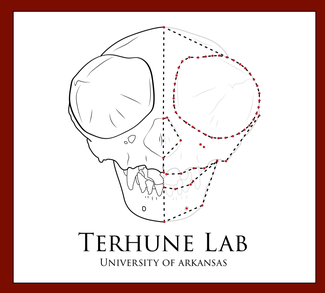
Examining fluctuating asymmetry in *Macaca fascicularis*

Ashly N. Romero[1], Claire A. Kirchhoff[2], Siobhan B. Cooke[3,4], and Claire E. Terhune[1]

[1]Department of Anthropology, University of Arkansas
[2]Department of Biomedical Sciences, Marquette University
[3]Center for Functional Anatomy and Evolution, Johns Hopkins University School of Medicine
[4]New York Consortium in Evolutionary Primatology, Morphometrics Group



Introduction

Symmetry is all around us. The right and left side of most organisms are the same, but reflected across the midline. Therefore, when asymmetries occur, it is most likely due to some error in the developmental process (Klingenberg, 2015). However, we don't know if all organisms exhibit similar responses to these errors during development in the adult phenotype. Measurements of random asymmetries (fluctuating asymmetry, or FA) provide a proxy for assessing developmental stability (Willmore et al., 2007). Previous work has examined FA in two great ape species (*Gorilla gorilla gorilla* and *Pan troglodytes troglodytes*), but how these levels compare to other taxa remains unclear (Romero, 2018). To elucidate the phylogenetic effect of developmental stability, we examined FA in crab-eating macaques (*Macaca fascicularis*) in addition to the great ape species previously mentioned.

Research Question and Hypothesis

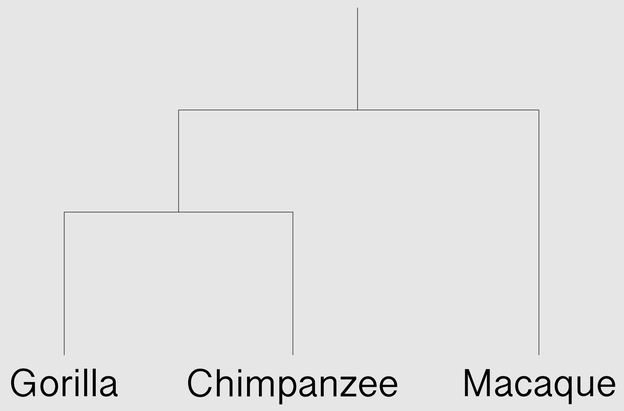


Fig. 1: Phylogeny showing relationships of taxa in this study.

Question: Does phylogeny influence developmental stability in primates?

Hypothesis: Macaques will exhibit a different degree of fluctuating asymmetry from western lowland gorillas (*Gorilla gorilla gorilla*) and central chimpanzees (*Pan troglodytes troglodytes*) due to the apes' closer phylogenetic relationship (Fig. 1), and thus similar levels of hypothesized developmental stability.

Materials and Methods

- 74 3D landmarks across face, base, and vault of adult crania with little to no breakage (Fig. 4; Landmark Editor)
- Geometric morphometric shape analysis (Procrustes fit and covariance matrix generation in MorphoJ)
- Generated Procrustes FA scores via Procrustes ANOVA (Fig. 3; MorphoJ)
- Two-way ANOVA testing taxon, sex, and interaction effect on Procrustes FA scores (R)

Genus	Female	Male	Total
Macaca	19	20	39
Gorilla	22	22	44
Pan	17	20	37

Fig. 2: Sample size for study

Fig. 3: Shapes represent the original and reflected copy of an organism, while the arrows represent distances measured to calculate FA for each individual

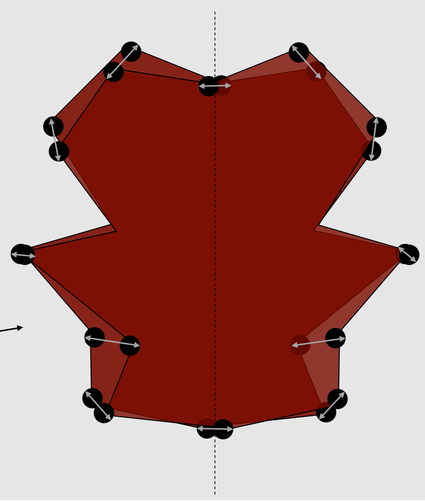
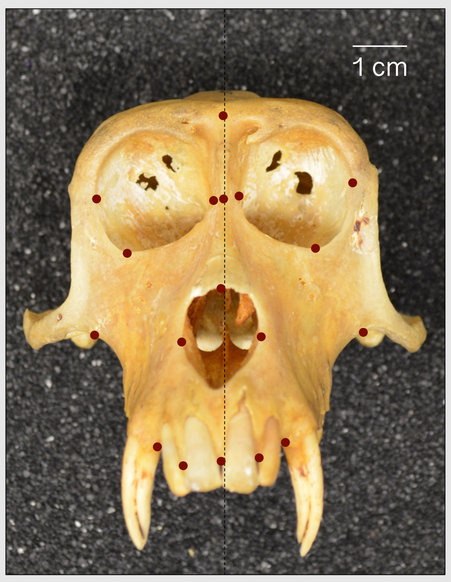


Fig. 4: Male *Macaca fascicularis* skull in FMNH collection



Results

Taxa:
Gorilla ≠ *Pan* (p<0.05)
Macaca ≠ *Pan* (p<0.05)
But… *Macaca* = *Pan* (p>0.05)

Sex:
Gorilla Female = *Gorilla* Male
Pan Female = *Pan* Male
Macaca Female = *Macaca* Male

No significant taxon*sex interaction

= means not statistically significantly different
≠ means statistically significantly different

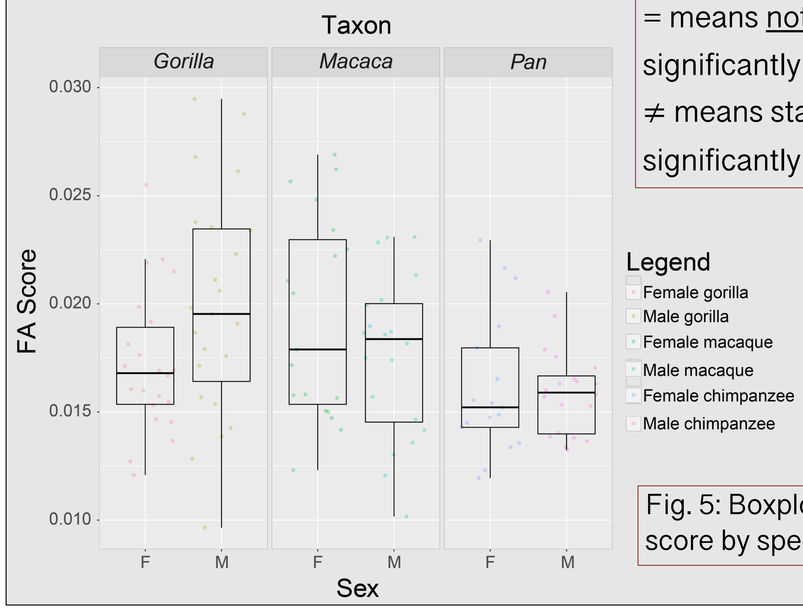


Fig. 5: Boxplots of FA score by species and sex

Discussion and Conclusion

→ These results suggest that fluctuating asymmetry, and therefore developmental stability, is more similar in macaques and chimpanzees than either group is to gorillas
→ This suggests that developmental stability may be less influenced by relationships and more by stress experienced during life of individuals, or other factors like growth rate (Mumby and Vinicius, 2013)
→ The samples sizes here are extremely limited, so more taxa with bigger sample sizes are needed to further clarify this relationship

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Contact

Ashly Romero
PhD Student

Email: anromero@uark.edu