Jamaican Symmetry Project: Long-Term Study of Fluctuating Asymmetry in Rural Jamaican Children

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Abstract Fluctuating asymmetry, small deviations from perfect bilateral symmetry, is negatively correlated with health and positively correlated with sexual selection in human adults, but the accumulation, persistence, and fitness implications of asymmetries during childhood are largely unknown. Here, we introduce the Jamaican Symmetry Project, a long-term study of fluctuating asymmetry and its physical and behavioral correlates in rural Jamaican children. The project is based on an initial sample of 285 children (156 boys and 129 girls), aged 5 to 11 years. We describe the design of the project and the methodology of measuring 10 paired morphometric traits. All traits except hand width showed fluctuating asymmetry. Fluctuating asymmetries of the legs tended to be related and were less than half as great as fluctuating asymmetries of the arms and ears. Therefore the legs may show high developmental stability resulting from selection for mechanical efficiency. A fluctuating asymmetry composite score revealed that boys have significantly lower fluctuating asymmetry than girls and that this effect resides mainly in the elbows. There were significant positive relationships between composite fluctuating asymmetry and age, height, and weight, but multiple regression analyses showed that age was negatively related to fluctuating asymmetry, whereas body size was positively correlated. These findings are compared with results from recent English studies.

An individual's degree of fluctuating asymmetry is emerging as a major variable in the study of human behavioral biology, with high symmetry showing numerous positive correlations with health, physical and mental performance, and attractiveness to members of the opposite sex [for a general review see

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Moller and Swaddle (1997)]. Fluctuating asymmetry refers to small deviations from perfect bilateral symmetry that fluctuate randomly left to right across a population and tend to cancel out to give perfect symmetry for the population itself. Fluctuating asymmetry is 1 measure of an important component of fitness, developmental stability (Van Valen 1962). Fluctuating asymmetry is sensitive to stress during development and genetic inability to compensate for stress, so degree of fluctuating asymmetry measures ability to achieve not just 1 desired phenotypic state, namely, perfect bilateral symmetry, but in principle many other desired phenotypic states as well [reviewed by Moller and Swaddle (1997)]. How developmentally stable is the genetic program? Fluctuating asymmetry gives both a specific and a general answer.

Bilaterally symmetric animals such as humans have a growth trajectory that appears to be designed to result in near symmetry in most paired morphological traits, such as ear size, digit length, knee width, and foot size. Indeed, we achieve symmetry to within roughly 1 part in 100, and humans are most symmetric in early adulthood, a time at which many measures of biological function reach a maximum. Perfect execution of this developmental plan is rendered more difficult as a result of stresses, which may be environmental [e.g., temperature stress (Parsons 1992), chemical stress (Hoffmann and Parsons 1989), and habitat destruction (Manning and Chamberlain 1994)] or genetic [e.g., inbreeding (Mather 1953; Thoday 1955) and harmful mutations (McKenzie and Clarke 1988)] [for a review see Moller and Swaddle (1997)].

In humans fluctuating asymmetry has been shown to be related to age (Wilson and Manning 1996), body weight (Manning 1995), metabolic rate (Manning, Koukourakis et al. 1997), running speed (Manning and Pickup 1998), intellectual performance (Furlow et al. 1997), and predisposition to breast cancer (Scutt et al. 1997) and other harmful conditions [see Thornhill and Moller (1997) for a review]. Many of the paired traits measured in these studies, such as ears, digit length, and breast size, have an important soft tissue component, and such traits may be subject to changes in size and symmetry, for example, during the menstrual cycle of women (Manning et al. 1996; Scutt and Manning 1996). Symmetry may therefore indicate hormonal status in relation to soft tissue and developmental stability in the skeleton.

Not surprisingly, fluctuating asymmetry is strongly related to sexual selection in humans. Men with symmetric bodies and faces are perceived by women as more attractive than men with higher asymmetry. Compared to men with high fluctuating asymmetry, symmetric men have higher facial attractiveness, more lifetime sexual partners, more extra-pair copulations, and earlier sexual experience, and their partners report more copulatory orgasms (Gangestad et al. 1994; Thornhill and Gangestad 1994; Thornhill et al. 1995; Gangestad and Thornhill, 1997a,b). In women breast symmetry is positively related to perceptions of attractiveness and men's interests in short- and long-term relationships (Singh 1995) and to increased probability of marriage (Manning et al. 1996). Lifetime reproductive success has also been found to be positively related to breast symmetry in Spain, the United States, and England (Moller et al. 1995; Manning et al. 1997). It is striking that women are at their most symmetric at the time of ovulation (Scutt and Manning 1996) and show then their strongest bias in favor of the smell of symmetric men (Gangestad and Thornhill 1998b). In men (and boys) more symmetric individuals are more aggressive (Manning and Wood 1998; Furlow et al. 1998).

There are much less data available concerning the patterns of fluctuating asymmetry and their selective consequences in children. Rapid growth and high metabolic rates in children may make the homeostasis of fluctuating asymmetry difficult. Livshits and Kobyliansky (1989) showed that Israeli infants (<73 hours old) had higher fluctuating asymmetry than children (5–18 years old) and that adults (26–42 years old) showed the lowest fluctuating asymmetry. Wilson and Manning (1996) measured body and facial fluctuating asymmetry in 680 English children aged 2 to 18 years [40 subjects (20 boys and 20 girls) per year group]. They found strong negative relationships between both absolute and relative fluctuating asymmetry and age. This overall reduction in asymmetry with age was interrupted by an increase between the ages of 12 and 15 years, and then the decline was resumed. Another study of 6000 Polish children showed a similar change in asymmetry of joint movement, hand strength, and the height of shoulders and pelvis during puberty but not in the earlier 2–11-year-old group (Wolanski 1972). The disparity between the Israeli and English data on the one hand and the Polish results on the other hand may arise from the different traits being measured.

Further comparative studies are needed to determine patterns of fluctuating asymmetry where growth rates and age at maturity vary between societies. Cross-sectional studies of children are helpful but are not as reliable as longitudinal data. We do not know whether the fluctuating asymmetry of a child of, say, 2 years of age relates to his or her fluctuating asymmetry at, say, 16 years. Nor do we know the importance of factors such as resting metabolic rate and growth rate in the determination of fluctuating asymmetry. Furthermore, fluctuating asymmetry may be important to a child because parental investment patterns may be positively related to the symmetry of children. The Jamaican Symmetry Project was set up to answer these and related questions. The project is a long-term study of fluctuating asymmetry in a rural population of children drawn from Southfield in the parish of St. Elizabeth, Jamaica.

This initial report describes the design of the study, the study population, the measurement methodologies for the 10 morphological traits, the statistical properties of the asymmetries, variation across the traits in degree of fluctuating asymmetry, and the children's overall fluctuating asymmetry in relation to sex, age, height, and weight.

Project Design

Because it seemed clear to us that fluctuating asymmetry was likely to emerge as a major variable, we thought it wise to invest in a long-term study of fluctuating asymmetry and its correlates in humans, preferably beginning with children in a relatively natural, well-defined population with little outmigration. By remeasuring fluctuating asymmetry at regular intervals (e.g., every 3–5 years), we could get the developmental trajectory of fluctuating asymmetry over time. Simultaneous remeasurement of variables such as height, weight, waist to hip ratio, academic performance, and various physical skills would permit correlations over the life cycle to be studied between these variables and fluctuating asymmetry. Many additional variables also can be measured (e.g., dancing ability, attractiveness, number of friends, aggressiveness), and findings in other populations (e.g., that British women with more symmetric ears are more likely to cradle their babies on the left side) can always be tested against the Jamaican database (Jamaican girls with more symmetric ears are, indeed, more likely to cradle dolls on the left side; Manning, Trivers et al. 1997). Finally, life outcomes, such as level of educational attainment and reproductive history, can be tracked as a function of fluctuating asymmetry.

Elementary school children are the youngest group for which it is easy to assemble large numbers for initial measurement and repeated restudy. Permission to do this kind of research in the United States is difficult to obtain. By contrast, permission for a long-term project was readily obtained in the Southfield district of the parish of St. Elizabeth in Jamaica, partly through years of residence in the community (R. Trivers) and partly through the foresight of the principal of Top Hill Primary School, Vernon Cameron. Even then, the 1 private school in the area, Munro Preparatory School, did not give us permission to measure any children (we sought to measure 20). (We estimate that less than 5% of the children in the Southfield area attend Munro.) A policy of paying modest sums (about $10 per individual) whenever participation of a child or a mother is desired has helped ensure high rates of participation at Top Hill Primary School (97% or more of those children were permitted to participate).

Because the fluctuating asymmetries we are measuring are about 2 orders of magnitude smaller than the traits being measured, we thought it wise to minimize measurement error by (1) using experienced measurers to take the caliper measurements (J.T. Manning, R. Thornhill, D. Singh), (2) measuring every variable twice, and (3) wherever possible, making permanent records from which numerous variables could later be measured and remeasured (dental casts, x-rays of hand bones, finger and palm prints, and facial photos). We failed in only 1 of these aims: Most of the facial photos are not fully frontal and hence are useless for calculations of fluctuating asymmetry.

Materials and Methods

Our sample is composed of 285 children (156 boys and 129 girls) recruited primarily from Top Hill Primary School but also from Mayfield All-Age and Epping Forest All-Age schools. We made an effort to measure all children attending Top Hill and succeeded in measuring 242 out of a total enrollment of 258 (only 4 children were refused permission to participate by their parents). The intake of these schools consists of children aged 5 to 11 years. Our first measurements were made in January 1996.

Fluctuating asymmetries were measured from paired morphological traits such as digit length and wrist width, dermatoglyphic fluctuating asymmetry, dental fluctuating asymmetry from casts, skeletal fluctuating asymmetry from x-rays of the hands, and facial fluctuating asymmetry from photographs. We report here results from the morphological traits. Nine paired traits were measured using vernier callipers recording to 0.01 mm: (1–3) length of the 3d, 4th, and 5th digits from the basal crease on the ventral surface of the hand to the tip of the digit; (4) ear size from the anterior to the posterior tip of the pinna; (5) elbow width; (6) wrist diameter; (7) hand width; (8) knee width; and (9) ankle width. A 10th trait, foot length, was measured to the nearest millimeter using a tape measure. To establish repeatability levels, we measured all traits twice and mean fluctuating asymmetries were calculated for each trait. Repeatability of measurements of these traits is known to be high (Manning 1995; Wilson and Manning 1996; Furlow et al. 1997). Absolute fluctuating asymmetries were calculated by subtracting the length of the right side of the trait from that of the left (L − R). Fluctuating asymmetries were also corrected for trait size (Palmer and Strobeck 1986) by calculating relative fluctuating asymmetry [(L − R)/0.5(L + R)].

Results

Means and standard deviations of age, height, and weight in our sample were as follows: boys, 8.16 ± 1.66 years, 130.24 ± 9.66 cm, and 26.35 ± 6.12 kg; girls, 8.17 ± 1.83 years, 129.86 ± 11.18 cm, and 25.56 ± 6.41 kg.

Repeatabilities (r_1) or intraclass correlation coefficients of the signed fluctuating asymmetries were calculated using model 2 single factor analysis of variance (ANOVA) tests:

$$r_1 = \frac{\text{group mean squares} - \text{error mean squares}}{\text{group mean squares} + \text{error mean squares}}. \qquad (1)$$

r_1 varied from 0.47 for wrists to 0.79 for ears (see Table 1). We tested our repeatabilities with repeated-measures ANOVA tests (Palmer and Strobeck 1986). This gives the ratio (F) of between-subject variance (i.e., the real differences between individuals) to our repeated-measures variance (i.e., the

Table 1. Repeatability (r_1) of Signed Fluctuating Asymmetries and Results of Repeated-Measures ANOVA Tests[a]

Trait	r_1	*F*	*p*	*n*
3d digit	0.70	5.69	0.0001	283
4th digit	0.71	5.81	0.0001	283
5th digit	0.76	7.26	0.0001	283
Ears	0.79	8.33	0.0001	283
Elbow	0.75	7.14	0.0001	281
Wrist	0.47	2.77	0.0001	281
Hand	0.62	4.31	0.0001	281
Knee	0.66	4.88	0.0001	271
Ankle	0.60	3.98	0.0001	271
Foot	0.67	5.07	0.0001	271

a. All traits showed significantly higher between-individual variance than within-individual (measurement error) variance.

measurement error). All traits showed significantly higher between-subject variance compared with our repeated measurements (Table 1). We concluded that the fluctuating asymmetries reflect real differences between our subjects. We therefore calculated mean fluctuating asymmetries from our repeated measurements.

Ideal signed fluctuating asymmetries have a mean of 0 and are normally distributed (Van Valen 1962). We tested the mean with *t* tests, with the mean set at 0, and we tested the distribution with tests of skewness and kurtosis (Palmer and Strobeck 1986; see Table 2). Considering first the results of the 1-sample *t* tests and tests for skewness, we found significant deviations from 0 for the signed asymmetries of the 3d digit, ear, elbow, hand, knee, and ankle and an indication of significant skewness in the 3d digit, 5th digit, elbow, knee, and ankle. Small deviations from a mean of 0 may be significant in large samples, but we do not think this indicates directional asymmetry in any biologically meaningful way. For example, 3d digit and/or ear signed asymmetry in some large samples [$n = 828$ from Livshits and Kobyliansky (1989); $n = 680$ from Wilson and Manning (1996); $n > 700$ from Furlow et al. (1997)] has failed to reveal significant deviations from 0, whereas other traits such as elbow width show evidence of directional asymmetry in some large samples but not in other samples taken from the same population (Livshits and Kobyliansky 1989). Consideration of large samples ($n > 700$) led Furlow et al. (1997) to suggest that the traits we have used, with the exception of hand width, do not show consistent directional asymmetry or skewness and therefore are suitable for analysis of fluctuating asymmetry. We therefore follow their advice and use in our analyses all traits with the exception of hand width. All traits showed leptokurtosis, as expected; that is, there was no evidence of antisymmetry (Van Valen 1962). Leptokurtosis was

Table 2. Mean Signed Fluctuating Asymmetries of 10 Traits and Results of 1-Sample *t* Tests with Mean Set at 0

Trait	*Mean Fluctuating Asymmetry*	*t*	*p*	*Skewness*	*Skewness p*	*Kurtosis*	*Kurtosis p*
3d digit	0.31	3.90	0.0001	0.30	0.04	1.35	0.001
4th digit	0.08	1.01	0.31	0.25	0.08	1.27	0.001
5th digit	−0.004	0.05	0.96	0.38	0.01	2.08	0.001
Ears	−0.35	4.92	0.0001	0.04	0.76	1.77	0.07
Elbow	1.71	21.20	0.0001	1.84	0.001	11.83	0.001
Wrist	0.06	0.97	0.33	0.002	0.96	0.16	0.59
Hand	−0.66	7.99	0.0001	0.08	0.58	0.71	0.01
Knee	−0.09	1.67	0.10	−2.50	0.001	15.55	0.001
Ankle	−0.16	3.80	0.0002	−1.47	0.001	7.53	0.001
Foot	0.06	0.96	0.34	−0.26	0.08	5.04	0.001

significant for the 3d, 4th, and 5th digits, hand, knee, ankle, and foot. Leung and Forbes (1997) argued that leptokurtosis arises as a result of developmental stability and indicates fluctuating asymmetry. Therefore we have used all traits, except hand width, in our analyses.

We used unsigned asymmetries, which have a half-normal distribution; summing fluctuating asymmetries tends to make the resulting unsigned composite fluctuating asymmetry normally distributed. Gangestad and Thornhill (1998a) argued that parametric statistics are sufficiently robust for departures from normality to be used in the analysis of fluctuating asymmetry. Therefore we have used parametric statistics in all our analyses.

There were no strong associations between unsigned fluctuating asymmetries of different traits. Correlation coefficients between trait fluctuating asymmetries varied between $r = 0.007$ (hand and knee) to $r = 0.21$ (knee and foot). However, a principal components analysis of all trait asymmetries did identify some trait groupings. Five factors accounted for 61% of the variance (factor 1, 15%; factor 2, 13%; factor 3, 12%; factor 4, 11%; factor 5, 10%). The orthogonal transformation solution showed that fluctuating asymmetries of the leg were correlated with factor 1 (knee $r = 0.66$, ankle $r = 0.68$, foot $r = 0.64$), those of the 3d digit, hand, and wrist were correlated with factor 2 (3d digit $r = 0.73$, hand $r = 0.55$, wrist $r = 0.64$), whereas ears ($r = 0.88$, factor 3), 4th digit ($r = 0.88$, factor 4), and 5th digit ($r = 0.84$, factor 5) were not related to other traits.

Mean relative fluctuating asymmetries and their standard deviations are shown in Table 3 together with mean relative fluctuating asymmetries of 6 comparable traits from the English study of Wilson and Manning (1996). Upper body fluctuating asymmetries varied from 0.018 for ears and 4th digit to 0.035 for elbow. These values were less than the means of comparable traits in the English study for 4 traits (3d, 4th, and 5th digits and ears) and

Table 3. Mean Relative Fluctuating Asymmetries and Their Standard Deviations for Jamaican Data and a Sample of English Children (n = 320, 160 boys and 160 girls) with the Same Age Range (5–12 Years)

Trait	*Jamaican Data*	*English Data (Wilson and Manning 1996)*
3d digit	0.017 ± 0.014	0.022 ± 0.002
4th digit	0.018 ± 0.016	0.025 ± 0.019
5th digit	0.023 ± 0.021	0.039 ± 0.032
Ears	0.018 ± 0.015	0.026 ± 0.019
Wrist	0.019 ± 0.015	0.017 ± 0.013
Hand	0.02 ± 0.014	0.02 ± 0.016
Elbow	0.035 ± 0.025	
Knee	0.007 ± 0.009	
Ankle	0.008 ± 0.009	
Foot	0.008 ± 0.010	
Mean composite fluctuating asymmetry	0.017 ± 0.005	0.025 ± 0.009

the same for 1 trait (hand). Lower body fluctuating asymmetries in the Jamaican sample were noticeably small, ranging from 0.007 for knees to 0.008 for ankles and feet. Leg fluctuating asymmetries were not measured in the English sample.

Summing fluctuating asymmetries over a number of traits sums the information in those traits. Correlations between fluctuating asymmetry and such traits as running speed (Manning and Ockenden 1994), body weight (Manning 1995), and age (Wilson and Manning 1996) are often higher for composite fluctuating asymmetries than single trait asymmetries. Therefore we summed relative fluctuating asymmetries for all traits except hand width. Mean composite fluctuating asymmetry was 0.017 ± 0.005 (Table 3). Because there was evidence of grouping of leg fluctuating asymmetries, we summed relative fluctuating asymmetries for knees, ankles, and feet. Mean composite leg fluctuating asymmetry was 0.008 ± 0.006. Composite fluctuating asymmetry for ears plus arm traits (except hand width) had a mean of 0.022 ± 0.007. The difference in means between these 2 sets of traits was significant (paired t test, arms-legs = 0.014, $t = 23.36$, $p = 0.0001$).

Fluctuating asymmetry showed significant differences between the sexes. Mean composite fluctuating asymmetry was less for boys than for girls (boys $x = 0.017 \pm 0.005$, girls $x = 0.018 \pm 0.005$, $t = 2.684$, $p = 0.008$). Table 4 shows that the sex differences in composite fluctuating asymmetry depend on elbows and to a lesser extent on the 4th digit. A similar sex difference was reported in the English sample of children, but this difference was not significant (Wilson and Manning 1996).

Age, height, and weight were all positively associated with composite fluctuating asymmetry (age, $r = 0.19$, $p = 0.002$; height, $r = 0.22$, $p = 0.0005$; weight, $r = 0.23$, $p = 0.005$; Figure 1), and there were no noticeable sex differences in these relationships (age, boys $r = 0.17$, $p = 0.047$, girls $r = 0.21$, $p = 0.02$; height, boys $r = 0.28$, $p = 0.001$, girls $r = 0.17$, $p = 0.07$; weight, boys $r = 0.26$, $p = 0.003$, girls $r = 0.21$, $p = 0.027$). The positive association between fluctuating asymmetry and age was surprising in view of the significant negative association between these variables reported in the English study (Wilson and Manning 1996). However, a multiple regression analysis with composite fluctuating asymmetry as the dependent variable and age, height, and weight as the independent variables showed that the positive relationship depends on height or weight and that age was negatively but nonsignificantly related to composite fluctuating asymmetry (Table 5). A further multiple regression analysis by sex indicated that this was particularly the case for boys, who showed a standardized coefficient of +0.42 for the association between height and composite fluctuating asymmetry and a standardized coefficient of −0.22 for the association between age and composite fluctuating asymmetry (Table 5).

Table 4. Sex Differences in Relative Fluctuating Asymmetries of Individual Traits and Composite Fluctuating Asymmetry

Trait	*Male Mean Fluctuating Asymmetry*	*Female Mean Fluctuating Asymmetry*	*t*	*p*
3d digit	0.017	0.017	0.29	0.77
4th digit	0.016	0.020	1.83	0.07
5th digit	0.023	0.024	0.20	0.84
Ears	0.017	0.019	1.37	0.17
Wrist	0.019	0.019	0.18	0.86
Elbow	0.031	0.039	2.90	0.004
Knee	0.006	0.007	0.44	0.66
Ankle	0.008	0.008	0.65	0.52
Foot	0.008	0.008	0.23	0.82
Composite fluctuating asymmetry	0.017	0.018	2.68	0.008

Discussion

The overall pattern of morphometric asymmetries in our Jamaican sample suggests 2 groups (upper and lower body traits) with differing developmental stabilities. The upper body traits have high fluctuating asymmetries, whereas the lower body traits have significantly lower asymmetries. This impression is reinforced by the groupings of trait fluctuating asymmetries revealed by principal components analysis. Such a difference could arise as a result of the mechanical demands on the legs. Small asymmetries may have

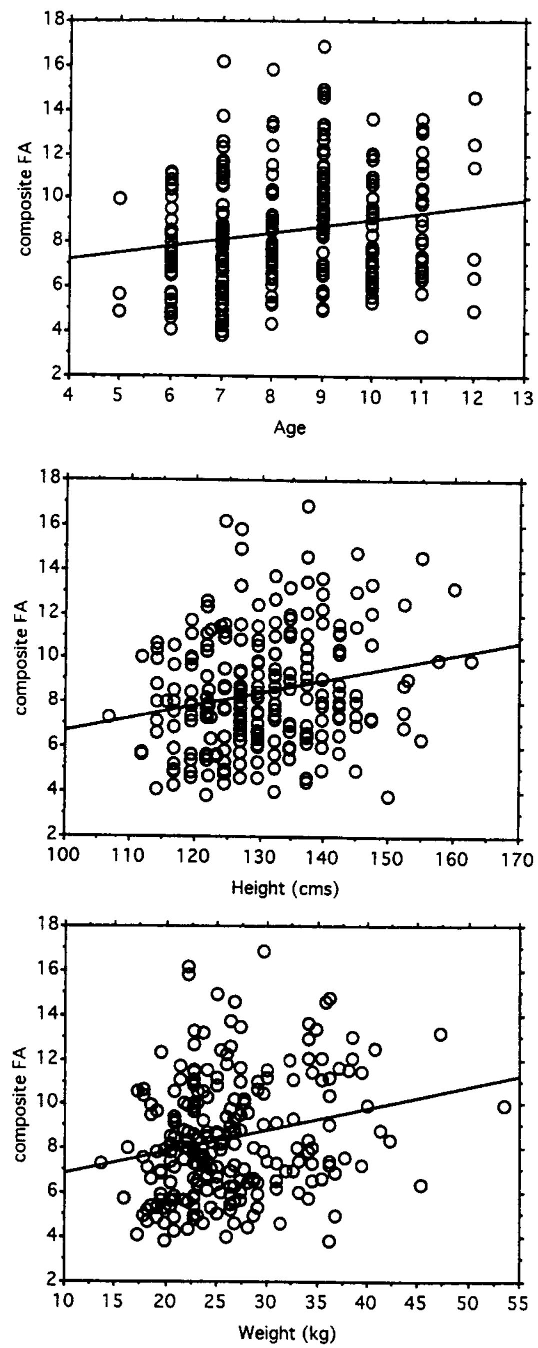

Figure 1. Simple linear regression of composite fluctuating asymmetry on children's age, height, and weight.

Table 5. Multiple Regression Analyses with Dependent Variable Composite Fluctuating Asymmetry and Independent Variables Age, Weight, and Height

Group	*Coefficient*	*Standardized Coefficient*	*t*	*p*
Both sexes				
Age	−0.042	−0.027	0.279	0.78
Height	0.032	0.124	0.827	0.41
Weight	0.060	0.142	1.049	0.30
Boys				
Age	−0.278	−0.175	1.302	0.20
Height	0.111	0.417	1.793	0.08
Weight	0.004	−0.009	0.046	0.96
Girls				
Age	0.155	0.106	0.728	0.47
Height	−0.025	−0.103	0.509	0.61
Weight	0.106	0.252	1.341	0.18

serious biomechanical consequences during running. The same strength of selection is unlikely to apply to such traits as ears and digits. This pattern is not apparent in Israeli data (Livshits and Kobyliansky 1989). However, in a sample of 167 English boys, aged 11 to 16 years, the mean composite relative fluctuating asymmetry for 4 upper body traits (3d, 4th, and 5th digits and ears) was significantly higher than mean relative fluctuating asymmetry of ankles (upper body fluctuating asymmetry $x = 0.028 \pm 0.02$, ankles $x = 0.013 \pm 0.01$, paired t test, $x\text{-}y = 0.015$, $t = 9.95$, $p = 0.0001$) (Manning and Wood, unpublished data, 1996).

There was a significant sex difference in the composite fluctuating asymmetries. Boys were more symmetric than girls. Much of this difference resided in the elbows and to a lesser extent the 4th digit. Livshits and Kobyliansky (1989) did not report a sex difference in their fluctuating asymmetries. The English study of Wilson and Manning (1996) reported higher fluctuating asymmetry in girls than in boys for all traits, but none showed significant differences. Further comparative work needs to be done before we can be sure that sex-dependent differences in children's fluctuating asymmetries are widespread.

Average fluctuating asymmetry for 6 traits was lower for our Jamaican children than for a comparable sample from Liverpool, England, with a similar age distribution. We have no idea why this is so, because we are comparing urban with rural, temperate with tropical, and an English sample of children with a Jamaican sample. The Jamaican children are a mixture of Africans (predominantly) and Europeans, with a small admixture of East Indians, Asians, and possibly Amerindians. They are probably more heterozygous than the English children, who are primarily European with small numbers of immigrants added, largely from Commonwealth countries. In general, heterozygosity and outbreeding are associated in many species with lower fluctuating asymmetry [see Moller and Swaddle (1997)]. So far as we know, there are no known systematic differences in fluctuating asymmetry between peoples located around the world, except that dermatoglyphic fluctuating asymmetry is consistently lower in African and African-derived populations than in Asian or European populations (Jantz and Webb 1982; Jantz 1979).

Age, height, and weight were all positively associated with fluctuating asymmetry. However, when the effect of body size was partialed out, age was negatively (but nonsignificantly) associated with fluctuating asymmetry. This finding is consistent with both the Israeli and the English studies (Livshits and Kobyliansky 1989; Wilson and Manning 1996). The relationships between age and metabolic rate and between growth and metabolic rate may explain our observations. A positive association between resting metabolic rate and fluctuating asymmetry has been shown in men but not in women (Manning, Koukourakis et al. 1997) and in prepubertal boys but not in prepubertal girls (Lewis et al., unpublished data, 1996). Wilson and Manning (1996) also pointed out that resting metabolic rate decreases with age in children in a form that is similar to the age-dependent reduction in fluctuating asymmetry. The interaction between age, height, and weight on the one hand and fluctuating asymmetry on the other may therefore arise because of the former traits' association with resting metabolic rate. At any 1 age fast-growing and therefore large children may have high resting metabolic rates, whereas older children and therefore larger children will have reduced metabolic rate with an associated reduction in fluctuating asymmetry. Disentangling the effects of age and body size on asymmetry should leave a negative association between age and fluctuating asymmetry and a positive correlation between body size and fluctuating asymmetry.

We have described our Jamaican study population and the patterns of some of their morphometric fluctuating asymmetries. Fluctuating asymmetry in children has behavioral correlates, for example, lateral cradling preferences in doll holding are related to ear asymmetry in girls but not in boys. Left-side cradling in girls is more common than right-side doll holding. The left-side cradlers were found to have more symmetric ears than the right-side cradlers (Manning, Trivers et al. 1997). Further reports will be concerned with fluctuating asymmetry and agressiveness, attractiveness, degree of handedness, dancing ability, waist to hip ratio, academic achievement, and numerous measures of physical skill, such as running and throwing. We will also report on correlations of fluctuating asymmetry with parental variables such as family size, economic status, and level of paternal investment.

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Brief Communications

Y-Chromosome DNA Haplotype 15 in Europe

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Abstract Haplotype 15 at 1 Y-chromosome-specific DNA polymorphism (p49/*Taq*I) was reported in a meta-analysis concerning 2418 males originating from 28 different geographic locations in Western Europe. The highest frequency of haplotype 15 (72.2%) was observed in French Basques, and it was previously deduced that this haplotype is the ancestral haplotype in Europe (Lucotte and Hazout 1996). Percentages of haplotype 15 geographic distribution show another high frequency in northwestern Europeans and a gradient of decreasing frequencies toward southeastern and peripheral countries. These results suggest that frequencies of haplotype 15 of the Y chromosome are useful to study the contribution of pre-Neolithic males to the present-day populations of Europe.

Variation in DNA sequences specific to the nonrecombinant part of the human Y chromosome are particularly interesting from an evolutionary point of view because it relates to paternal ancestry. The most informative probe for this objective is p49 (locus *DYS1*), which is able to identify some *Taq*I male-specific fragments, with the *A, B, C, D, F,* and *I* fragments being polymorphic between individuals (Lucotte and Ngo 1985). Sixteen main haplotypes at the *DYS1* locus (numbered 1–16) were identified in the first population study using the p49 probe (Ngo et al. 1986) on DNA samples of unrelated males living in Paris. Haplotype 15 (*A3,C1,D2,F1,I1*) was the most widespread haplotype (23%) in this initial study, and elevated frequencies of haplotype 15 were confirmed in other populations from Western Europe in later studies (Torroni et al. 1990; Spurdle and Jenkins 1992; Persichetti et al. 1992; Jobling 1994; Semino et al. 1996). This is the main reason that we study in the present

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