Ontogenetic Shape Variation in the Facebase 3D Facial Norm Data
Trish E. Parsons, Zachary D. Raffensperger, Mary L. Marazita and Seth M. Weinberg
Center for Craniofacial and Dental Genetics, Oral Biology Department, University of Pittsburgh School of Dental Medicine

The 3D Facial Norms project "spoke" of Facebase has two major goals; 1) create a large, publicly available database of 3D human facial and genetic data and 2) use the data contained therein to identify specific genes and pathways that influence midfacial phenotypic variation. This poster displays a preliminary, non-exhaustive geometric morphometric examination of the facial norm phenotypes as the sample approaches 1,000 subjects. The left column presents a series of descriptive statistics about the current make up of the sample including the gross size and shape variation within the sample. The middle column describes the landmarks used for analysis, how allometry was handled for rest of the analyses and what kinds of shape variation separates the different age groups in the sample after a correction for allometry. The last column takes a closer look at the age groups and each box tests whether or not sexual dimorphism is present in the three age groups even after allometry is removed.

Summary Statistics
Sample Size: 631 Females n = 362, Males n = 369
Youngest Age: 0.00
Oldest Age: 40.7
Median Age: 24.1
Total Number of Shape Data Variables Analyzed: 67,032
Number of Landmarks Collected: 24 three dimensional landmarks

Total Variation

These two principal component (PC) scatter plots paint the picture of the nature of the shape variation in the sample. Each dot on the graph represents the shape of one individual in the sample; the shape variables have not been corrected for rest of the analyses and what kinds of shape variation separates the different age groups in the sample. The graph on the right is color-coded by sex; the sexes only show mild separation tendencies on PCs 3 and 7. The ellipses in the groups apart with mature subjects on the right, juveniles on the left and adolescents in between (though largely overlapping with both). The 95% frequency ellipses show the general pattern of overlap between the groups. The scatter plot on the right is color coded by sex; the sexes only show mild separation tendencies on PCs 3 and 7. The ellipses in the center represents the 85% confidence interval of the means for each sex.

Does size explain these trends in the overall variation?

From the previous regression of the first PC on CS, we know that the size differences in the sample are very large and are likely overwhelming other types of shape variation. In order to be able to look beyond the variation differences that are due to size-related shape differences, we need to remove that variation. One way to do this is to use a multivariate regression of total shape on CS. The scatter plot to the left shows this variation. This reduces 11.53% of the total variation in the sample (which consists of individuals ages 3 - 40 with a p-value < 0.0001 after a X100000 permutation test). The rest of the analyses presented below and to the right of this column will use the residuals of this regression and so are testing shape not related to size.

Centroid Size (CS) predicts a significant amount of the variation captured by the first PC; 41.6% (p-value < 0.0001), pooled in group by sex, plot on the left. While significant, it shows that other factors causing facial shape differences between age groups. CS also only predicts 5.50% of the shape variation that separates the sexes (p-value = 0.0031, pooled in group by age, right). From the previous regression of the first PC on CS, we know that the size differences in the sample are very large and are likely overwhelming other types of shape variation. In order to be able to look beyond the variation differences that are due to size-related shape differences, we need to remove that variation. One way to do this is to use a multivariate regression of total shape on CS. The scatter plot to the left shows this variation. This reduces 11.53% of the total variation in the sample (which consists of individuals ages 3 - 40 with a p-value < 0.0001 after a X100000 permutation test). The rest of the analyses presented below and to the right of this column will use the residuals of this regression and so are testing shape not related to size.

The Shape, Whole Shape and Nothing but the Shape...

The figure on the left displays the 24 landmarks used in this geometric morphometric analysis presented on this poster. These landmarks include nasion, proionion, subnasale, labiale superius, stomion, labiale inferius, submentale, gnathion, left/right (l/r) vomerines, l/r incisurae, l/r alae, l/r anterior process, l/r rami, l/r ploths, l/r cloelion and l/r troquin. These same landmarks were also used to create the 'trextip' in the ensuing analyses. All analyses were performed using MorphoJ. 1/464 and metrics were created in landmark 3.0.6.6.

These same landmarks were also used to create the 'trextip' in the ensuing analyses. All analyses were performed using MorphoJ. 1/464 and metrics were created in landmark 3.0.6.6.

The Shape on Centroid Size Regression

This work was supported by NIH Grant number 1U01DE020078 Facebase Consortium Annual Meeting, Los Angeles, CA, June 24-26 2012

Ladies and Gentlemen...

This canonical variate analysis was performed on a subset of the sizes-removed (two middle volumes) sample data - specifically all subjects over 19 years of age (n = 722, 255 males and 467 females). The Procrustes distance between the two groups, 0.0208, was deemed statistically significant with a p-value = 0.049. Each end of the CV1 is represented by the faces on each side. This shows that even after allometry is removed, men and women adults have different facial shapes.

Lads and Lasses...

This canonical variate analysis was performed on a subset of the sizes-removed sample data - specifically all subjects between 11 and 18 years of age (n = 111, 49 males and 62 females). The Procrustes distance between the two groups, 0.038, was deemed statistically significant with a p-value = 0.002. The shapes of each end of variation is shown on the sides. This shows that even prior to reaching full maturity, sexual dimorphism is present and starts shortly after puberty.

The Shape, Whole Shape and Nothing but the Shape...

The PC2 and PC3 are separated from the younger groups along the CV1 and the juveniles and adolescents separate along the CV2.

Ch-ch-ch-changes...

This work was supported by NIH Grant number 1U01DE020078 Facebase Consortium Annual Meeting, Los Angeles, CA, June 24-26 2012

These same landmarks were also used to create the 'trextip' in the ensuing analyses. All analyses were performed using MorphoJ. 1/464 and metrics were created in landmark 3.0.6.6.

Gents and Lads...

This canonical variate analysis was performed on a subset of the sizes-removed sample data - specifically all subjects between 3 and 10 years of age (n = 119, 64 males and 55 females). The Procrustes distance between the two groups, 0.0148, was deemed statistically significant with a p-value = 0.013. This shows that even prior to reaching full maturity, sexual dimorphism is present and starts shortly after puberty.

This canonical variate analysis was performed on a subset of the sizes-removed sample data - specifically all subjects between 3 and 10 years of age (n = 119, 64 males and 55 females). The Procrustes distance between the two groups, 0.0148, was deemed statistically significant with a p-value = 0.013. This shows that even prior to reaching full maturity, sexual dimorphism is present and starts shortly after puberty.