A175   A Geometric Morphometric Approach to Quantify the Impact of Admixture on Craniofacial Form

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Learning Overview: After attending this presentation, attendees will be familiarized with the implementation of two-dimensional geometric morphometric methods applied to a large sample of photographs in an attempt to understand how admixture may influence craniofacial form.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by addressing a significant gap in available data for measuring the effect of admixture on ancestry analysis. Geometric morphometric methods for two-dimensional data permit an exploration of the differences in craniofacial morphology between various levels of admixed individuals.

Craniofacial form is under multidimensional selection borne as modular interactions, or functional morphotypic phenotypes. Multidimensional trait analysis can be used to quantify these interactions and, perhaps more importantly, may be used to construct statistical contrasts of the various forms—as *a priori* group designations—to one another in what is generally a high-dimensional shape space.[1] Geometric morphometric methods permit the exploration and quantification of this shape space as a single analytical unit.

This study uses a sample of digitized photographs from Caroline Bond Day's original thesis.[2] Day (1889–1948) was the first African American woman to obtain an advanced degree in anthropology, in any of the four fields.[3] As a Harvard/Radcliffe student, Day was mentored and influenced by E.A. Hooton, who published (and wrote the foreword to) Day's thesis, *A Study of Some Negro-White Families in the United States*.[2] Using a novel combination of sociological and anthropological data, Day examined aspects of biology and sociology within a sample of families having self-identified dual heritage, or admixture. More than 400 family photographs and individual portraits comprising data from 346 families—along with genealogical, physiological, and sociological data—are amassed within Day's thesis. These data are presented through the lens of admixture in the United States and the impact admixture had on sociological and biological aspects of each family. Day's dedication to data collection and her superb data management and reporting provide a dataset for a modern analysis of admixture and the influence of admixture on craniofacial form.

Many of the current research efforts devoted to studies of admixture focus on individuals of Hispanic ancestry and are thus of limited utility. Other works are based on such small sample sizes that the results are questionable, at best. To address these shortcomings, this study selected 197 photographs from Day's thesis with demonstrable head rotation angles between 0 and 10 degrees and that are free of objects (e.g., hair, shadows) obscuring facial landmarks.[4] To standardize pooling, Day's original assessments of "*degree of blood quantum from Negro to White*" were compressed: (1) 0–25%; (2) 26–50%; (3) 51–75%; and (4) 76–100%. Coordinate data for 24 soft tissue landmarks were collected and analyzed for each group using the geomorph package in R.[5,6]

A generalized Procrustes analysis was used to align and superimpose the landmark data and to calculate mean shape values for each group. These aligned data are used for all subsequent analyses. Multidimensional methods used to explore shape variability within and among various degrees of admixture include thin-plate splines, principal components analysis of the Procrustes landmark data to measure shape variability, and Procrustes Analyses of Variance (ANOVAs) with permutation to evaluate the observed patterns of shape variation and covariation within and among samples.

Several functional regions expressing shape differences were observed in the analysis. American Blacks had broader noses (nasal aperture width), narrower chins (gonial flare), and slightly wider zygomatics (bizygomatic breadth). However, identifying these differences required considerable magnification to visualize the shape differences (mag >x2). In fact, the Procrustes ordinary least squares ANOVA ($p=0.436$; $z=0.055$; permutations=1,000) indicate identifiable shape differences are not statistically significant. Additional explorations incorporating other levels of admixture were also insignificant.

The concept of admixture in the United States reflects historical events, such as forced relocation of Africans and Native Americans to and within the United States.[7] The continuing levels of admixture can reveal fine-scale genetic differences in ancestry, but these differences may not be expressed in skeletal tissues. In fact, the very concept of "admixture" represented in morphological characters is typological and as such is ill-advised as a descriptor for analyses. Larger samples of known individuals of self-reported levels of genetic admixture are needed before any assertions regarding admixture estimation in skeletal remains can be made.

Reference(s):

1. Ross, A.H., D.E. Slice, S.E. Williams (2010). *Geometric Morphometric Tools for the Classification of Human Skulls*. Department of Justice, Office of Justice Programs, National Institute of Justice. http://www.ncjrs.gov/App/publications/abstract.aspx?ID=253252. Last accessed 20 May 2019.
2. Day, C.B. (1932). *A Study of Some Negro-White Families in the United States*. Cambridge, MA: Peabody Museum of Harvard University. Reprinted in 1970, New York: Negro Universities Press.
3. Giles, E. (2012). Two faces of Earnest A. Hooton. *Am. J. Phys. Anthropol.*, 149: 105-113. doi:10.1002/ajpa.22162.
4. Stephan, C.N. (2017). Estimating the Skull-to-Camera Distance from Facial Photographs for Craniofacial Superimposition. *J Forensic Sci*, 62: 850-860. doi:10.1111/1556-4029.13353.
5. Adam, D.C., Collyer, M, Kaliontzopoulou, A, Sherratt, E. (2017). *Geometric Morphometric Analyses of 2D/3D Landmark Data*. URL: http://geomorphr.github.io/geomorph/. Last accessed: 3 June 2019.
6. R Core Team (2018). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/. Last accessed 3 June 2019.
7. Bryc K., Durand E.Y., Macpherson J.M., Reich D., Mountain J.L. (2015)The genetic ancestry of African Americans, Latinos, and European Americans across the United States. *Am J Hum Genet*; 96:37–53.

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