Original Article

Physique Correlates with Reproductive Success in an Archival Sample of Delinquent Youth

Jeremy E. C. Genovese, Cleveland State University, College of Education and Human Services. Cleveland, OH, USA  Email: j.genovese@csuohio.edu

Abstract: This study examines predictions from evolutionary psychology about relationships between physique and reproductive success using longitudinal data on 200 delinquent youth from Sheldon’s (1949) somatotype research. Number of children (offspring count) in 1979 was used as the measure of reproductive success. Nonparametric bootstrap correlations and confidence intervals were calculated between offspring count and 11 measures of physique (endomorphy, mesomorphy, ectomorphy, andromorphy, gynomorphy, primary structural integration, secondary structural integration, general strength, hand strength, height, and weight). There were noteworthy correlations with mesomorphy, andromorphy, gynomorphy, primary structural integration, secondary structural integration, general strength, and hand strength, all in the directions predicted by evolutionary psychology. While no prediction was made for endomorphy, ectomorphy, or weight; height was expected to be correlated with offspring count, but this study did not find support for this relationship.

Keywords: evolutionary psychology, reproductive success, somatotype, physique, Sheldon, William, H. (1898 - 1977).

Introduction

Constitutional psychology studies the relationship between human behavior and the structure of the human physique. Although constitutional psychology has folk antecedents stretching back to the ancient Greeks (Roback, 1952) scientific attempts to study the behavioral correlates of physique can be traced to the writings of Di-Giovanni (Roback, 1952), Pende (1928) and Kretschmer (1936/1970).

It was Sheldon (1940), however, who created the most comprehensive system of constitutional psychology. Sheldon believed that the human physique, or somatotype, consisted of three measurable components; endomorphy, mesomorphy, and ectomorphy. Endomorphy refers to the body’s fat component. Mesomorphy captures the muscularity of
Physique correlates with reproductive success

the body, while ectomorphy refers to linearity. While Sheldon often used the vocabulary of typology, it is important to note that this system is essentially metric and that all people are assigned values ranging from one to seven on all three morphologic components. Sheldon (1942) claimed to have found strong correlations between somatotype and human behavior. He posited three fundamental dimensions of temperament, each associated with a component of physique;

1. Visceratonia (associated with endomorphy) is characterized by lassitude, slow reaction to stimuli, and love of eating and physical comfort.
2. Somatotonia (associated with mesomorphy) is characterized by assertiveness, risk taking, aggressiveness, and indifference to pain.
3. Cerebrotonia (associated with ectomorphy) is characterized by physical and emotional restraint, fast reaction to stimuli, and social inhibition (Sheldon, 1942).

Table 1 shows the correlations between temperament and somatotype found by Sheldon (1942).

Table 1. Correlations between temperament and somatotype reported by Sheldon (p. 400, 1942)

|                | Endomorphy | Mesomorphy | Ectomorphy |
|----------------|------------|------------|------------|
| Viscerotonia   | .79        | -.23       | -.40       |
| Somatotonia    | -.29       | .82        | -.53       |
| Cerebrotonia   | -.32       | -.58       | .83        |

Note. All coefficients are significant at \( p < .01 \). N = 200.

However, these results were strongly criticized on methodological grounds. Sheldon’s early method of somatotyping, used in the 1942 study, involved a degree of subjective judgment (Carter and Heath, 1990; Cortés and Gatti, 1972; Parnell, 1958) and the ratings of temperament were made by the same researcher (Sheldon) who somatotyped the subjects. Sheldon fully acknowledged this latter point;

in attempting to define an individual in terms of so general a concept as a patterning of his static and dynamic components, we of course expose ourselves more or less recklessly to the danger of the halo error. Having once set up criteria for the measurement of ectomorphy, for example, and having established (or even suspected) the existence of a relationship between cerebrotonic and ectomorphy, it is admittedly difficult not to see cerebrotonic characteristics wherever ectomorphy is observed (Sheldon, 1942, p. 423, emphasis in the original).

Sheldon’s justification, “the strongest defense we can offer against the halo is simply the fact that we are well aware of its nature” (Sheldon, 1942, p. 424), seems unpersuasive. Thus, it was easy to explain Sheldon’s findings as an example of unconscious researcher bias. These methodological weaknesses, along with Sheldon’s penchant for making eccentric pronouncements, contributed to a general dismissal of constitutional psychology. This marginalization was compounded by the publicity surrounding the Ivy League posture photo scandal, where students were deceived into participating as subjects for nude somatotype photographs. Today it is not unusual to see constitutional psychology characterized as pseudoscience (Rafter, 2007; Rosenbuam, 1995).
Nevertheless, constitutional psychology can not be so easily dismissed. For example, there is now a large literature on the relationship between somatotype and a variety of health conditions, including hypertension and heart disease (Singh, 2007). Both Child (1950) and Cortés and Gatti (1965) tried to replicate Sheldon’s psychological findings using more objective somatotyping procedures and self-report measures of temperament. These results are shown in Tables 2 and 3.

| Table 2. Correlations between temperament and somatotype reported by Child (p. 447, 1950) |
|---------------------------------|---------------------------------|---------------------------------|
|                                  | Endomorphy | Mesomorphy | Ectomorphy |
| Viscerotonia                     | .13**      | .13**      | -.15**     |
| Somatotonia                      | .03        | .38**      | -.37**     |
| Cerebrotonia                     | -.03       | -.38**     | .27**      |

*Note. N = 400. **p < .01.*

| Table 3. Correlations between temperament and somatotype reported by Cortés and Gatti (p. 57, 1972) |
|---------------------------------|---------------------------------|---------------------------------|
|                                  | Endomorphy | Mesomorphy | Ectomorphy |
| Viscerotonia                     | .35**      |             |             |
| Somatotonia                      |             | .22*        |             |
| Cerebrotonia                     |             |             | .34***      |

*Note. *p < .05, **p < .01, ***p < .001. N = 114. Other values not reported.*

While the effect sizes were lower than those found by Sheldon, the pattern of correlations in these studies is essentially the same. There is now a substantial body of research showing weak to moderate correlations between somatotype and such variables as occupational interest (Deabler, Hartl, and Willis, 1975), academic performance (Parnell, 1958), temperament type (Peterson, Liivamagi, and Koskel, 2006), and susceptibility to hypnosis (Edmonston, 1977). Perhaps the most studied behavioral correlate of somatotype is the relationship between criminal behavior and mesomorphy (Cortés and Gatti, 1972; Glueck and Glueck, 1956). In a review of the research, Ellis and Walsh (2000) note that “to date, all studies have reported significant tendencies for delinquents and criminals to be more mesomorphic than persons in general” (p. 278).

These relationships demand an accounting. Lindzey (1967) suggested five possible categories of explanation:
1. Environmental factors that contribute to a particular physical trait may also contribute to a particular personality trait. Here Lindsey cites a study by Landauer and Whiting (1964) who used cross cultural evidence to suggest that infant stress and stimulus affect both stature and personality.
2. Physical structure may directly facilitate or limit behavior. To make this point Lindsey (1967) draws an example from athletics:
Physique correlates with reproductive success

Even the most dedicated and competitive 145-pound athlete cannot aspire realistically to play first-string tackle for a Big Ten university, nor is it likely that the 260-pound tackle could ever compete successfully in a marathon race or as an effective jockey (p. 230).

There is now a large body of research showing relationships between somatotype and type of athletic endeavor (e.g., Carter, Ackland, Kerr, and Stapff, 2005).

3. Early differences in physical attribute may give an individual slight advantage or disadvantage in certain behaviors. Through a process of reinforcement or punishment these slight differences will be magnified over time. This is often proposed as a social explanation for the behavioral correlates of somatotype. For example, Gibbons (1976) claimed that “fat delinquents and fat ballplayers are uncommon because social behavior involved in these cases puts fat, skinny, or sickly boys at a disadvantage. Following this line of reasoning the findings reflect the workings of social factors, not biology” (p. 74). However, as Cortés and Gatti (1972) noted, this argument actually makes the case for an interaction between social and biological factors.

4. Social expectations about physique might shape behavior. For example, the belief that the fat person is jolly may create a self-fulfilling prophecy effect. There is a long folk tradition of characterological and physiognomic claims (Fosbroke, 1914; Roback, 1952) that might still shape our expectations.

5. Common biological factors may shape both physique and behavior. For example, levels of thyroid hormone affect both brain and body development (Tanner, 1990) and high levels of androgen hormones may cause an individual to be both more aggressive and more mesomorphic (Ellis, Das, and Buker, 2008).

Lindzey (1967) pointed out that many psychologists found this last type of explanation “objectionable” (p. 231). An obvious objection is that physique is not static and seems to be influenced by environmental factors. Anecdotally, we know that there are 97 pound ectomorphs who transform themselves into muscular mesomorphs (Maedear, 1999). However, the great difficulty that people have losing and keeping off weight suggests that underlying biogenetic mechanisms may play a powerful role in the regulation of body morphology. Research on obesity shows a substantial genetic component (Grilo and Pouge-Geile, 1991; Stunkard, Harris, Pedersen, and McLearn, 1990), as do studies of the heritability of the three components of somatotype (Bouchard, 1997). Walker and Tanner (1980) found that somatotype ratings at age 8 were good predictors of rating at age 18.

Evolutionary Concerns

Sheldon was very interested in placing his model in an evolutionary framework. He argued that body morphology differences were rooted in proportion of tissue derived from the three germ layers formed during gastrulation and his three components of physique were each named for the one of the germ layers; endoderm, mesoderm, and ectoderm. For example, Sheldon argued that extreme endomorphs had expanded digestive viscera, derived from endoderm, and this explained both their greater body fat and greater appetite. It is true that there is great variation in the size of digestive organs. Williams (1975) noted “that some stomachs hold six or eight times as much as others” (p. 220), but this does not tell us if Sheldon’s embryological determinism is true. Lineage differentiation of the germ layers is an important process in evolution (Buchsbaum, Buchsbaum, Pearse, and Pearse, 1987;
Physique correlates with reproductive success

Tam, Kanai-Azuma, and Kanai, 2003), but it is far from clear that this explains individual differences in human somatotype. An alternative explanation might be that there are genes that affect both personality and eating or exercise behaviors. For example, a study by Yasuno et al. (2001) found that the number of dopamine D2 receptors sites in the amygdala was correlated with body mass index and with the personality trait harm avoidance. Such genetic variance could be under selective pressure and one can discuss the evolutionary forces that shape human physique without invoking Sheldon’s speculation about germ layers.

Evolutionary psychologists have been interested in the sexual selection of the human physique and have suggested that a number of physical traits may play a role in human mating and reproductive success. These traits include masculinity, somatotype, body symmetry, hirsuteness (Dixson, Halliwell, East, Wignarajah, and Anderson, 2003), and hand strength (Gallup, White, and Gallup, 2007). Height in males has also been identified as a physical characteristic associated with reproductive success (Pawlowski, Dunbar, and Lipowicz, 2000).

The evolutionary neuroandrogenic hypothesis (ENA), proposed by Ellis (2003), is an example of a model that links physique, behavior, and selection. Ellis suggested the ENA as an explanation for criminal and aggressive behavior. He explained its two central propositions:

one is concerned with the effects of testosterone on brain functioning, and how brains exposed to high testosterone are more prone toward criminal behavior. The other proposition offers an evolutionary explanation for most forms of criminality and for why testosterone affects brain functioning to enhance criminal behavior (p. 18)

Accordingly, “ENA theory asserts that males are more prone than females to victimize others due to the fact that male brains are exposed to higher levels of testosterone and other androgens throughout most of their lives” (Ellis, Das, and Buker, 2008). Ellis and his colleagues (2008) predicted that higher testosterone would be correlated with both aggressive behavior and “with masculine mannerisms, masculine body appearance, physical strength, strength of sex drive, low-deep voice, upper body strength, lower body strength, and amount of body hair” (p. 699). These predictions were confirmed in their study of 11,000 college students.

Female mate choice plays an important role in ENA theory (Ellis, 2005) and the model predicts that male mesomorphy, body hair, general strength, hand strength, and height should be correlated with greater reproductive success.

Other constitutional traits, besides muscularity, such as symmetry and hand strength might also serve as fitness indicators subject to sexual selection. For example, Miller (2000) argues that “for traits that normally grow symmetrically, like faces and breasts, the exact degree of symmetry can be a powerful indicator of developmental stability, which in turn is a major component of developmental fitness”(p. 229).

Hand strength could be an independent indicator of fitness or simply a byproduct of mesomorphy.

Most studies of human sexual selection have used attractiveness to the opposite sex as the dependent variable (e.g. Dixson, et al. 2003; Roney and Maestripieri, 2004). It has been more difficult to investigate actual reproductive success as an outcome variable, perhaps, because of the lack of relevant longitudinal data. Cross-sectional studies (e.g.
Davenport, 1923) are flawed because they do not control for age or cohorts effect. A 50 year old is more likely to have more children than a 20 year old. Social norms about appropriate family size may change over time (Damon and Thomas, 1967).

Research by Parnell (1958) suggested that there might be a relationship between male mesomorphy and number of children, but his results were not statistically significant. Parnell’s (1984) follow up study did not find a relationship between male somatotype and number of children. However, rather than measuring the three components of somatotype directly, Parnell asked 860 male Birmingham University students to classify their parent’s somatotype. They were given 18 sets of standard somatotype photographs, 9 male and 9 female, and were asked which somatotype most closely resembled their parents. Each parent was classified into one of 9 discrete somatotype categories and Parnell used a Chi Square procedure to see if there was a relationship between membership in the 9 categories and family size. Such a procedure could not directly test the relationship between each somatotype component and number of children.

This study tests the relationships between 11 measures of physique (endomorphy, mesomorphy, ectomorphy, andromorphy, gynomorphy, primary structural integration, secondary structural integration, general strength, hand strength, height, and weight) and reproductive success using longitudinal data from Sheldon’s somatotype research.

In 1939 Sheldon (1949) began a study of 200 adolescents living at the Charles Hayden Goodwill Inn, a shelter program for troubled boys where he served as director of the Youth Guidance Clinic. After the initial results were published in 1949, six follow up reviews were conducted (1958 – 1960, 1963-1964, 1970, 1973, 1975, 1979) and these findings were published in 1982 (Hartl, Monnelly, and Elderkin, 1982). While the researchers recorded the number of children each participant fathered, they did not consider this as an outcome variable. Number of children provides a real world measure of reproductive success. The purpose of this study is to investigate the relationship between somatotype and other measures of physical constitution and number of children in this longitudinal data set.

**Materials and Methods**

**Data**

There are two published sources for the data; *Varieties of Delinquent Youth: An Introduction to Constitutional Psychiatry* (Sheldon, 1949) and *Physique and Delinquent Behavior: A Thirty-Year Follow Up of William H. Sheldon’s Variety of Delinquent Youth* (Hartl et al., 1982). Archival materials held by the Ohio State University (Elderkind, 1995; Hartl, 1997) were also consulted.

The Hayden Goodwill Inn was built in 1938 and served as a residence for males ages 15 to 21 referred by social service agencies, courts, and parole officials. It was financed by a private charity; the Morgan Memorial. The home had the capacity for 80 residents and about 500 individuals passed through each year during the initial data collection. Sheldon (Sheldon, 1949) described his sampling procedure this way;

During the three-year period from 1939 to 1942 we were able to study and follow a group of about 400 youths. From this number 200 were selected for the follow-up study which has eventuated in the present report. The basis of selection of the 200 was simply the relative completeness of information on the boy, after elimination of...
Physique correlates with reproductive success

those with specific and gross physical handicaps together with a few who presented nothing in their histories which was either particularly delinquent or particularly arrestive of attention (p. 8).

Hartl et al. (1982) seem aware of the limitations posed by Sheldon’s non-random sampling, but defend the importance of this longitudinal data set:

We believe that the biographical approach adopted in this book is justified by our overarching aim to attain the maximum understanding of the individual from his life experiences. We acknowledge that cause and effect relations cannot be “proved” by this method. However, we believe our conclusions can point a path that other more definitive studies find fruitful (pp. 4 – 5).

As a matter of statistical reasoning we can not make population inferences from this non-random sample. However, as Edgington (1987) pointed out, non-random samples are the norm in psychology and “the main burden of generalizing from experiments always has been, and must continue to be, carried out by nonstatistical rather than statistical logic” (p. 8).

Hartl et al. (1982) had great success following the subjects over the subsequent decades. At the final data collection in 1979 they were able to locate or obtain information on 192 of the original 200. Of these 46 had died, but it was possible to collect data from relative interviews, social service agency records, and death certificates. Ages at death ranged from 19 to 65 with a mean of 42.6. For those who survived to the final data collection, the ages ranged from 49 to 68 with a mean of 55.8.

Sheldon (1949) provided some demographic information on the sample; 12 of the subjects were African American, 1 was described as mixed race, 4 were Arab American, and 183 were European American. According to Sheldon the mean IQ was 89.2, but he did not identify the IQ test used.

Independent Measures

Data are available on the following 11 dimensions of physique:

1. Endomorphy; a measure of the relative the roundness of the physique and is associated with fat or obese body types.
2. Mesomorphy; measure of the relative dominance of muscle and bone and is associated with muscular body types
3. Ectomorphy; a measure of the relative dominance of linearity and is associated with thin body types.
4. Andromorphy; a measure of the relative masculinity of the overall physique. A large quantity of body hair would be an example of an andromorphic trait.
5. Gynomorphy; a measure of the relative femininity of the overall physique. A lack of body hair would be an example of a gynomorphic trait.
6. Primary structural integration; according to Hartl et al. (1982) primary structural integration “refers to the aesthetic harmony and symmetry or soundness of the physique as a whole,” (p.10). Thus primary structural integration can be thought of as a measure of the symmetry of the entire body
7. Secondary structural integration; a measure of the symmetry of secondary traits, such as hands, hair, and joints. Facial symmetry could not be considered because the subject’s faces were obscured in the photographs.
8. General strength; an assessment of the individual’s total strength relative to size
Physique correlates with reproductive success

9. Hand strength was measured using a ranking anchored to performance on a hand dynamometer.
10. Height
11. Weight

For the final publication Hartl et al. (1982) recalculated the ratings for endomorphy, mesomorphy, and ectomorphy, from the original somatotype photographs using an objective procedure, devised by Sheldon in 1969 (Sheldon, Lewis, and Tenney, 1969), and usually called the Trunk Index method, in preference to Sheldon’s earlier more subjective estimates. Walker and Tanner (1980) found that the Trunk Index approach had better statistical properties because the three components were more independent and showed greater inter-rater reliability.

While inter-rater reliability data are not available for this sample, there is evidence suggesting that the somatotype ratings are generally reliable. The Hartl et al. (1982) Trunk Index ratings correlate highly with Sheldon’s original ratings (Carter and Heath, 1990). Heath (Carter and Heath, 1990) also ranked 199 of the 200 photographs using the Heath-Carter photoscopic somatotyping procedure. The Heath-Carter approach uses a different scale and has been criticized on a number of grounds (Harrison, Weiner, Tanner, and Barnicot, 1977), however the rankings do correlate highly with the Sheldon’s original ratings and with the ratings of Hartl et al. (1982).

Hartl et al. (1982) assigned andromorphy, and gynomorphy scores based on a check list procedure explained in detail in Appendix 1 of Physique and Delinquent Behavior. These scores replace Sheldon’s gynandromorphy index, which combined both the feminine and masculine traits into a single index.

Scores for primary structural integration, and secondary structural integration were also reassigned, however Hartl et al. (1982) did not use a check list procedure because they thought of structural integration as an “assessment that anyone with aesthetic perception or appreciation of beauty in form and proportion would make of the physique under consideration” (p. 9). While they did accept that the structural integration ratings were “somewhat arbitrary” (p. 10), they do note that an individual rated as having high structural integration must have “good anatomical proportion” (p. 9). Hartl et al. (1982) relate structural integration to “the capacity of the body to withstand the strains of gravity, of external traumata, and of kinesis – or the demands of movement” (p. 9). This suggests a concept similar to symmetry as understood by evolutionary psychologists. Deviation from symmetry is called fluctuating asymmetry. According to Møller and Swaddle (1997), “the expression of individual asymmetry provides a measure of how well that individual can buffer its development against internal genetic and external environmental stresses during morphogenesis” (p. 10). Prokosch, Yeo, and Miller (2005) point out that symmetry and fluctuating asymmetry are inversely related to each other.

The seven dimensions rescored by Hartl et al. (1982) are used in this study in preference to Sheldon’s original assignments. For general strength, hand strength, height, and weight only Sheldon’s original ratings are available.

Sheldon had objective physical strength data (physical fitness index; Rogers, 1926) on “about half the cases” (Sheldon, 1949, p. 99). However, Sheldon found that this score was subject to considerable improvement on practice and also to wide fluctuation under different motivational conditions, as Dr. Rogers, has indicated. We therefore substituted a rating for a score and based the ratings not
Physique correlates with reproductive success

only on the test but also on prolonged observations of the activities of the boy, especially his relations with other boys (p. 99–100). Sheldon rightly cautions that “these ratings are not offered as very precise data” (p. 100).

For hand strength Hartl et al. (1982) tells us that “on nearly all cases hand strength was measured with a hand dynamometer” (p. 48). Sheldon (1949) concurs indicating that “on nearly all of the boys we have scores made by squeezing a hand dynamometer” (p. 100). However he also noted that at least some subjects exhibited low motivation for squeezing the dynamometer and “so we turned to a rating based not only on dynamometer scores but also on such enterprises as contests in turning of broom handles in one another’s hands and in the hand’s of the examiner” (p. 100).

Measure of Reproductive Success

Number of biological children (offspring count) is the dependent variable in this study. Consistent with other research on reproductive success (e.g. Kaplan and Hill, 1985, Korpelainen, 2000), miscarriages, children who died without offspring, or were permanently institutionalized were not included. However, it should be noted that their inclusion would not have seriously altered the findings. The offspring count ranged from 0 to 10 with a mean of 1.7. The sample included 72 childless individuals.

Analysis

The data were analyzed with SPSS and Simstat. Given the non-normality of the data and Sheldon’s sampling procedure, a non-parametric bootstrap procedure was used. The bootstrap is a nonparametric statistical technique where the sample is iteratively resampled with replacement. With each resample the estimators are recalculated and a distribution of the test statistic is generated. The bootstrap makes fewer assumptions than traditional parametric approaches and is deemed more appropriate for less than optimal samples (see Chernick, 1999 and Edgington, 1987 for theoretical justification and technical details). Here the bootstrap is used to calculate the 95% confidence intervals around Spearman’s rho. Both confidence intervals and statistical significance have been reported.

Results

For seven of the variables (mesomorphy, andromorphy, gynomorphy, primary structural integration, secondary structural integration, general strength, and hand strength) there are noteworthy correlations with reproductive success. These correlations are all in the direction predicted by evolutionary psychology. Readers will note that three of these correlations (secondary structural integration, general strength, and hand strength) are not statistically significant at the .05 level. Traditional hypothesis testing would have us accept the null hypothesis in these three cases because the 95% confidence interval subsumes zero. However, in these cases the zero value occurs at the extreme end of the confidence interval and justifies describing these relationships as noteworthy (Thompson, 1999).
Table 4. Nonparametric correlations between physique and number of children

| Variable                          | Correlation | Bootstrap 95% Confidence Interval |
|----------------------------------|-------------|-----------------------------------|
| 1. Endomorphy                    | -.06        | -.2028, .0767                     |
| 2. Mesomorphy                    | .18*        | .0379, .3089                      |
| 3. Ectomorphy                    | -.03        | -.1745, .1076                     |
| 4. Andromorphy                   | .21**       | .0680, .3400                      |
| 5. Gynomorphy                    | -.19**      | -.3169, -.0561                    |
| 6. Primary structural integration| .23**       | .0951, .3619                      |
| 7. Secondary structural integration| .12        | -.0194, .2607                     |
| 8. General strength              | .13         | -.0135, .2625                     |
| 9. Hand strength                 | .14         | -.0072, 2754                      |
| 10. Height                       | -.01        | -.1456, .1301                     |
| 11. Weight                       | .09         | -.0433, .2318                     |

Note. Spearman’s rho. Bias corrected. 10,000 re-samples.
* p < .05. ** p < .01

No prediction was made about endomorphy, ectomorphy, and weight. The correlations for these variables were not noteworthy. Height was expected to be correlated with offspring count, but these data do not support this prediction. Intercorrelations between the predictor variables are shown in Table 5.
Physique correlates with reproductive success

It is difficult to interpret even a small table of correlations. Factor analysis, a technique for exploring the latent structure of a correlation matrix, is helpful here. Table 6 shows the nonparametric principal component solution (eigenvalue >1; varimax rotation, see Mittag, 1993, for details of nonparametric factor analysis) to the matrix of noteworthy correlations. This solution is interesting because it suggests the existence of a body build – strength factor and a symmetry factor.

| Variable                        | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 |
|--------------------------------|----|----|----|----|----|----|----|----|----|----|
| 1. Endomorphy                  |    |    |    |    |    |    |    |    |    |    |
| 2. Mesomorphy                  | -.13|    |    |    |    |    |    |    |    |    |
| 3. Ectomorphy                  | -.08|.56|    |    |    |    |    |    |    |    |
| 4. Andromorphy                 | -.18|.80|.53|    |    |    |    |    |    |    |
| 5. Gynomorphy                  | .65|.27|.03|.34|    |    |    |    |    |    |
| 6. Primary structural integration | -.01|.44|.10|.40|.12|    |    |    |    |    |
| 7. Secondary structural integration | -.03|.01|.27|.02|.00|.63|    |    |    |    |
| 8. General strength            | -.23|.66|.45|.61|.37|.42|.01|    |    |    |
| 9. Hand strength               | -.22|.36|.03|.35|.37|.36|.17|.59|    |    |
| 10. Height                     | .38|.26|.79|.33|.25|.09|.26|.28|.09|    |
| 11. Weight                     | .78|.23|.04|.11|.39|.23|.08|.08|.07|.49|

Note. Spearman’s rho
The findings of this study are in agreement with the predictions made by evolutionary psychology. Measures of muscularity (mesomorphy), masculine features, symmetry, and strength are correlated with having more children. While the correlations may seem modest, it is important to keep in mind that “when viewed from the lens of evolution, small relations can be very important because these effects can multiply across generations” (Geary, 2005, p. 655).

Evolutionary theory suggests that there should be a relationship between body symmetry (often described in terms of its inverse – fluctuating asymmetry, FA) and reproductive success (Møller and Swaddle, 1997). Gangestad and Thornhill (1999) argue that as a marker of developmental imprecision, FA offers a window through which to view a more fundamental property of an organism: its exposure to, and ability to resist the harmful effects, important threats to its well-being and hence, its level of adaptation to its environment (p. 402).

While some writers (e.g. Miller, 2000) have thought of symmetry as a general “proxy for heritable fitness” (p. 410), this study suggests that it may be useful to think of symmetry and body muscularity as separate factors. Each factor may convey different information about fitness and, under some circumstances, there could be opposing or compromise.
Physique correlates with reproductive success

selection acting on these traits (Gangestad and Scheyd, 2005; Minkoff, 1983). The validity of this insight rests heavily on the assumption, made here, that Sheldon’s primary and secondary structural dimensions are analogs for body symmetry. It must be acknowledged that this assumption could be reasonably doubted and that only additional research with objective symmetry measures can clarify this issue.

The one anomalous finding is height. Most studies have found a positive association between male height and reproductive success (e.g. Mueller and Mazur, 2001). A possible explanation might be that since these men grew up in the great depression and often came from economically disadvantaged families, special environmental factors may have confounded the relationship. However, anthropometric historians have reported that average height continued to increase during the depression (Wu, 1994), and Sheldon reported that the average height for the sample (175.3 centimeters) as being very close to the population mean for adult males. Moreover, even if general social conditions depressed height for the sample as a whole, it would not explain why within sample variation for height was unrelated to variation in the number of offspring.

Mueller and Mazur (2001) examined reproductive success and stature in the Class of 1950 of the West Point U.S. Naval Academy. They found that, in their sample, tall men had more children because they were more likely to have second families with younger wives. It is possible that divorce and remarriage were more available to the better educated, more prosperous, graduates of West Point than to the former residences of the Hayden Goodwill Inn. Mueller and Mazur (2001) also note that their military sample would have excluded individuals with genetic disorders characterized by both tallness and low fertility (e.g. Klinefelter’s syndrome). In any event a better understanding of the how the relationship between stature and offspring count is mediated by social, cultural, and economic factors might help explain the anomalous result reported here.

A large number of studies have found that men who have more masculine traits, are more symmetric, and have greater muscle mass are perceived as being more attractive by women. This study was able to look beyond the mediating variable of attractiveness and measure actual reproductive success. Archival data are limited by the assumptions made and methods used by the original researchers. In this study legitimate questions can be raised about Sheldon’s sampling methods and the rigor of his measurements, especially for the structural integration variables. However, this research suggests that somatotype remains a useful approach to quantifying physique. While Sheldon’s dream of a comprehensive constitutional psychology based on his dimensions may never be realized, understanding how body morphology is related to sexual selection, mating effort, and other behaviors remains an important area for research.

A major limitation of this study is the lack of information about the mates of the subjects. Parnell’s (1958; 1984) work suggested that there are important somatotype interaction effects; a kind of associative mating, where a woman’s own somatotype affected her mate choice. He felt that this process may help explain “the maintenance of the somatotypic status quo in the general population” (Parnell, 1958, p. 43). Associative mating many help explain the low correlation between height and reproductive success found here. Additional research is needed on this point.

No information on the contraceptive practices of the subjects was available. Thus, it is possible that contraception acted as a confounding variable and that actual reproductive success would have been different in an ancestral environment.
Another limitation is that, although Hartl et al. (1982) went to great lengths to find complete information on the subjects, questions of paternity can not be certain. In addition, there could have been children born out of wedlock who were not reported.

Acknowledgements: The author wishes to thank Teresa Kammerman, MD for reviewing the manuscript and Rebecca Jewett, Assistant Curator of the Rare Books and Manuscripts Collection at The Ohio State University Libraries, for assistance with archival material.

Received 01 April 2008; Revision submitted 20 June 2008; Accepted 23 June 2008

References

Bouchard, C. (1997). Long-term stability of body mass and physique. Nutrition, 13, 573-575.
Buchsbaum, R., Buchsbaum, M., Pearse, M., and Pearse, V. (1987). Animals without Backbones (4th ed.). Chicago: The University of Chicago Press.
Carter, J., Ackland, T., Kerr, D., and Stapf, A. (2005). Somatotype and size of elite female basketball players. Journal of Sports Sciences, 23, 1057-1063.
Carter, J.E., and Heath, B.H. (1990). Somatotyping – Development and Applications. Cambridge, UK: Cambridge University Press.
Chernick, M.R. (1999). Bootstrap Methods: A Practitioner's Guide. New York: John Wiley and Sons.
Child, I. (1950). The relation of somatotype to self-ratings on Sheldon's tempermental traits. Journal of Personality, 18, 440-453.
Cortés, J., and Gatti, F. (1965). Physique and self-description of temperament. Journal of Consulting Psychology, 29, 432-439.
Cortés, J., and Gatti, F. (1972). Delinquency and Crime: A Biopsychological Approach. New York: Seminar Press.
Damon, A., and Thomas, R. (1967). Fertility and physique-height, weight, and ponderal index. Human Biology, 39, 5-13.
Davenport, C.D. (1923). Body-Build and its Inheritance. Washington, DC: Carnegie Institution.
Deabler, H.L., Hartl, E.M., and Willis, C.A. (1975). Physique and personality: Somatotype and vocational interest. Perceptual and Motor Skills, 41, 382.
Dixson, A., Halliwell, G., East, R., Wignarajah, P., and Anderson, M. (2003). Masculine somatotype and hirsuteness as determinants of sexual attractiveness to women. Archives of Sexual Behavior, 32, 29-39.
Edmonston, W.E. (1977). Body morphology and the capacity for hypnosis. Annals of the New York Academy of Science, 296, 105 – 118.
Edgington, E.S. (1987). Randomization Tests (2nd ed.). New York: Marcel Dekker, Inc.
Elderkin, R.D. (1995). William H. Sheldon Collection of Roland Elderkin (Box 1). Ohio State University Library, Remote Depository, Columbus, OH.
Ellis, L. (2003). Genes, criminality, and the evolutionary neuroandrogenic theory. In A. Walsh and L. Ellis (Eds.), Biosocial Criminology; Challenging Environmentalism’s Supremacy (pp. 13 – 34). New York: Nova Science Publishers, Inc.
Ellis, L. (2005). A theory explaining biological correlates of criminality. *European Journal of Criminology, 2*, 287–315.

Ellis, L., Das, S, and Buker, H. (2008). Androgen-promoted physiological traits and criminality: A test of the evolutionary neuroandrogenic theory. *Personality and Individual Differences, 44*, 699-709.

Ellis, L., and Walsh, A. (2000). *Criminology: A Global Perspective*. Boston: Allyn and Bacon.

Fosbroke, G.E., (1914). *Character Reading Through Analysis of the Features*. New York: G.P. Putnam’s Sons.

Gallup, A.C., White, D.D., and Gallup, G.G. (2007). Handgrip strength predicts sexual behavior, body morphology, and aggression in male college students. *Evolution and Human Behavior, 28*, 423-429.

Gangestad S.W., and Scheyd, G.J., (2005). The evolution of human physical attractiveness. *Annual Review of Anthropology, 34*, 523–548.

Gangestad, S.W., and Thornhill, R. (1999). Individual differences in developmental precision and fluctuating asymmetry: A model and its implication. *Journal of Evolutionary Biology, 12*, 402 – 416.

Geary, D.C. (2005). Evolution of life-history trade-offs in mate attractiveness and health: Comment on Weeden and Sabini (2005). *Psychological Bulletin, 131*, 654-657.

Gibbons, D.C., (1976). *Delinquent Behavior* (*2*nd ed.). Englewood Cliffs, NJ: Prentice Hall Inc.

Glueck, S., and Glueck, E. (1956). *Physique and Delinquency*. New York: Harper and Brothers.

Grilo, C., and Pogue-Geile, M. (1991). The nature of environmental influences on weight and obesity: a behavior genetic analysis. *Psychological Bulletin, 110*, 520-37.

Harrison, G.A., Weiner, J.S., Tanner, J.M., and Barnicot, N. A. (1977). *Human Biology: An Introduction to Human Evolution, Variation, Growth, and Ecology*. Oxford: Oxford University Press.

Hartl, E.M. (1997). *Emil M. Hartl Collection*. Ohio State University Library, Remote Depository, Columbus, OH.

Hartl, E.M., Monnelly, E.P., and Elderkin, R.D. (1982). *Physique and Delinquent Behavior: A Thirty-year Follow-up of William H. Sheldon’s Varieties of Delinquent Youth*. New York: Academic Press.

Kaplan, H., and Hill, K. (1985). Hunting ability and reproductive success among male Ache foragers: Preliminary results. *Current Anthropology, 26*, 131-133.

Korpelainen, H. (2000). Fitness, reproduction and longevity among European aristocratic and rural Finnish families in the 1700s and 1800s. *Proceedings of The Royal Society B Biological Sciences, 267*, 1765–1770.

Kretschmer, E. (1936/1970). *Physique and Character: An Investigation of the Nature of Constitution and of the Theory of Temperament*. (W.J.H. Sprott, Trans.). New York: Cooper Square Publishers, Inc.

Landauer, T.K., and Whiting, J.W.M. (1964). Infantile simulation and adult stature of human males. *American Anthropologist, 66*, 1007–1025.

Lindzey, G. (1967). Behavior and morphological variation. In J.N. Spuhler (Ed.). *Genetic Diversity and Human Behavior*. (pp. 227–240). New York: Wenner-Gren Foundation.
Maeder, J. (1999, May 16). Charles Atlas body and soul. The Daily News (New York), pp. 31.

Miller, G.F. (2000). The Mating Mind: How Sexual Choice Shaped the Evolution of Human Nature. New York: Doubleday.

Minkoff, E.C. (1983). Evolutionary Biology. Reading MA: Addison-Wesley Publishing.

Mittag, K.C. (1993). Scale-free nonparametric factor analysis: A user friendly introduction with concrete heuristic examples. Austin, TX: Southwest Educational Research Association. (ERIC Document Reproduction Service No. ED 355 281).

Møller, A.P., and Swaddle, J.P. (1997). Asymmetry, Developmental Stability, and Evolution. Oxford: Oxford University Press.

Mueller, U., and Mazur, A. (2001). Evidence of unconstrained directional selection for male tallness. Behavioral Ecology and Sociobiology, 50, 302–311.

Parnell, R.W. (1958). Behavior and Physique: An Introduction to Practical Somatometry. London: Edward Arnold Publishers LTD.

Parnell, R.W. (1984). Family Physique and Fortune: A Study in Multifactorial Inheritance. West Midlands, UK: Parnell Publications.

Pawlowski, B., Dunbar, R.I.M., and Lipowicz, A. (2000). Tall men have more reproductive success. Nature, 403, 156.

Pende, N. (1928). Constitutional Inadequacies: An Introduction to the Study of Abnormal Constitutions. (S. Naccarati, Trans.), Philadelphia: Lea and Febiger.

Peterson, J., Liivamagi, J., and Koskel, S. (2006). Associations between temperament types and body build in 17–22 year-old Estonian female students. Papers on Anthropology, 25, 142–149.

Prokosch, M.D., Yeo, R.A., and Miller, G.F. (2005). Intelligence tests with higher g-loadings show higher correlations with body symmetry: Evidence for a general fitness factor mediated by developmental stability. Intelligence, 33, 203-213.

Rafter, N. (2007). Somatotyping, antimodernism, and the production of criminological knowledge. Criminology, 45, 805–833.

Roback, A.A. (1952). The Psychology of Character; With a Survey of Personality in General. Cambridge, MA; Sci-Art Publishers.

Rogers, F.R. (1926). Physical Capacity Tests in the Administration of Physical Education. New York: Teachers College, Columbia University.

Roney, J.R., and Maestripieri, D. (2004). Relative digit length predicts men’s behavior and attractiveness during social interactions with women. Human Nature, 15, 271–282.

Rosenbaum, R. (1995, January 15). The great Ivy League posture photo scandal. The New York Times, pp. A26.

Sheldon, W.H. (with Stevens, S.S. and Tucker, W.B.) (1940). The Varieties of Human Physique: An Introduction to Constitutional Psychology. New York: Harper and Row.

Sheldon, W.H. (with Stevens, S.S.), (1942). The Varieties of Temperament: A psychology of Constitutional Differences. New York: Harper and Row.

Sheldon, W.H. (with Hartl, E.M., and McDermott, E.), (1949). Varieties of Delinquent Youth: An Introduction to Constitutional Psychology. New York: Harper and Brothers.

Sheldon, W.H., Lewis, N.D.C., and Tenney, A.M. (1969). Psychotic patterns and physical constitution: A thirty-year follow-up of thirty-eight hundred psychiatric patients in
Physique correlates with reproductive success

New York State. In D.W. Siva Sankar (Ed.), Schizophrenia: Current Concepts and Research (pp. 838–912). Hicksville, New York: PJD Publications.

Singh, S.P. (2007). Somatotype and disease – A review. The Anthropologist: International Journal of Contemporary and Applied Studies of Man, 3 (Special Issue), 251–261.

Stunkard, A., Harris, J., Pedersen, N., and McClearn, G. (1990). The body-mass index of twins who have been reared apart. New England journal of medicine, 322, 1483-1487.

Tam, P.L., Kanai-Azuma, M., and Kanai, Y. (2003). Early endoderm development in vertebrates: Lineage differentiation and morphogenetic function. Current Opinion in Genetics and Development, 13, 393–400.

Tanner, J.M. (1990). Foetus into Man: Physical Growth from Conception to Maturity. (Revised and enlarged edition). Cambridge, MA: Harvard University Press.

Thompson, B. (1999). If statistical significance tests are broken/misused, what practices should supplement or replace them? Theory and Psychology, 9, 165–181.

Walker, R.N., and Tanner, J.M., (1980). Prediction of adult Sheldon somatotypes I and II from ratings and measurements at childhood ages. Annals of Human Biology, 7, 213–224.

Williams, R.J. (1975). Biochemical Individuality: The Basis for the Genotrophic Concept. Austin, TX: University of Texas Press.

Wu, J. (1994). How sever was the great depression? Evidence from the Pittsburgh region. In J. Komlos (Ed.), Stature, Living Standards, and Economic Development: Essays in Anthropometric History. (pp. 129–152). Chicago: University of Chicago Press.

Yasuno, F., Suhara, T., Sudo, Y., Yamamoto, M., Inoue, M., Okubo, Y. et al. (2001). Relation among dopamine D2 receptor binding, obesity and personality in normal human subjects. Neuroscience Letters, 300, 59-61.