# Fluctuating Dermatoglyphic Asymmetry and the Genetics of Liability to Schizophrenia

## Therese Ann Markow and Kevin Wandler

**Abstract.** Schizophrenic subjects were compared to normal and psychiatric control subjects for degree of fluctuating asymmetry in two dermatoglyphic traits, a-b ridge count and fingertip pattern. The schizophrenic group exhibited significantly greater fluctuating asymmetry than either control group. Furthermore, indicators of disease severity such as early onset and declining course of illness correlated with degree of asymmetry. Both of these observations are expected if a disorder has a polygenic basis, since fluctuating asymmetry is a marker of polygenic inheritance.

**Key Words.** Schizophrenia, genetics, fluctuating asymmetry, liability.

In a bilaterally symmetrical organism such as man, each half of the body tends to develop as a mirror image of the other. One exception that may occur is called "fluctuating asymmetry." Fluctuating asymmetry is a nondirectional, random asymmetry that may occur for any measurable bilateral feature of an organism such as length of arms or size of feet. Fluctuating asymmetry therefore differs from those directional asymmetries found in all members of a species such as number of lobes in the right or left lung in man.

Fluctuating asymmetry occurs when, during the development of an organism, environmental factors interfere with the ability of that organism to execute its developmental program the same way in both sides. Some individuals are better able than others to buffer these environmental interferences during development. Buffering ability is dependent upon an individual's genotype, in particular, the relative number of heterozygous loci (Lerner, 1954; Waddington, 1957). Heterozygous individuals develop more smoothly than homozygotes because they are better able to buffer a range of environmental interferences. The consequence is that high levels of heterozygosity are associated with higher degrees of bilateral symmetry, while homozygosity results in fluctuating asymmetry or increased bilateral differences. This association has been empirically demonstrated in experimental organisms such as *Drosophila* and the house mouse (Tebb and Thoday, 1954; Reeve, 1960; VanValen, 1962; Bader, 1965).

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Therese Ann Markow, Ph.D., is Associate Research Professor, Department of Zoology, Arizona State University, Tempe, AZ. Kevin Wandler, M.D., is Medical Director, Drug and Alcohol Dependency Department, Cigna Health Plan, Phoenix, AZ. (Reprint requests to Dr. T.A. Markow, Dept. of Zoology, Arizona State University, Tempe, AZ 85287, USA.)

In humans, a number of congenital defects are hypothesized to be under the control of multiple genetic factors acting additively. A certain number of alleles are required to reach a threshold at which the trait is expressed. When the threshold for expression is reached, the individual is expected to be homozygous for factors at a number of the loci responsible for causing the trait. This homozygosity should result in a higher fluctuating asymmetry for unrelated bilateral traits as well as produce the congenital defect in question.

This expectation has been tested for morphological congenital defects such as cleft lip with or without cleft palate [CL(P)]. Adams and Niswander (1967) demonstrated that individuals exhibiting the polygenic form of cleft lip, CL(P), showed greater bilateral asymmetry for dental features and for dermatoglyphic traits than normal individuals. Furthermore, fluctuating asymmetry is higher in the normal relatives of CL(P) patients, suggesting a higher concentration of the responsible polygenes in these families (Woolf and Gianas, 1976, 1977).

Schizophrenia has been shown to have a familial basis (Gottesman and Shields, 1982), but the exact nature of its transmission has yet to be elucidated (Matthysse and Kidd, 1976). A review of all family studies supports a model of multifactorial inheritance with threshold similiar to CL(P) (McGue et al., 1983).

Below we describe a study of fluctuating asymmetry for two dermatoglyphic traits, a-b ridge count and fingertip pattern, in a group of schizophrenic patients and two control groups. Our study was undertaken to test the prediction that if schizophrenia has a multifactorial basis, schizophrenic patients will be characterized by increased fluctuating asymmetry.

## Methods

**Subjects.** A group of 81 patients with the *DSM-III* (American Psychiatric Association, 1980) diagnosis of schizophrenia were identified through Maricopa Medical Center, Phoenix, Arizona. The majority were of paranoid or undifferentiated type. Before inclusion in the sample, patients were also evaluated according to the Flexible Criteria of Carpenter et al. (1973), and only those individuals meeting $\geqslant 4$ criteria were studied. Bilateral symmetry was also measured in two control groups. The first was a population consisting of 49 individuals with a *DSM-III* diagnosis of affective disorder, under treatment at Maricopa Medical Center. The affective group contained a majority of individuals with a bipolar diagnosis but included all forms of affective psychoses. The second control group consisted of 69 faculty and staff at Arizona State University and staff at Maricopa Medical Center. Finally, during the course of the investigation, we obtained prints on a smaller number of patients with a diagnosis of schizoaffective disorder. These patients met the diagnostic criteria for both schizophrenia and affective disorders, and a differential diagnosis with any degree of certainty was not possible.

**Dermatoglyphics.** Dermatoglyphic traits were selected for detection of bilateral asymmetry because of the ease with which permanent prints are obtained and because of the fact that they do not change after birth. Permanent handprints were created according to the technique of Aase and Lyons (1971). Two different measures were made from the prints of the right and left hands. The first was the a-b ridge count (Cummins and Midlo, 1943). This measure was obtained by counting all the ridges touching a straight line between the a and b triradii (excluding nascent ridges and triradial points). The difference between a-b ridge counts of the right and left hands of each individual was determined. Intrapair variances of schizophrenics and controls were compared by an $F$ test. The significance of the difference between groups was determined by the Student Newman-Keuls multiple range test for unequal samples (Sokal and

Rolf, 1969). Second, we classified the fingerprints of each individual into one of three groups: loops, arches, and whorls (Cummins and Midlo, 1943). Paired digits were compared for the presence of symmetry. Each individual was assigned a score ranging from 0 to 5 depending on the number of dissimilar digits. An individual showing no dissimilarities for any of the five paired digits received a score of 0. Asymmetry was analyzed by analysis of variance and the Student Newman-Keuls multiple range test for unequal samples.

## Results

The mean number of ridges between the a and b triradii was not significantly different between the right and left hands (Table 1). Table 2 presents the mean intrapair variances for a-b ridge counts of schizophrenics and controls. The multiple range test places schizophrenics in a different subset from the affective patients and the normal controls. The affective patients and controls did not differ in ridge count asymmetry. Mean dissimilarities for fingertip patterns appear in Table 3. Significantly greater dissimilarities are seen in schizophrenics. Again, the affective and normal groups do not differ. Schizoaffective patients overlap with schizophrenic patients and controls.

**Table 1. Mean ab ridge counts on right and left hands of psychiatric patients and controls**

| Groups | Right mean | SD | Left mean | SD | n |
|---|---|---|---|---|---|
| Control | 41.67 | 5.29 | 42.59 | 5.51 | 69 |
| Affective | 43.02 | 5.21 | 43.37 | 5.21 | 49 |
| Schizoaffective | 42.00 | 6.31 | 43.15 | 7.19 | 14 |
| Schizophrenic | 41.10 | 7.17 | 42.34 | 6.71 | 81 |

**Table 2. Mean ab ridge count differences between the right and left hands of psychiatric patients and controls[1]**

| Group | n | Mean | SD | Subset[2] |
|---|---|---|---|---|
| Control | 69 | 2.55 | 2.11 | a |
| Affective | 49 | 2.78 | 2.26 | a |
| Schizoaffective | 14 | 3.15 | 2.66 | a, b |
| Schizophrenic | 81 | 4.21 | 2.92 | b |

1. $F = 5.96$, $df = 2$, $p < 0.01$.
2. Student Newman Keuls multiple range for unequal samples at $\alpha = 0.05$.

**Table 3. Mean number of differences in fingertip patterns between the right and left hands of psychiatric patients and controls[1]**

| Group | n | Mean | SD | Subset[2] |
|---|---|---|---|---|
| Control | 69 | 1.130 | 0.85 | a |
| Affective | 49 | 1.310 | 1.02 | a |
| Schizoaffective | 14 | 1.371 | 1.06 | a, b |
| Schizophrenic | 81 | 1.538 | 1.14 | b |

1. $F = 4.02$, $df = 2$, $p < 0.05$.
2. Student Newman-Keuls multiple range test for unequal samples at $\alpha = 0.05$.

If schizophrenia does, in fact, have a multifactorial basis as our data suggest, two other predictions can be made, both of which concern the severity of the disorder. Individuals with the greatest number of genetic factors are expected to exhibit more severe forms of the trait as well as more severe asymmetry. For schizophrenia, one measure of severity or degree of predisposition should be age of onset. Individuals having the greatest genetic liability are expected to show symptoms earlier. Another measure of severity is the actual cause of the illness. We obtained information on both of these variables from patient charts to assess the correlations between the degree of asymmetry for a-b ridge count and quantitative measures of severity of the disorder.

It was not possible to determine the ages at which patients first displayed aberrant behavior, but it was possible in most cases to obtain the age at which first hospitalization occurred. Asymmetry for a-b ridge count in schizophrenics was inversely correlated with age at first hospitalization ($r$ = -0.281, $p$ = 0.02). Individuals who were younger when first hospitalized tended to be more asymmetrical for a-b ridge count. For the affective group, there was an absence of any correlation between a-b ridge asymmetry and early age at first hospitalization ($r$ = 0.25, $p$ = 0.08).

We also devised a 3-point scale for classifying course of illness. One of us (K.W.) performed a blind rating of course of illness by chart review. A score of 1 indicated recurrent acute episodes with fair adjustment in between. A score of 2 was assigned to patients showing chronic marginal adjustment with recurrent exacerbations. Patients with long-term progressive deterioration received a score of 3. The mean asymmetries for schizophrenic patients with scores of 1, 2, and 3 were 2.87, 3.56, and 6.67, respectively ($F$ = 5.54, $df$ = 2, $p$ = 0.006), showing a strong relationship between declining course of illness and greater fluctuating asymmetry. The mean asymmetries for affective disorder patients with course of illness scores of 1, 2, and 3 were 2.64, 1.89, and 2.91, respectively ($F$ = 1.22, $df$ = 2, NS). Because the sample of schizoaffective patients was small, correlations of asymmetry and severity were not attempted.

## Discussion

The mean a-b ridge counts in our sample are similar to those reported by other investigators (Darlu and Iagolnitzer, 1984). The absence of any significant directional right-left differences is important evidence that the differences observed represent fluctuating rather than directional asymmetry. Schizophrenics are clearly characterized by significantly greater fluctuating asymmetry than either control group. This observation is expected if liability to schizophrenia has a polygenic basis and if affective disorders are influenced by a single major locus.

We are aware that the age at first hospitalization may be somewhat later than the actual age of onset for the disorder, and we are also aware that the scale for course of illness is only as accurate as the available records for each of the patients. However, we still feel that the correlations provide additional support for a multifactorial basis for liability to schizophrenia, although the possible action of a major effect locus and polygenic modifiers still cannot be ruled out.

Different models have been proposed to account for the familial component in liability for unipolar and bipolar illnesses, including some monogenic and polygenic hypotheses. Some researchers have investigated the possible distinction of these two

forms genetically (Tsuang et al., 1985). The observation that with respect to asymmetry, patients with affective disorders are grouped with normal controls can be interpreted as arguing against a multifactorial basis. In addition, the correlational data do not provide any basis for linking the genetics of schizophrenia with affective disorders.

Literature can be cited to support the inclusion of schizoaffective disorder as a form of schizophrenia, a form of affective disorder, or a heterogeneous entity (Tsuang and Loyd, 1985). Interestingly, the mean a-b ridge asymmetry and fingertip asymmetry of schizoaffective patients both fall in between the values for schizophrenics and normal controls. A larger sample would be necessary for more meaningful analysis and conclusions about the nature of this disorder.

Measurement of fluctuating asymmetry holds promise as a tool for discriminating between disorders on the basis of genetic etiology. The minor differences in finger pattern frequencies previously suggested for schizophrenics are not attributable to any particular genetic causality (Slater and Shields, 1953; Singh, 1967). While the present study supports a polygenic model for liability to schizophrenia, it does not rule out the possibility of genetic heterogeneity. Schizophrenia is sufficiently complex to be accounted for by more than one model. Future resolution of different subtypes biologically may be facilitated by examining fluctuating asymmetry in groups of schizophrenic patients that differ by some diagnostic criteria or by family history. We are currently pursuing this problem.

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