H60 Repeatability and Error of Cranial Landmark Coordinates

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After attending this presentation, attendees will be introduced to issues of intra- and inter-observer error in the collection of three- dimensional landmark coordinates.

This presentation will impact the forensic community and/or humanity by addressing issues of repeatability and error in geometric morphometric methods of data collection.

Historically, size and shape analyses have relied on the application of multivariate statistical methods to linear distances, ratios, and/or angles derived from caliper measurements (Lynch et al. 1996; Rohlf and Marcus 1993; Ross et al. 1999). One of the limitations of caliper derived metric data is that the measurements are confined to the positions of the caliper endpoints, which are defined by anatomical locations or landmarks. The end result is a linear distance measure incapable of fully capturing all of the information available about the relative positions of these landmarks in space (Bookstein 1991).

Modern methods of the geometric morphometrics address many of the shortcomings associated with traditional metrics by focusing on the analysis of landmark coordinates (Rohlf and Marcus 1993). Unlike traditional metrics, coordinate data fully archive all of the geometric information available in the anatomical structures. These newer three- dimensional methods have gained much popularity in physical anthropology over the last decade being adopted by many evolutionary theorists, clinicians, and forensic anthropologists. Data capturing techniques range from direct digitization of landmarks via 3D digitizers to point extraction from scanned images. However, these new modes of data acquisition and analyses have undergone little to no systematic testing for accuracy. The purpose of this study is to evaluate the repeatability and error associated with the collection of cranial landmark data using these newer modalities. Three skulls were selected for this study from the C.A. Pound Human Identification Laboratory. Nineteen standard homologous cranial landmarks were collected using a Microscribe 3DX and G2X ® digitizer and the software ThreeSkull written by Steve Ousley. Each skull underwent three separate digitization sessions by two separate observers for a total of six digitizations for each skull. Because the skulls were not “fixed” in a common coordinate system between digitizing sessions, interlandmark linear distances (ILDs) were used in the subsequent statistical analysis rather than the landmark coordinates. All possible ILDs between the nineteen landmarks (n = 171) for each digitizing session (n = 3) for each observer (n = 2) for each skull (n = 3) were calculated using the program PAST (Paleontological Statistics, 2001, http://folk.uio.no/ ohammer/past/download.html). Digitization error (within-subject error or the proportion of the total variance explained by multiple digitizing sessions of the same skull) was tested using a mixed model analysis of variance (ANOVA). Sixteen percent of the 171 ILDs showed error in excess of five percent. Repeatability (between-observer variation) was tested using ANOVA using the general linear model (GLM) routine. Significant between-observer difference was found for fourteen ILDs. The majority of the between-observer variation included Type III landmarks (e.g., alare and euryon). These landmarks are fairly accurate when instrumentally derived as linear distances in traditional morphometrics (e.g., maximum cranial breadth or XCB). However, they are highly variable when attempting to archive their exact anatomical location and the authors caution the use of Type III landmarks in geometric morphometrics.

Cranial Landmarks, Repeatability, Geometric Morphometrics

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