A28 Testing the Traits of TA3: Setting a Baseline for Method Development and Performance

Sara M. Getz, PhD, University of Wisconsin - Platteville, Platteville, WI 53818-3099; Patrick D. Byrnes, PhD, University of Wisconsin - Platteville, Platteville, WI 53818*

Learning Overview: The goal of this presentation is to compare age estimates produced using the Transition Analysis (TA) method and the newly developed Transition Analysis 3 (TA3) traits for a sample of modern individuals.[1,2]

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing baseline accuracy and precision data for estimates produced using TA3 traits in a similar statistical framework as the original TA method. These data can be used to evaluate the efficacy of alternative analytical and statistical procedures for generating age estimates from the TA3 reference sample, including sex- and population-specific approaches.

Accurate, unbiased, and reasonably precise age estimations for the entire adult lifespan are necessary for both forensic and paleodemographic applications. TA produces individualized age estimates from components of the pubic symphyses, iliac auricular surfaces, and cranial sutures. Despite using a more sophisticated statistical approach than other commonly used methods, TA performs poorly for individuals between 45–75 years of age. Although trait correlations and high inter-observer error for some features may contribute, this error is most strongly attributable to insufficient age-related change in the indicators in that portion of the lifespan.

To address this issue, a National Institute of Justice (NIJ) award was granted to an international team to identify new age-informative traits, characterize those features in modern populations, and investigate analytical approaches. The TA3 reference sample currently contains data from 1,694 documented individuals from four modern skeletal collections: William M. Bass Donated Collection (*n*=437), Pretoria Bone Collection (*n*=484), Chiang Mai University Skeletal Collection (*n*=418), and Bocage Museum Collection (*n*=355). Although initial efforts focused on directly integrating new features into a version of the existing TA framework, the number of features identified and the complexities of their correlations spurred the investigation of a number of alternative approaches.

In this study, age estimates for individuals from the University of Athens Human Skeletal Reference Collection (*N*=199) were independently generated using TA and TA3 traits. Using TA software ADBOU 2.1.046, a maximum likelihood point age and 95% prediction interval was estimated for each individual based on the combined reference sample (all males and females from all samples) and a uniform prior distribution.

Of the 80 features in the TA3 Trait Manual (Public Distribution Ver. 1.0), ten features are no longer under consideration by the NIJ team and two features had definition changes between the collection of these test data and the release of the reference dataset. Probabilities for 68 traits generated from logistic models fitted to the reference data were combined to form a single log-likelihood function of age, from which a maximum likelihood point estimate and a 95% prediction interval were calculated. For non-binary traits, variants were converted to dichotomous pairs and the most age-informative transition was included in this analysis. To facilitate future comparisons with the TA3 software currently in beta testing, only data from the right side of the skeleton were used.

TA produced accurate estimates (known age fell into the estimated 95% prediction interval) for 73.3% of the individuals with an average precision (age interval length) of 34.2 years. Using the 68 TA3 traits in the simplified transition analysis procedure, the accuracy dropped marginally to 70.8%, but the precision increased to 17.2 years. In other words, accuracy remained essentially the same, while the width of the age interval was reduced by nearly 50%. This significant increase in precision without a correspondingly large reduction in accuracy is particularly surprising given that the TA program includes a statistical correction for correlated features while the procedure tested here does not. Additionally, while TA overestimated age for individuals in the first half of the lifespan, and increasingly underestimated age thereafter, the TA3 estimates exhibited no systematic age-estimation bias and were collectively indistinguishable from the identity line.

By using data calculated from the pooled reference sample (non-sex- and population-specific probabilities), a uniform prior distribution, and no correction for correlated features, this work provides a baseline for the minimum performance that can be expected using the TA3 traits, even on individuals from populations not directly represented in the reference data. Moving forward, investigating a wide array of approaches for generating estimates from the TA3 dataset will provide many avenues toward a promising future for adult age estimation.

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Reference(s):

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2. Milner G.R., Boldsen J.L., Ousley S.D., Getz S.M., Weise S., and Tarp P. 2019. *Transition Analysis 3 (TA3) Trait Manual. Public Distribution Ver. 1*. NIJ Award # 2014-DN-BX-K007.

Age Estimation, Transition Analysis, TA3

*Presenting Author