H62 A New 3D Landmark Reference Database for Sex and Ancestry Assessment in Human Skulls

Ann H. Ross, PhD, NC State University, Sociology & Anthropology, Campus Box 8107, Raleigh, NC 27695-8107; and Petra Urbanová, PhD, Kotlarska 2, Brno 611 37, CZECH REPUBLIC*

After attending this presentation, attendees will understand the principles on which advanced software tools for assessing an individual's biological sex and ancestry from a human skull are grounded, such as the importance of a large cranial reference database, the basics of geometric morphometrics (shape analysis) to comprehend advances in studies of craniofacial morphology, and their applicability for identifying skeletal remains.

This presentation will impact the forensic science community by presenting a collaborative project aimed to advance methodological and computer-assisted techniques currently available in the field of forensic anthropology and to facilitate and substantiate craniofacial examinations.

Portable Three-Dimensional (3D) devices (e.g., MicroScribe®, Polhemus® digitizers) have enabled researchers to rapidly acquire coordinate landmark data, are relatively user-friendly, and are accurate. If the use of data acquisition hardware is combined with methods of geometric morphometrics, they will augment classification rates for biological sex and ancestral affinity, in particular if based on craniofacial morphology. Additionally, new developments in 3D technologies have made it possible to facilitate medicolegal examinations in unidentifiable remains using non-invasive and non-contact approaches such as computed tomography and other more affordable 3D scanners that have modified the manner in which traditional osteometrics are executed. Virtual 3D data can be easily transported and shared between laboratories; they represent an unlimited source of morphological data and provide a real-time access for re-examination of physical evidence. Similar to direct digitization of skeletal remains, collecting 3D coordinates has been shown to be advantageous when identifying virtual skeletons than more traditional methods.

However, processing 3D landmark data involves a large learning curve, particularly in the area of theoretical background requiring computer-assisted shape analysis algorithms, and multivariate statistics, and integrating geometric morphometrics into an everyday routine has been challenging. Recently, in order to overcome these challenges the software programs 3D-ID developed by Slice and Ross and COLIPR developed by Urbanová and Králík were created. They both use a landmark-based approach combined with discriminant and canonical variates analysis in order to provide the best classification for an unknown individual. However, the performance of the algorithms and a broader applicability are mainly dependent upon the representativeness of the incorporated reference database. While 3D-ID includes eight groups with a minor coverage of European populations, COLIPR was developed to be used primarily in a context of European ancestry groups.

A new reference database has emerged from a collaborative project between forensic scientists and both software applications, which has given rise to a comprehensive cranial dataset of approximately 2,400 specimens with 16 distinct groups (Native Africans, Asians, Carribeans, central Europeans, eastern Europeans, southeastern Europeans, southern Europeans, southwestern Europeans, Mesoamericans, African Americans, European Americans, Hispanic Americans, Afro-Brazilians, Japanese Brazilians, European Brazilians, Peruvians) based on their ancestry and geographical origin (twice as many if biological sex is included). Combined with additional methodological improvements in classification algorithms and online availability, the new reference database will extend diagnostic power and applicability to a broader range of skeletal cases. For instance, an overall rate of biological sex estimation computed on 21 landmarks and the total number of incorporated groups reaches 81% of correctly classified cases if only shape variables are included and 87% of correctly classified cases if shape and size variables are combined. However, if input coordinates are adjusted according to population-specific cranial morphology and patterns of sexual dimorphism, the classification rate exceeds 95% of correctly classified cases.

Sex and Ancestry Assessment, Reference Database, Software Tools

 ** Presenting Author*