preted as due to a "change for the worse" in the changed component, to a change in relative value (*15*). Our results are not consistent with this hypothesis since, if wheel-running has any value at all for the animal, the change from VI to Ext in the changed component will entail a smaller reduction in the value of that component with the wheel available than without.

The relation between the response-competition hypothesis and additivity theory is not yet clear. Both involve competition: between interim and terminal responses in the first case, between incompatible instrumental and induced terminal (Pavlovian) responses in the second. The induction of Pavlovian terminal responses by contrast manipulations, however, may itself be attributable (wholly or in part) to reallocation of terminal and interim behaviors between the two schedule components according to the mechanisms here described.

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10. The minimal condition for the contrast prediction is that an increase in the time available for the competing activity (that is, the time in the changed component made available by the abolition of food-related activities in that component) reduces its competitive effect on the terminal response in the unchanged component. This is just the well-accepted behavioral equivalent of the economic law of diminishing marginal utility [H. Rachlin and B. Burkhard, *Psychol. Rev.* **55**, 22 (1978); J. Allison, M. Miller, M. Wozny, *J. Exp. Psychol. General*, in press]. A formal account of the competition hypothesis, applied to the generalization-gradient peak shift and inhibitory gradients, as well as to contrast, is given in J. E. R. Staddon [in *Operant-Pavlovian Interactions*, H. Davis and H. M. B. Hurwitz, Eds. (Lawrence Erlbaum, Hillsdale, N.J., 1977), pp. 103–131]. This account assumes for simplicity that competition can be represented by a system of linear equations, but many quantitative models are compatible with the general idea. An account invoking terminal-interim competition has recently been offered for local contrast effects by P. Killeen [in *Advances in the Experimental Analysis of Behavior*, M. Zeiler and P. Harzem, Eds., vol. 1, in press]. The terminal-interim distinction was originated by Staddon and Simmelhag (*11*) and was reviewed, with emphasis on interim activities and interim versus terminal competition, by Staddon (*9*). The utility to the animal of stimuli that allow it to allocate interim and terminal activities efficiently has been suggested by L. Green and H. Rachlin [*J. Exp. Anal. Behav.* **27**, 255 (1977)]. J. F. Rand [*ibid.* **25**, 103 (1977)] has shown that pigeons allocate interim activities preferentially to the unreinforced stimulus in successive discrimination.
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14. In this theory, interactions between stimuli are mediated by the behaviors they control. If two stimuli, A and B, are presented at the same time, the effect of A on the behavior controlled by B will depend on whether or not the behaviors occasioned by A and B are compatible. Hence stimuli cannot be categorized as absolutely excitatory or inhibitory in their effects.
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Emotions Are Expressed More Intensely on the Left Side of the Face

Abstract. *Pictures of human faces posing six distinct emotions (plus a neutral expression) and their mirror reversals were split down the midlines, and left-side and right-side composites were constructed. Subjects judged left-side composites as expressing emotions more intensely than right-side composites. The finding indicates hemispheric asymmetry in the control over emotional expression in the face.*

Anecdotal and experimental evidence has suggested that the left and right sides of the face are physiognomically asymmetrical (*1*). On the basis of case studies, Wolff (*1*, *2*) proposed that the right side of the face is consciously expressive and "public," while the left side of the face is more inhibited and "private." Furthermore, Wolff claimed that the right side of the face is perceived as more similar to the whole face than the left side is. Although the first proposition has never been examined experimentally, the second has (*3*, *4*). In such studies the procedure has been to split photographs of a full face and its mirror reversal down the midline to construct composite photographs of the face, one made up of the left side and one made up of the right (Fig. 1).

Generally, the right-side composite face is judged more similar to the original face than the left-side composite (*4*). However, these studies failed to obtain judgments of the similarity of the composites to a mirror reversal of the original face. Gilbert and Bakan (*3*) demonstrated that when this condition is included, subjects judge whichever side of the face appearing more to their left to be more similar to the whole face than whichever side appears more to their right. They concluded that judgments of facial asymmetry in expression are determined by biases of the perceiver rather than by asymmetry in actual ex-

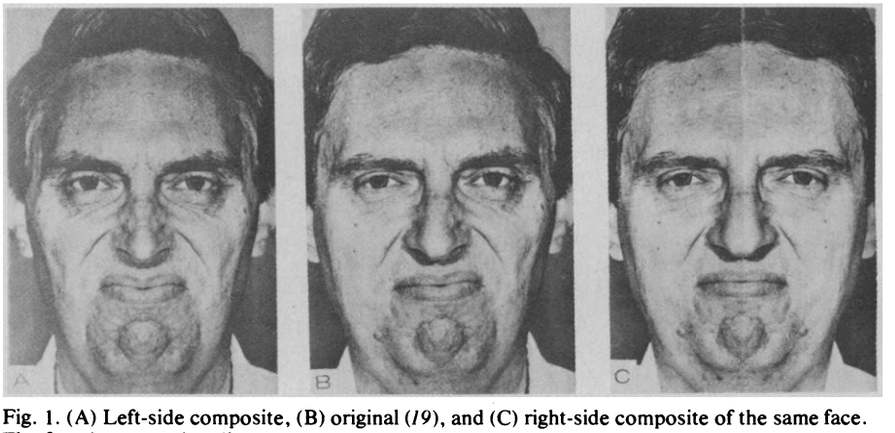

Fig. 1. (A) Left-side composite, (B) original (*19*), and (C) right-side composite of the same face. The face is expressing disgust.

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pression. These findings notwithstanding, Wolff's first proposition that the sides of the face differ in expressiveness may nevertheless be valid. Indeed, the fact that subjects can discriminate between left-side and right-side composites of the same face underscores the existence of perceptible physiognomic differences. The question we posed for investigation is whether these differences are consistent and, in particular, whether the left and right sides of the face are asymmetrical in emotional expressiveness.

Cross-cultural data (*5*) indicate that at least six distinct emotions can be reliably recognized in the human face: happiness, surprise, fear, sadness, anger, and disgust. A set of photographs of posed facial expressions of these emotions as well as photographs of faces expressing emotional neutrality collected by Ekman and Friesen (*6*) produce reliable and accurate judgments of emotional expression in large samples of subjects. Seventy photographs of 14 posers were chosen for our study so that the seven emotions and photographs of males and females were equal in representation and that the quality of the photographs was uniform (*7*). Slides were then made of the original and the left-side and right-side composite photographs (*8*).

Four groups of subjects were each presented 54 slides, with six of the slides presented to all groups to examine possible group biases (*9*). The other 48 slides differed for each group. In all, 210 different slides were presented. The size of the groups varied from 20 to 26 subjects with a total of 86 subjects (57 males, 29 females). In order to examine differences between the composites in intensity of expression, subjects were asked to rate on a 1 to 7 scale the intensity of expression for the emotion portrayed in each slide. Each slide was projected for 10 seconds and subjects were given 35 seconds in which to record their responses.

The left-side composites were judged to express emotions more intensely than the right-side composites. An analysis of covariance on mean ratings of intensity on the left-side and right-side composites, with ratings for the original face as a covariate, yielded a significant main effect for the type of composite [$F(1,56) = 9.39, P = .004$], with left-side composites being judged more intense. The main effect for the type of emotion portrayed was also significant [$F(6,55) = 4.05, P = .002$], indicating that subjects judged the emotions to differ overall in intensity. Sex of the face expressing the emotions did not have a main effect, nor were there any significant interactions in this analysis. Mean ratings of intensity were higher for left-side than right-side composites for all emotions except happiness (*10*). Of the 70 different faces presented, 45 were judged as expressing emotion more intensely on the left side ($P < .005$). Left-side composites were judged as more intense than right-side composites for 11 of 14 posers ($P < .01$) (*11*).

Substantial evidence supports right-hemispheric superiority for facial recognition (*12*) and some evidence indicates right-hemispheric specialization for the processing of emotional information (*13*). Neuroanatomically, both hemispheres have ipsilateral and contralateral projections innervating facial muscles, with a greater preponderance of contralateral projections, particularly in the lower part of the face (*14, 15*). In addition, evidence from studies of brain-damaged patients suggests greater right-hemispheric cortical control over the left side of the face (*16, 17*). In light of these findings, our results point to greater right-hemispheric involvement in the production of emotional expression.

A puzzling implication of these findings emerges when one considers the role of emotional expression as a communication system. In a face-to-face situation, the right side of the face of a person expressing an emotion will most likely fall in the perceiver's left visual field, which projects to the perceiver's right hemisphere. Furthermore, the perceiver has a bias to judge the half of a face appearing more to the left as more similar to the whole face than the half which appears more to the right (*3*). This creates a situation in which the side of the face which is more intense in emotional expression is more likely to be projected to the hemisphere which is relatively inferior in facial recognition and in the processing of emotional information. This situation may be viewed either as advantageous or as disadvantageous depending upon the desirability of effective communication of emotional intensity. It is also possible that the greater emotional expressiveness of the left side of the face evolved in order to compensate for the relative inferiority of the left hemisphere in facial recognition and the processing of emotional information.

The issue of hemispheric control of emotional expression may be related to the degree to which emotions are posed or voluntarily expressed as compared to involuntary or reflexive expression. Brain lesion studies point to the possibility of a dissociation in the control of voluntary and the involuntary emotional expressions (*18*). The slides used in this study were taken of subjects deliberately attempting to convey particular emotions. Whether or not the same asymmetry in intensity of expression would be obtained with more spontaneously occurring emotional expressions is a matter for future investigation. Findings of differences in hemispheric control over these two types of emotional expression may help further elucidate the nature of functional brain asymmetry. On the other hand, given our knowledge about the functional differences between the two hemispheres, the asymmetry between the two hemispheres in the production of emotional expression may shed some light on the organization of emotions and emotional communication.

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8. Two black and white photographs, 11½ by 17 cm, were made of each face, one in the original orientation and one in the reversed orientation. The original and reversed prints were cut vertically through the midline of the face and two left sides and the two right sides were joined to make left-side and right-side composites. Each composite was therefore exactly symmetrical. Slides (35 mm) were then made of the original photograph and the two composites.
9. No effects of group were found. With the exception of the six slides presented to all four groups, the assignment of slides, as well as the order of slides within groups, was random.
10. Strictly speaking, the absence of a significant interaction between type of emotions and composites precludes post hoc comparisons among the means to test the effect separately for each emotion. However, such comparisons may be useful for exploratory purposes. Mean ratings of intensity were significantly higher for left-side than for right-side composites for the emotions of disgust and anger ($P < .01$).
11. Subjects were also instructed to rank order the four out of seven emotions most likely expressed in each slide in order to examine differences among the composite and original face in accuracy of recognition of the emotions. The original and the two composites did not differ with regard to accuracy of recognition.
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Prenatal Exposure to Prednisone in Humans and Animals Retards Intrauterine Growth

Abstract. *Prednisone treatment for infertility and subsequent pregnancy maintenance in humans resulted in a significant decrease in the birth weight of full-term infants and a marked increase in the percentage of newborn infants weighing 2500 grams or less, that is, "light for dates" in comparison to control offspring. A parallel experiment with mice indicated that the reduction of birth weight was caused by exposure to corticosteroids rather than to maternal disease or malfunction.*

Since their synthesis nearly three decades ago, corticosteroids have been the treatment of choice for such life-threatening disorders as lupus erythmatosus, Addison's disease, and asthma to less serious complaints such as dermatitis and tennis elbow (*1*). Serious threats to maternal well-being, at times, necessitate corticosteroid therapy during pregnancy (*2-4*). Moreover, adrenocortical hormones have been used expressly to induce ovulation and support pregnancy in women suffering from infertility. Specifically, steroid therapy is administered when the suspected etiology of the disorder is a mild abnormal elevation of adrenal androgen levels (*5*). Thus, both the incidental and deliberate treatment of pregnancy with corticosteroids have resulted in the exposure of large numbers of fetuses to augmented adrenal hormone levels.

The paucity of reports on the possible effects on the human fetus of these powerful substances is surprising. Those reports which do exist are based on small numbers of individuals and fall into one of two categories. In one type of study, subjects received relatively large amounts of corticosteroids for the alleviation of severe symptomatology unrelated to pregnancy (*2-4*). In the second type, the offspring were evaluated during clinical trials in which low doses of corticosteroids were administered over long periods for infertility and subsequent maintenance of pregnancy (*5, 6*). In both types of experiments, little risk of exposure was noted for either mother or offspring, although somewhat higher frequencies of stillbirth and spontaneous abortion as well as isolated instances of cleft palate occasionally were reported (*4, 6*).

These reports of negligible effects on the human fetus are in marked contrast to data derived from animals in which exposure to corticosteroids during gestation apparently produces deleterious effects. Such effects as resorption, stillbirth, reduced weight and length, cleft palate, and decreased thymus weight have been observed in chick embryos and mouse, rat, and rabbit fetuses exposed to corticoids (*2, 7, 8*). However, the dosages administered in most of these investigations were proportionally higher than those used for therapeutic treatment in humans. To our knowledge, no studies have been conducted with animals subjected to long-term treatment with low doses of corticosteroids analogous to the treatment used frequently for human infertility.

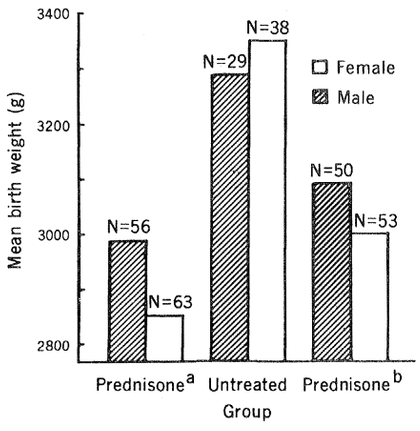

Fig. 1. Mean birth weight of male and female human infants exposed or not exposed prenatally to prednisone. (*Prednisone*^{a}) based on data from all prednisone-exposed offspring. (*Prednisone*^{b}) based on data from only those subjects that did not qualify as "light for dates" (weighing 2500 g or less at birth); only one subject in the untreated group was "light for dates."

Since no study of human offspring exposed to low dosages of corticosteroids throughout gestation could be found, we studied a large sample of offspring of women who were treated with corticosteroids for infertility and for maintenance of pregnancy. In any study of the offspring of women treated with drugs during pregnancy, the most serious confounding variable is the maternal disease or malfunction which necessitated the initiation of therapeutic intervention. This makes it difficult, if not impossible, to extricate the effects of the treatment from those of the maternal complaint. Therefore, we undertook a simultaneous study of laboratory animals treated with corticosteroids in dosages proportional to those given humans. Thus, if similar effects were obtained from the human and animal subjects, any observed consequences could be more confidently ascribed to the treatment. Furthermore, by terminating pregnancy in mice at various intervals during adrenocortical hormone administration, we could make a time-related assessment of drug exposure.

The full-term offspring of all women who received prednisone (*9*) during pregnancy (N = 119) at a private southern California infertility clinic between 1955 and 1975, served as the experimental subjects. The women in this group received 10 mg of prednisone per day for infertility and treatment was continued throughout pregnancy. No other steroid hormone therapy was administered to women in this group during these pregnancies. The comparison group was composed of the offspring of 67 women from the same clinic population who did not require prednisone or any other hormonal therapy during pregnancy. Thus, mothers of offspring from both the experimental and comparison groups were comparable in that they were subject to problems of infertility sometime during their reproductive lives.

Length of gestation in most cases was calculated from temperature charts and

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