

diurnal BP variation may contribute to the ethnic differences in cardiovascular morbidity.

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**Less is more: why simple rules are adaptive solutions to complex foraging problems.**

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For over 30 years, primatologists have assumed that the optimal solution for choosing an efficient spatial route through a set of known locations (such as fruit trees) is analogous to that for the Traveling Salesman Problem (TSP). The TSP, common in human geography and business applications, involves finding the shortest route among  $N$  points, and is very difficult to solve for large  $N$ . However, virtually all algorithms for solving the TSP assume precise knowledge of the location of the goals to be visited. For wild animals, such precision in spatial knowledge is unlikely. When spatial location is known only vaguely, simple and robust rules may actually perform better, or not notably worse, than complex algorithms that assume perfect knowledge. In this talk I present a set of results on travel route choice and efficiency based on simulations of simple "rules of thumb" versus conventional computer algorithms to "solve" the TSP. As the degree of spatial vagueness and the number of goals increase, the performance of the TSP algorithm declines relative to the "rule of thumb" algorithm. Thus, the use simple rules for spatial movements by primates may not reflect cognitive constraints, but in fact might be an adaptive trait.

**Assessing craniofacial secular change in American whites and blacks using geometric morphometry.**

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Striking changes in craniofacial size and, especially, shape have been documented for American Whites and Blacks of both sexes over the last 125 years using traditional craniometrics. The skull has become narrower and the vault has increased in height and length. The use of three-dimensional data in the form of Cartesian coordinates allows complex anatomical variation to be more readily depicted. It therefore provides a more precise understanding of the anatomical modifications responsible for secular change.

In this paper, we examine secular change in the face and vault shape of American Whites and Blacks from the mid-19<sup>th</sup> to the mid-20<sup>th</sup> century using three-dimensional

landmark data. Cartesian coordinates of 18 anatomical landmarks were obtained for 316 American White and Black crania. Additionally, coordinates for 7 landmarks were reconstructed from traditional cranial measurements on approximately 700 crania. Procrustes analysis and principal component analysis were carried out on residuals. The principal components were then regressed on year of birth, and an analysis of variance was conducted on the main effect of ancestry and the interaction of ancestry and year of birth.

Results suggest that most of the secular trend in American crania is associated with changes in the posterior vault. Secular changes in the craniofacial skeleton, especially in vault height, parallel those observed in stature. This suggests that the alterations in crania of American Blacks and Whites may be driven by improvements in nutrition and health during infancy and childhood. However, genetic changes over the last 125 years cannot be ruled out.

**Morphometric shape variations associated with retroflexion of the human fetal midline cranial base.**

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Developmental variations of the ventral angle between the primate anterior and posterior cranial base are said to underlie changes to the spatial relationships between the face, the endocranium, the oropharynx and the cervical spine. While numerous past studies have documented basicranial angulation and changes to its associated anatomy over ontogenetic time, the alterations of basicranial shape (i.e. form minus size) remain to be fully investigated. This study explores midline shape changes of the basicranium, including the median aspect of the midface, during human prenatal development with the null-hypothesis that the nature of the shape variation accompanying angulation depends on the progress of endochondral ossification in creating gradients of differential growth between cartilage and bone.

Fifty-four formalin preserved human fetuses, ranging from 10 to 29 weeks gestation, were imaged using high-resolution MRI. Coordinates for ten landmarks defining the midline basicranium and midface were acquired and degrees of ossification were scored. Shape variations of this landmark configuration were explored with geometric morphometric techniques. Results showed relevant shape variations along PC1 (34% of total variance) with increasing fetal centroid size (PC1 scores vs. centroid size:  $r = 0.86$ ,  $P < 0.001$ ) that are contemporaneous with the degree

of ossification. The shape changes observed are centered over the sphenoid body and midface and are consistent with basicranial retroflexion and facial projection and anterosuperior rotation. No direct link was established between ossification and the nature of the shape variation. However, the findings suggest that ossification may play a role in modulating the magnitude and location of the major shape variations that accompany angulation of the human fetal basicranium.

**Within-individual variation in heart rate and energy expenditure at rest.**

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Estimation of the rate of energy expenditure at rest (REE) is integral to field studies of human energetics. Estimated REE is commonly used in combination with measures of time allocation and measures of energy expenditure during activity to derive estimates of total daily energy expenditure (TDEE). Estimates are often derived from published equations or from field measurements with portable metabolic analyzers.

Twenty-four undergraduates participated in a repeated measures study of the flex-HR method of estimating TDEE. A TEEM 100 (Medical Graphics) portable metabolic analyzer was used to measure O<sub>2</sub> consumption, CO<sub>2</sub> production, and heart rate for each participant while standing, sitting and lying down during each of five laboratory sessions spread over 13 weeks. From these measures, an average REE and an average resting heart rate were calculated as the mean of the rates during sitting, standing, and lying down. Preliminary analysis of these results shows substantial variation within participants across the five measurements. The coefficient of variation for each participant for REE ranges from 2% to 14% (median 8.3%), while the coefficient of variation for each participant for heart rate ranges from 3% to 14% (median 8.2%).

The significance of these results is evaluated with respect to the estimation of TDEE of free-living individuals in longitudinal studies that employ single measures of REE in combination with repeated applications of heart-rate-, observation- or recall-based methods of estimating time spent at rest.

**Sexual dimorphism and testicle size in white-collared lemurs (*E. albocollaris*).**

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Previous studies of strepsirhine primates have revealed little sexual body size dimorphism, particularly in Lemuriformes. Re-

searchers have suggested that other forms of dimorphism – including canine dimorphism – may be more prevalent among smaller primates. Initial observations of white-collared lemurs (*Eulemur albocollaris*) indicated the possibility of sex differences in canine length. Accordingly, we investigate body size and canine dimorphism in this species, with comparisons to closely related red-fronted lemurs (*Eulemur fulvus rufus*) and a hybrid population. We also present data on variation in testicle size in these populations.

We analyze dimorphism using non-parametric bootstrap with replacement to generate 95% confidence limits for ratios of mean male and mean female values. Our results indicate sex differences in canine length in *E. albocollaris* (significant at  $\alpha = 0.05$ ), as well as limited evidence for slight size dimorphism in this species (both favoring males). In addition, we find limited evidence for slight size dimorphism in this species (both favoring males). We also find some indication of canine dimorphism in the hybrid population, but none in *E. f. rufus*. Neither of these latter taxa show size dimorphism. *E. f. rufus* males have larger testicles on average, as well as greater variation in size. *E. albocollaris* males have intermediate testicle size and hybrid males the smallest. This variation among populations may be related to differences in social structure, including group size and cohesion. In addition, variation in aggressive encounters between social groups may relate to morphological characters linked to mating systems.

#### **Subadult sex determination from the skeleton.**

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The purpose of this study is to test previously established sex determination methods using the ilium and the mandible as well as the predictive value of the first cervical vertebra on a sample of subadults of known age and sex. Long bone measurements and visual observations were recorded for 240 skeletons from the Hrdlicka Collection housed at the Smithsonian Institution in Washington, DC. Crosstabulation and logistic regression analysis revealed results that were not as accurate as those found previously, but all were above 50%. It was also found that the first cervical vertebra is not a good sex predictor in the subadult. Using all the methods proposed, the sex of subadult skeletons can be estimated with an accuracy of about 73%. This percentage is well above chance (50%) and shows that these methods would be very useful in paleodemography and forensic cases.

#### **The paleoepidemiology of celiac disease: osteological evidence from prehistoric Europe.**

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Though celiac disease (gluten intolerance, non-tropical sprue) affects 1% of modern people of European descent, and up to 5% of some modern North African populations, it has received little consideration as a cause of disease in past societies. Celiac disease is a malabsorption syndrome resulting from the consumption of gluten-containing grains (wheat, rye, barley, spelt, triticale, kamut, etc) in genetically susceptible individuals, and is associated with skeletal and dental pathologies, including cribra orbitalia, porotic hyperostosis, spina bifida, rickets, and hypoplastic dental enamel defects. Untreated celiac disease can be lethal, and so was undoubtedly subject to strong negative selective pressure in farming societies that relied on gluten-containing grains such as wheat. However, a study of pathological indicators in European skeletal material indicates that the skeletal pathologies associated with celiac disease achieve peak frequency not in the Neolithic, when grain-based agriculture was first introduced, but much later, during the Middle Ages, when access to non-grain foodstuffs was severely reduced. It is important to understand the past distribution of celiac disease in order to understand why this genetically-based disorder is still so prevalent in wheat-eating cultures. Such a study is also critical to answering the question of why Europeans would have adopted a subsistence system based on foodstuffs whose consumption led to disability and death in a certain percentage of the population.

#### **Associations with blood pressure in Blackfeet women.**

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Although blood pressure and its determinants have been studied in a number of populations that have undergone recent modernization, factors associated with blood pressure in Native American populations are not widely reported. The present study examines blood pressure and its association with nutritional status and socioeconomic factors in Blackfeet women in Montana.

As part of a larger study, 141 women, ages 18-93 years, had their blood pressure (two readings, averaged for analyses) and pulse measured in a seated position using a protocol. Height, weight, five circumferences, and four skinfolds were measured using standard anthropometric techniques. Participants also

were interviewed concerning socioeconomic characteristics, reproductive histories, and other domains.

Mean systolic blood pressure (SBP) was 122.3±17.9 mm Hg (median 120). Mean diastolic blood pressure (DBP) was 74±11 mm (median 72). SBP was associated, in bivariate analyses, with age ( $p < .001$ ), BMI ( $p < .001$ ), weight ( $p < .002$ ), and waist-hip ratio (WHR) ( $p < .005$ ), but not with any socioeconomic variables. However, in stepwise regression, education consistently entered with BMI and age to explain 26%-28% of the variance. DBP was associated with BMI ( $p < .02$ ), weight ( $p < .01$ ), education ( $p < .004$ ), household income ( $p < .02$ ), and current employment ( $p < .001$ ). In stepwise models, BMI, employment, and education explained 9%-10% of the variance.

In Blackfeet women, SBP and DBP are positively associated with body mass; SBP tends to increase with age, as is typical of modernized populations; and education has a positive effect on both SBP and DBP. These and other findings are discussed further and interpreted.

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#### **The reproductive ecology of high pastoralist fertility.**

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Research on the relationship between mode of subsistence and fertility is crucial to developing a theoretically informed reproductive ecology of human subsistence/productive systems and to understanding the evolutionary origins of agriculture and population growth. While human population ecology of hunter-gatherers (e.g., Howell 1979; Hill and Hurtado 1996), horticulturalists (e.g., Wood et al. 1985; Wood 1992; Nell and Weiss 1975) and agriculturalists (Knodel 1988; Wrigley and Schofield 1981) have been well studied, comparatively less is known of pastoralists. Several studies pose that pastoralists exhibit low to moderate levels of natural fertility and with few exceptions (e.g., Leslie 1988; Brainard 1986) low levels relative to neighboring agriculturalists (Muhsam 1951; Henin 1968, 1969; Ganon 1975; Hill 1985; Duncan and Randall 1988; Marriott 1994; see also Sellon and Mace 1997). However, in a detailed comparison of pastoralist and agriculturalist demography, Randall (1994) concludes that fertility differences, if they are real and not due to poor data quality, are insignificant. New demographic findings from Levantine Beduin pastoralists reveal relatively high natural fertility (TFR = 8.805). These findings will be presented in conjunction with recent demo-