be mediated by connections between trigeminal afferents and neurons that directly control feeding. Given the high correlation between brain stimulation reward and the jaw movements we observed after stimulation ceased, it is possible that the increased modulation of trigeminal motoneurons (which facilitates chewing behavior) is related to the positive reinforcement associated with feeding. As such, this suggestion is consistent with response-oriented theories of reinforcement (*21*), in which reinforcement is thought to be isomorphic with the facilitation of the neural systems underlying species-specific motor behaviors. These theories in turn have received further support from the finding that stimulation of other important motor systems, specifically the extrapyramidal system (*22*), and cerebellum (*23*), supports ICSS.

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13. Electrodes were implanted at the following coordinates: 9.6 to 10.6 mm posterior to bregma, 1.2 to 2.8 mm lateral to the midline, and 7.5 to 8.9 mm below the level skull surface. A detailed description of the apparatus for both ICSS and SBB tests is given by A. G. Phillips and H. C. Fibiger [*Behav. Biol.* **16**, 127 (1976)]. Brain stimulation was a 60-hertz sine wave of 0.2-second duration.
14. Frozen sections of each brain (30 $\mu$m) were stained with thionin. Sections containing the tip of the electrode tract were examined by two observers and plotted on coronal sections redrawn from the atlas of E. Fifkova and J. Marsala [in *Electrophysiological Methods in Biological Research*, J. Bures, M. Petran, J. Achar, Eds. (Academic Press, New York, 1967), p. 653].
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# Assortative Mating by Unwed Biological Parents of Adopted Children

Abstract. *Analyses of data obtained from 662 unwed couples whose children were relinquished for adoption reveal that biological parents of adopted children mate assortatively. For physical characters, assortative mating of unwed parents was similar to that of wed parents; for behavioral characters, however, there was less assortative mating by the unwed parents. Because assortative mating inflates estimates of genetic parameters in adoption studies, future studies should collect information on both biological parents.*

Although adoption studies are crucial for the genetic analysis of complex human behaviors (*1*), effects of assortative mating (similarity between mates) on such studies have not usually been considered. Because data have not been reported for unwed fathers, estimates of the importance of genetic factors have been based on the correlation between unwed mothers and their adopted children. These estimates, however, may be inflated if unwed parents mate assortatively. For example, if the "true" heritability of a character in a population is .5 and assortative mating for the trait is .4, the correlation between unwed mothers and their adopted children will estimate a heritability of .70—a situation not implausible for a character such as intelligence (as estimated by IQ) (*2*).

Married couples mate assortatively for many physical and behavioral characters (*3*). We now report that unwed biological parents of adopted children also mate assortatively. We obtained mate correlations for behavioral and physical characters of 662 unwed couples whose children were relinquished for adoption through a nonresidential adoption agency in western United States from 1951 to 1976. The unwed parents provided most of the information during an interview with a social worker at the adoption agency, although it was often necessary for them to take the forms home in order to obtain information about their parents (the biological grandparents of the adopted child). For 25 percent of the files, the unwed father was available to answer questions about himself; for the rest, the unwed mother supplied information about the father (*4*). Nearly all the unwed parents were Caucasian.

The unwed couples represented a broad range of the population (Table 1). The mate correlations (assortative mating coefficients) for unwed and wed parents [who had participated in the Hawaii Study of Cognition (*5*)] are listed in Table 2. For the physical characters, with the exception of age, assortative mating coefficients of unwed couples do not differ significantly from those of wed parents. These coefficients are also similar to those reviewed by Spuhler (*3*) for married couples. In his review, the weighted

Table 1. Means, standard deviations (S.D.), and sample sizes (*N*) for unwed mothers and fathers.

| Variables | Unwed mothers | | | Unwed fathers | | |
|---|---|---|---|---|---|---|
| | Mean | S.D. | *N* | Mean | S.D. | *N* |
| Age | 21.1 | 4.4 | 660 | 23.9 | 5.9 | 659 |
| Education | 12.6 | 2.9 | 661 | 13.0 | 3.1 | 647 |
| Father's education* | 11.9 | 4.0 | 580 | 12.6 | 3.1 | 291 |
| Mother's education* | 12.0 | 2.5 | 595 | 12.6 | 4.6 | 298 |
| High school grade average† | 2.8 | 0.6 | 330 | 2.6 | 0.7 | 202 |
| Occupational NORC rating (*11*) | 67.3 | 9.6 | 440 | 63.1 | 11.3 | 475 |
| Father's NORC rating* | 63.9 | 11.5 | 601 | 64.2 | 11.8 | 405 |

*Refers to the biological grandparents of the adopted child. †Grades were converted to a four-point system in which the highest grade was 4.

Table 2. Assortative mating coefficients for unwed and wed couples. Pearson product-moment correlations were computed for all variables except hair color, eye color, bone structure, facial shape, and skin complexion. Gamma was computed for these nominal variables, and their significance was evaluated with chi square. Assortative mating by unwed parents in our sample is largely independent of temporal factors. When we partialed out the year of the adopted child's birth from $r$, the coefficients never changed by more than .02. When age of the unwed couples was also partialed out, the coefficients were still within .05 of those reported in the table. Abbreviation: $N$, number of couples.

| Variables | Unwed couples | | Wed couples (*5*) | |
|---|---|---|---|---|
| | Coefficient | $N$ | Coefficient | $N$ |
| Physical | | | | |
| Age | .70* | 658 | .86* | 797 |
| Height | .21* | 660 | .23* | 799 |
| Weight | .14* | 606 | .12* | 797 |
| Hair color | .10* | 660 | | |
| Eye color | .17* | 644 | .10* | 797 |
| Bone structure | .09 | 384 | | |
| Facial shape | .30* | 197 | | |
| Skin complexion | .34* | 628 | | |
| Behavioral | | | | |
| Education | .23* | 646 | .46* | 795 |
| Midparent education† | .05 | 239 | .31* | 764 |
| High school grade average | .26* | 183 | | |
| Occupational NORC rating (*11*) | .15* | 373 | .25* | 212 |
| Father's NORC rating† | .18* | 378 | | |
| Musical ability | .23* | 413 | | |
| Athletic ability | .33* | 418 | | |

$*P < .01$. †Refers to the biological grandparents of the adopted child.

mean coefficients for United States samples were .76 for age, .23 for height, and .20 for weight, none of which differs significantly from those we report. However, with respect to the behavioral variables for which there are comparison data, the assortative mating coefficients of unwed parents are lower than those of wed couples. The difference is significant ($P < .01$) (*6*) for the two education variables but not for occupational rating. This difference is not due to restriction of range; in fact, the variances are slightly greater for unwed than wed parents (*7*).

Assortative mating coefficients may vary considerably in smaller samples. We computed mate correlations for the two adoption studies for which raw data on unwed parents have been published. In the classic study by Skodak and Skeels (*8*), the correlation for education level was .62 for the 59 unwed couples for whom data were recorded. However, our analysis of Munsinger's (*9*) data showed little assortative mating by the study's 41 unwed couples for a social-education index ($r = .17$).

Two conclusions can be drawn from analyses of the large data set in our study. (i) Assortative mating occurs among unwed couples whose children are relinquished for adoption; and (ii) Correlations are similar to those of wed couples for physical, but perhaps not for behavioral, characters. Together, these conclusions suggest that future adoption studies should collect information on both biological parents so that genetic parameters may be estimated by regressing scores of adopted offspring on midparent values. Unlike correlations between parent and child, the regression of offspring on midparent scores is not a mathematical function of the mate correlation (*10*).

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1. See, for example, critics of behavioral genetics such as R. Lewontin [*Annu. Rev. Genet.* **9**, 387 (1975)].
2. If $t$ is the correlation between the mates' phenotypes and $h^2$ is heritability in the narrow sense, then the correlation between single parents and offspring in an adoption study is $\frac{1}{2} h^2 (1 + t)$. Thus, the single parent–single offspring correlation will inflate heritability estimates by a factor of $(1 + t)$. A review of assortative mating for IQ provided a mean estimate for $t$ of approximately .4 [J. N. Spuhler, in *Genetic Diversity and Human Behavior*, J. N. Spuhler, Ed. (Aldine, Chicago, 1967)].
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7. We also considered other possible biases. For example, it might be hypothesized that the unwed parent correlations are lower for behavioral characters because information regarding such measures is less accurate. However, it seems unlikely that education and occupation are less accurately reported than variables such as age, height, and weight. Another possible problem concerns ascertaining paternity of the child. The fact that the assortative mating coefficients for physical characteristics are so similar for unwed and wed couples suggests that this is not a serious bias.
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$$b_{P_oP_m} = \mathrm{Cov}_{P_oP_m}/V_{P_m}$$

(Cov is the covariance and V is the variance.)

$$\mathrm{Cov}_{P_oP_m} = \tfrac{1}{2} V_A(1 + t)$$

Where $V_A$ is the additive genetic variance, and

$$V_{P_m} = \tfrac{1}{2} V_P(1 + t)$$

thus,

$$b_{P_oP_m} = V_A/V_P = h^2$$

11. The NORC occupational rating is an empirically derived evaluation of job status developed by O. D. Duncan for the National Opinion Research Center [A. J. Reiss, O. D. Duncan, P. K. Hatt, C. C. North, *Occupations and Social Status* (Free Press, Glencoe, Ill., 1961)]. Assortative mating coefficients were computed only for those couples in which both members were employed.
12. Supported by grants from the University of Colorado's Biomedical Research Grant, the Grant Foundation, and the National Institute of Mental Health (MH-28076).

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## Vibrotactile Pattern Perception: Extraordinary Observers

Abstract. *Two sighted people showed a remarkable ability to perceive vibrotactile patterns generated by the Optacon, a reading aid for the blind. These individuals were able to read at very high rates, 70 to 100 words per minute, through their fingertips. Additional testing showed them to be much better than other people at discriminating and recognizing vibrotactile patterns.*

While participating in experiments testing the ability of observers (O's) to identify vibrotactile patterns presented to their fingertips, two O's demonstrated an extraordinary talent for perceiving these patterns. The two were among a number of sighted O's who were tested on vibrotactile patterns generated by letters of the alphabet. They seemed to warrant the adjective "extraordinary" because they were able to discriminate between pairs of patterns when other O's could not, because they could readily recognize patterns when other O's could not, and because they could read at high rates through their fingertips when other O's could not.

The device used to generate the vibrotactile patterns is the Optacon (*1*), a reading aid for the blind that converts