



## Physical Anthropology Section – 2010

### H45 Biometric Assessment of the Accuracy of a Large Sample of Three-Dimensional Computerized Facial Approximations

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The goal of this presentation is to assess whether three-dimensional computerized facial approximations generated by ReFace are biometrically similar to three-dimensional models of their corresponding known faces. This study is the first of its kind to evaluate such a large number of facial approximations ( $n = 288$ ).

This presentation will impact the forensic science community by providing the first large-scale evaluation of the accuracy of three-dimensional computerized facial approximations using objective biometric techniques. The establishment of biometric similarities between computerized facial approximations and known faces has implications for the application of computerized methods to solving unidentified decedent cases.

ReFace is a computerized facial approximation program which generates faces for unidentified decedents using a large reference database currently populated by head CT scans of American males and females of African-, Asian-, and European-descent. An unknown skull is imported into the system as a 3D model, either as a CT scan or surface scan, and registered to the reference skulls within the user-specified sex/ancestry demographic in order to calculate a statistically likely face. Any known biological information, such as age, height, or weight can also be used to influence the final approximation. To date, evaluations of the accuracy of ReFace approximations have been carried out by human recognition studies using face pool selections and resemblance ratings and by computer recognition studies.

In this study, the [ReFace] reference database, consisting of three-dimensional bone and skin models, was used as the test sample in a leave-one-out validation in which one head at a time was excluded from the system and treated as an unknown. For each individual, average approximations were generated with only sex and ancestry specified and with no modifications for age, height, or weight. Because the reference faces within each demographic are topologically equivalent, landmarks of interest could be placed on one canonical face from which x-, y-, and z-coordinates could be generated for the corresponding landmarks on each known face and each approximation within a particular demographic. For this study, 34 anthropometric and constructed landmarks were chosen to evaluate the accuracy of the three-dimensional configurations of the most influential and centrally located facial features: the eyes, nose, and mouth. Landmarks along the perimeter of the face were avoided because they vary considerably with weight, and landmarks along the brow ridges were also avoided because they are essentially determined by the shape of the underlying supraorbital ridges. Three-dimensional coordinates were used to calculate all interlandmark distances ( $n = 561$ ) for each known and approximated face. Euclidean distances were calculated for each pairwise combination of faces, and for each approximation, the rank of its corresponding known face according to the Euclidean distance was evaluated.

When each demographic was evaluated separately, the rank 1 recognition rate, or the percentage of known faces with the smallest Euclidean distance to its approximation, ranged from 6.25% for African-descent males ( $n = 48$ ) and females to 23.40% ( $n = 48$ ) for Asian-descent males ( $n = 47$ ). The average rank of the known face ranged from 8.33 for European-descent females ( $n = 49$ ) to 14.19 for African-descent females ( $n = 48$ ). Average ranks of the known faces for all demographics were significantly higher than that expected by chance. In order to further assess the strength of association, each approximation was compared to all known faces ( $n = 288$ ). The average rank of the known face when considering all individuals was 20.94 and the median rank was 7, meaning that for 50% of the approximations, the known face ranked somewhere in the top 7. The rank 1 recognition rate for the overall evaluation was 16.67%.

The results of this study indicate that facial approximations generated by ReFace are biometrically similar to their corresponding known faces even when compared against a large face pool. Higher ranks than those obtained in this study may be obtained by including more landmarks, especially around the eyes. This study also suggests that the soft tissue structure of the face is highly influenced by the morphology of the underlying craniofacial skeleton and can be estimated fairly accurately by a statistically-oriented computerized facial approximation program, such as ReFace.

#### Facial Approximation, Facial Recognition, Human Identification