98) = 10.42, p < .001$. As can be seen in Figure 1, consciously shaped expressions of thoughtfulness, which actors consciously shaped while viewing themselves in a one-way mirror, evinced especially expressive movements in the right side of the face. As expected by the additive model of hemispheric involvement, no differences in the expressiveness of posed sadness were evident across the two sides of the face. Moreover, inspection of the right panel of Figure 1 reveals that, as expected, spontaneously emitted sad expressions were more apparent in the left side of the face than were spontaneously emitted thoughtful expressions. However, the asymmetry in expressiveness was no greater in the former than in the latter conditions. This contradiction of our expectations may stem from (a) differential impact of the manipulations on hemispheric involvement (e.g., eliciting a spontaneous expression of sadness by story reading may involve the left hemisphere more than expected, since reading per se typically involves left-hemispheric activity), (b) a complication in the notion of an additive model of hemispheric involvement, or (c) the absence of the hypothesized facial asymmetries. This latter possibility seems especially unlikely, since the predicted two-way interactions were found in the present study. Hence, though the three-way interaction bespeaks the need for further research, its presence is highly intriguing and, for the most part, consistent with the experimental hypotheses.

Summaries of pairwise comparisons among the experimental means using the Duncan multiple range test and between experimental and external control means using the Dunnett's test are provided in Table 1. The most interesting effects revealed in these analyses were the slightly elevated ratings of expressiveness for the right-side composites of neutral expressions and the similarity between the neutral expression and the expression elicited by reading a passage about mathematics. In retrospect, this passage may not have been as thought provoking to actors as we had expected it to be (but see Ornstein et al., 1979).[4]

Analyses of the subscales constituting the measure of expressiveness revealed patterns of results similar to those depicted in Figure 1. The ratings of emotionality distinguished between the right- and left-side composites more clearly than the ratings of intensity, which may be attributable to the fact that raters completed the emotionality scale before the intensity scale and completed both within a 10-sec span of time following each slide.

Discussion

These results support previous anecdotal and experimental observations that the right and left sides of the face differ in the nature of their expressiveness. We obtained the expected interaction between composite and spontaneity of expression, indicating, as Wolff (1933, 1943) suggested, that voluntarily shaped (i.e., public) expressions are especially pronounced on the right side of the face, whereas spontaneous, or less consciously controlled expressions, are more evident on the left side of the face. Further, we observed a marginally significant interaction between composite and type of expression, which bespoke the predicted right-side composites depicting particularly expressive portraits of thoughtfulness and left-side composites evidencing slightly more expressive portraits of sadness. These two-way interactions were anticipated by the contralateral hemispheric control model for expressive movements in the human face.

We reasoned further using this model that should both hypothesized processes occur in the present study, a three-way interaction would emerge. To review this reasoning briefly, the two-way interactions, when superimposed, are in two instances facilitative and in two instances inhibitive of obtaining asymmetric hemispheric involvement. Since previous research suggests that an additive model accounts nicely for the effects of task demands on hemispheric involvement (Kinsbourne, 1978; Schwartz et al., 1975), we reasoned that a three-way interaction would be produced by the demands on hemispheric involvement by the simultaneous operation of the processes underlying each predicted two-way interaction. This reasoning was borne out, at least in part, by the three-way

---

[4] When the factor of the poser was included in the analyses, a number of interactions involving this factor were obtained. This finding is consistent with our speculation in Footnote 2 that the normal facial expressions of people show great variability and individual differences. In other words, the general processes predicted by Wolff (1933, 1943) are evident, but a substantial amount of the variance is left unaccounted for. It remains for future research to search out the idiosyncratic sources of this residual variance.

We next conducted a reanalysis of the data treating the poser as a random- rather than a fixed-effects factor. This reanalysis was performed to assess the confidence with which we might generalize these results beyond the specific materials (e.g., the poser) that were employed (cf. Clark, 1973). Before reporting the results, we should note that this procedure is particularly conservative in the present study because (a) quasi-F ratios were used to test the experimental hypotheses, and (b) though we employed a sizable subject pool ($n = 50$), we used a small number of posers ($n = 4$). Together, these conditions produced fairly unpowerful statistical tests of the experimental hypotheses (see Clark, 1973). Nevertheless, a number of the hypotheses were confirmed in this reanalysis. Though the three-way interaction was not significant, the following expected two-way interactions were significant: Composite × Spontaneity of Expression, $F(2, 6) = 7.91$, $p < .05$, and Spontaneity × Type of Expression, $F(1, 4) = 19.83$, $p < .05$. These results provide some evidence that our observations are not limited to the present experimental materials.

Table 1
Mean Rating of Expressiveness as a Function of the Composite and the Spontaneity and Type of Expression

	Voluntarily posed		Spontaneous		
Composite	Sad	Thoughtful	Sad	Thoughtful	Neutral
Right side	4.18_c^a	4.69_d^a	$4.43_{c,d}^a$	3.59_a	3.40
Original orientation	4.12_c^a	4.16_c^a	4.18_c^a	3.62_a^a	3.13
Left side	$4.07_{b,c}^a$	$4.08_{b,c}^a$	4.58_d^a	$3.74_{a,b}^a$	3.10

Note. Entries among the 12 experimental cells with dissimilar subscripts differ at the .05 alpha level by the Duncan multiple range test.
[a] The mean differs from the corresponding external control (neutral) mean at the .05 alpha level by Dunnette's test.

interaction displayed in Figure 1. Consciously controlled expressions of thoughtfulness, coaxed from actors by appealing to them to pose as if lost in thought on a complex problem, were perceived as especially expressive on right-side composites, whereas consciously shaped poses of sadness were indistinguishable across composites. On the other hand, more spontaneously produced expressions of thoughtfulness, emitted by actors while reading a technical passage, appeared similarly in the various composites, whereas the spontaneous expressions of sadness were especially apparent in left-side composites of the face. We also observed an interaction between the type and spontaneity of expression, which further suggests that the demands introduced by these factors were interactive.

These findings suggest that (a) lateral asymmetry exists in the expressive movements of the human face, (b) this asymmetry is affected by whether the expression is consciously shaped or spontaneously emitted and by whether it derives from cognition or emotion, and (c) the expressiveness on each side of the face is influenced by the operation of the contralateral hemisphere. We next examine more closely the evidence and alternatives that exist for each of these specific conclusions.

The first inference from the present study, that lateral asymmetry exists in the human face, seems secure given the highly significant effects and interactions obtained in the traditional analyses of variance and comparisons. One might argue, however, that the present results are limited to the experimental materials and, hence, are of little significance. This critique, of course, focuses on the issue of external validity and hinges on the treatment in the analyses of the poser as a fixed-effects factor (cf. Clark, 1973).

A reanalysis of these data treating the poser as a random-effects factor (see Footnote 4) provides some reassurance regarding the generalizability of the present results, but it is somewhat disquieting that the predicted three-way interaction failed to reach statistical significance in this reanalysis. We suggested that the use of only four posers substantially reduced the power of these tests and may account for the failure to obtain the predicted three-way interaction, quasi $F(2, 6) = 2.03$. Consistent with this reasoning, the interaction between the type of expression (emotional vs. thoughtful) and composite was significant in the traditional analysis of variance, which treated the poser as a fixed-effects factor, but it was not significant in the reanalysis. Nevertheless, this interaction is likely to be generalizable, since it replicated and extended the observations reported by Sackeim and Gur (1978). Similarly, we found that subjects rated voluntarily shaped faces as more expressive than those spontaneously displayed. This main effect for spontaneity of expression was found, too, by Schwartz, Ahren, and Brown (1979) in an electromyographic study of lateralized facial muscle response.

We found this effect to be significant statistically when the poser was treated as a fixed-effects factor, but it too was not significant in the reanalysis. These comparisons are not meant to suggest that the "fixed-effects fallacy" does not apply in the present area of study, but rather that, as Clark (1973) warned, the quasi-F ratios needed to test the interesting experimental hypotheses are only as powerful as the least powerful random-effects factor. It seems entirely possible, then, that four posers was an insufficiently large sample to accept confidently the null hypothesis in the present study. Indeed, evidence that several of the predicted interactions *were* significant in the renalysis and that several of the remaining effects have been observed elsewhere confers support to the notion that lateral asymmetry exists in the expressive movements of the human face.

The second inference contains two parts: Lateralized movement in the human face is influenced by whether it is consciously shaped or spontaneously emitted and whether it derives from cognition or emotion. Turning first to the former conclusion, we should point out that Schwartz et al. (1979) recently reported findings that parallel those in the present study. In their study of the electromyographic (EMG) "output" (i.e., integrated EMG activity) over the zygomatic (cheek) and corrugator (eyebrow) muscles of the left and right side of the face, Schwartz et al. (1979) found that for spontaneous facial expression of negative emotions, there was greater left than right zygomatic muscle output, whereas there was no detectable laterality for voluntary expressions of negative emotions. These observations, which were made using very different procedures and materials than we employed, further substantiate the importance raised here of distinguishing between spontaneous and voluntary facial expressions.

Nevertheless, it might be argued that our manipulations of spontaneous and voluntary expressions effected predominantly imaginal and semantic associations while posing versus reading, respectively, and that these latter differences rather than the spontaneity of the expression led to the physiognomic asymmetries that the subjects observed. Several responses to this possibility are in order. First, Schwartz et al. (1979) directly tested this hypothesis and found no evidence that asymmetrical facial EMG activity was altered by the imaginal/semantic requirements of the task. Second, and more importantly, this interpretation cannot explain the present finding that the expressions evinced while reading, which we termed "spontaneous" because poser did not have as much time or motive to shape them consciously when reading compared to when posing, tended to be more expressive in left- rather than right-side composites. Expressions voluntarily constructed by posers, on the other hand, resulted in the opposite pattern of lateralized expressiveness (see Figure 1). The outcome expected by the imaginal/semantic interpretation, of course, is the exact opposite of this pattern of data. Thus, the collective evidence suggests that lateralized responses in the human face *are* affected by whether the expression is consciously shaped or spontaneously emitted.

Second, we concluded that the perceived asymmetry in facial expressions is influenced by whether the expressions derive from cognition or emotion, but this influence we consider more tentative. Traditionally, people have associated facial expressions with emotions of one kind or another (e.g., positive, negative, strong, weak). Drawing on the research on cerebral specialization and information processing, we have suggested that whether the facial movements result from thoughtful or emotional processes *also* determines the nature and extent of this asymmetry. Though we obtained support for this hypothesis in the present study, we cannot be sure that posing thoughtfully and reading a mathematics text induced totally non-affect-laden information processing (cf. Cacioppo & Petty, 1979a, 1979c). A particularly interesting alternative interpretation is that the manipulations designed to elicit (nonemotional) "thoughtful" expressions actually (or additionally), elicited positive affect, and positive affect rather than analytical processing produced the observed asymmetry.

Sackeim and Gur (1978) studied the asymmetry evidenced in expressions of happiness as well as sadness, surprise, fear, and so forth. They reported that expressions of emotions, except for happiness, are expressed more intensely on the left side of the face. More recently, Schwartz et al. (1979) examined the lateralized movements in the face that accompanied involuntary expressions of "positive" (i.e., happiness, excitement) and "negative" (i.e., sadness, fear) emotions. They observed greater left than right muscle output for negative emotions, as we did here, and they found greater right than left muscle output for positive emotions, an effect we found for what we have termed *thoughtful* expressions. Which factor is prepotent in this situation must be determined in future research, for Schwartz et al.'s (1979) data too are ambiguous on this point. Specifically, they found this latter effect was due to the "excitement" rather than the "happiness" tasks, which were designed to represent weak and strong positive emotional responses, respectively. According to the positive emotion hypothesis, both, but particularly happiness, should have produced this effect.

The final inference drawn from the present data is that the expressiveness of each side of the face is influenced by the relative involvement of the contralateral hemisphere. This conclusion is in accord with that drawn by others (e.g., Sackeim & Gur, 1978; Schwartz et al., 1979) and, if not accurate, certainly illustrates the paucity of parsimonious accounts for three-way interactions in this area of research. Moreover, the study by Schwartz et al. (1979) is particularly informative regarding this hypothesis. The notion that the asymmetrical expressiveness of the human face is due to the specialized operation of the contralateral hemisphere suggests, too, that the lower part of the face is tied more closely than the upper part in the production of these lateralized expressive movements. This inference is based on anatomical evidence that the face is innervated ipsilaterally and contralaterally by both hemispheres, with contralateral projections predominating in the lower part of the face (Gatz, 1970). The results of the Schwartz et al. (1979) study are in complete agreement with this line of reasoning. They found laterality over the zygomatic muscles, which are located in the lower-to-middle part of the face, but they found no laterality whatsoever over the corrugator muscles, which are located in the upper portion of the face.

References

Cacioppo, J. T., & Petty, R. E. Attitudes and cognitive response: An electrophysiological approach. *Journal of Personality and Social Psychology*, 1979, *37*, 2181–2199. (a)

Cacioppo, J. T., & Petty, R. E. Neuromuscular circuits in affect-laden information processing. *Pavlovian Journal of Biological Science*, 1979, *14*, 177–185. (b)

Cacioppo, J. T., & Petty, R. E. Lip and nonpreferred forearm EMG activity as a function of orienting task. *Journal of Biological Psychology*, 1979, *9*, 103–113. (c)

Cacioppo, J. T., & Petty, R. E. Electromyographic specificity during covert information processing. *Psychophysiology*, in press.

Clark, H. H. A critique of language statistics in psychological research. *Journal of Verbal Learning and Verbal Behavior*, 1973, *12*, 335–359.

Dimond, S. J., & Beaumont, J. G. Experimental studies of hemisphere function in the human brain. In S. J. Dimond & J. G. Beaumont (Eds.), *Hemispheric function in the human brain*. New York: Halsted Press, 1974.

Donchin, E., Kutas, M., & McCarthy, G. Electrocortical indices of hemispheric utilization. In S. Harnad, R. W. Doty, L. Goldstein, J. Jaynes, & G. Krauthamer (Eds.), *Lateralization in the nervous system*. New York: Academic Press, 1977.

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

Garrity, L. I. Electromyography: A review of the current status of subvocal speech research. *Memory & Cognition*, 1977, *5*, 615–622.

Gatz, A. J. *Manter's essentials of clinical neuroanatomy and neurophysiology*. Philadelphia, Pa.: Davis, 1970.

Gazzaniga, M. S., & LeDoux, J. E. *The integrated mind*. New York: Plenum Press, 1978.

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

Kinsbourne, M. Biological determinants of functional bisymmetry and asymmetry. In M. Kinsbourne (Ed.), *Asymmetrical function of the brain*. Cambridge, England: Cambridge University Press, 1978.

McGuigan, F. J. *Cognitive psychophysiology: Principles of covert behavior*. New York: Prentice-Hall, 1978.

McGuigan, F. J., & Winstead, C. L., Jr. Discriminative relationship between covert oral behavior and the phenomic system in internal information processing. *Journal of Experimental Psychology*, 1974, *103*, 885–890.

Milner, B. Interhemispheric differences in the localization of psychological processes in man. *British Medical Bulletin*, 1971, *27*, 272–277.

Ornstein, R., Herron, J., Johnstone, J., & Swencionis,

C. Differential right hemisphere involvement in two reading tasks. *Psychophysiology*, 1979, *16*, 398–401.

Sackeim, H. A., & Gur, R. C. Lateral asymmetry in intensity of emotional expression. *Neuropsychologia*. 1978, *16*, 473–481.

Schwartz, G. E. Biofeedback, self-regulation, and the patterning of physiological processes. *American Scientist*, 1975, *63*, 314–324.

Schwartz, G. E., Ahern, G. L., & Brown, S. L. Lateralized facial muscle response to positive and negative emotional stimuli. *Psychophysiology*, 1979, *16*, 561–571.

Schwartz, G. E., Davidson, R. J., & Maer, F. Right hemisphere lateralization for emotion in the human brain: Interactions with cognition. *Science*, 1975, *190*, 286–288.

Sperry, R. W., Gazzaniga, M. S., & Bogen, J. E. Interhemispheric relationships; the neocortical commissures; syndromes of hemisphere disconnection. In P. J. Vinken & G. W. Bruyn (Eds.), *Handbook of clinical neurology* (Vol. 4). Amsterdam, The Netherlands: North Holland, 1969.

Wolff, W. The experimental study of forms of expression. *Character and Personality*, 1933, *2*, 168–173.

Wolff, W. *The expression of personality*. New York: Harper & Row, 1943.

Received October 17, 1979 ■