Cranial Fluctuating Asymmetry and Reproductive Fitness in the Cayo Santiago Rhesus Macaques

Ashly N. Romero,[1] D. Rex Mitchell,[2] Claire E. Terhune[1]

[1]Department of Anthropology, University of Arkansas
[2]College of Science and Engineering, Flinders University

Caribbean Primate Research Center
University of Puerto Rico

TERHUNE LAB
UNIVERSITY OF ARKANSAS

Introduction

Fluctuating asymmetry (FA) refers to random deviations from bilateral symmetry and is frequently used as a proxy for developmental instability, which has in turn been suggested to hold an association with reproductive fitness. However, any links observed between FA and fitness are tenuous at best. If FA is indeed related to reproductive fitness, then this supports the idea that FA is genetically controlled to some degree and not as firmly related to environmental stress as many studies suggest. Investigations concerning a number of phenotypic traits from a range of species have found both decreased fecundity associated with FA[1] or found no effect[2,3]. We tested the association between offspring count and craniofacial FA in female rhesus macaques (*Macaca mulatta*) from Cayo Santiago, Puerto Rico to expand this research into nonhuman primates.

Fig. 1 & 2: Rhesus macaques *(Macaca mulatta)* on the island of Cayo Santiago

Research Question and Hypothesis

Question: Is increased fluctuating asymmetry (FA) associated with decreased fitness in the Cayo Santiago rhesus macaques?

Hypothesis: Levels of FA will be higher in individuals with fewer offspring, indicating that there are reproductive costs associated with FA and, thus, that fitness is decreased in individuals with increased FA.

Fig. 3: *Macaca mulatta* female from the island of Cayo Santiago (CPRCMUS-000853)

Fig. 4: *Macaca mulatta* female from the island of Cayo Santiago (CPRCMUS-004318)

Materials and Methods

Using geometric morphometric shape analysis on 112 adult, female rhesus macaques, we placed 35 fixed landmarks across the cranium and calculated an FA score for each individual in geomorph[4,5]. We used offspring count as a proxy for fitness in our analysis. Individuals without any offspring in the collection were removed from analyses because it is impossible to know if offspring are not included in the collection or if the individual did not reproduce, reducing the sample to 70 individuals.

- Regression of offspring count on age to calculate "age-adjusted" residuals that control for differences in offspring count related to age at death
- Regression of unsigned FA scores on the age-adjusted offspring residuals

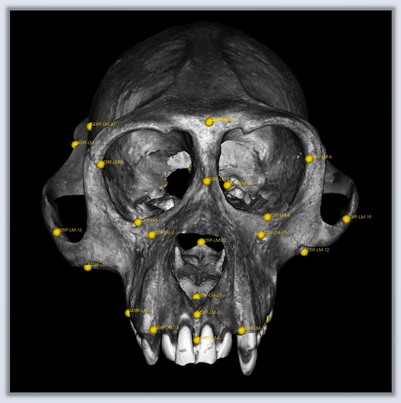


Fig. 5: Anterior view of landmarks on 3D model in study (CPRCMUS-04439)

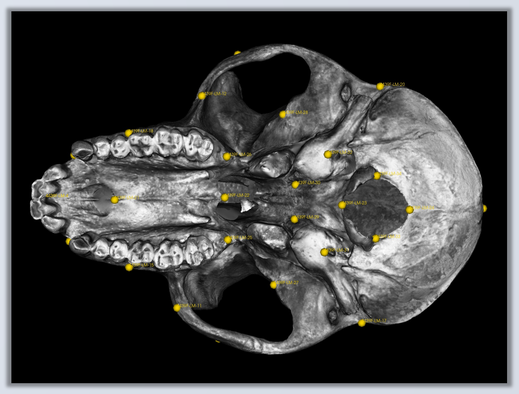


Fig. 6: Inferior view of landmarks on 3D model in study (CPRCMUS-04439)

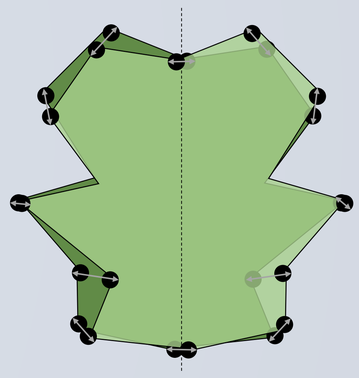
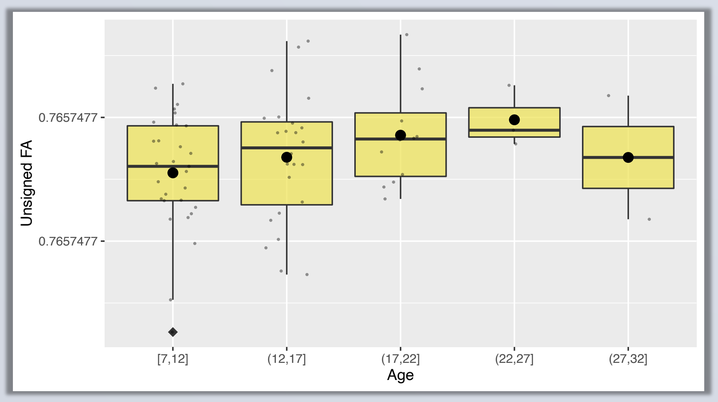


Fig. 7: Shapes represent the original and reflected copy of an organism, while the arrows represent distances measured to calculate FA level for each individual

Results

Fig. 8: Boxplot of FA levels for individuals in the sample.



- FA is detectable in the sample (p=0.016)
- Age is significantly related to offspring count (p=0.001).
- Age-adjusted residuals for offspring count are not significantly related to levels of FA.

Table 2: Regression results. Asterisk denotes significant results. Asterisk (*) denotes significance.

Variables	r^2	p-value
Age (x) Offspring count (y)	0.22	<0.001*
FA (x) Age-adjusted offspring count (y)	0.04	0.06

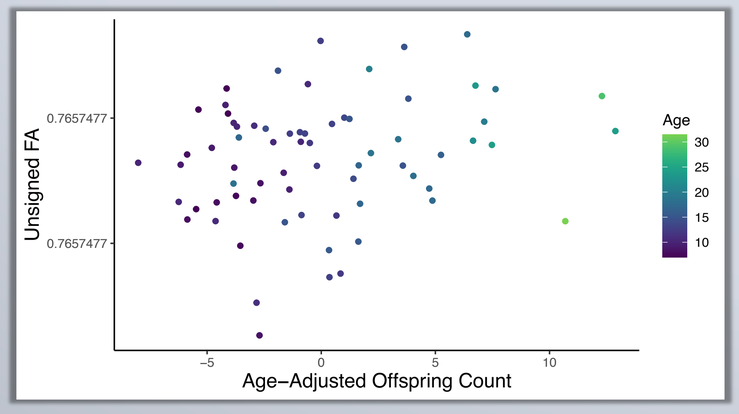


Fig. 9: Regression of FA level (x) on age-adjusted offspring count (y; fitness proxy)

Discussion and Conclusion

- There is not likely a relationship between FA and number of offspring, following what was previously demonstrated in humans[3].
- FA is probably not related to reproduction in rhesus macaques. These results support the idea that FA, and therefore developmental instability, do not affect reproductive fitness in rhesus macaques.

Fig. 10: Individual CPRCMUS-00338 who had nine offspring that are included in the CPRC collection. This is not the most asymmetric individual (FA=0.765747683623865).

References

1 Radwan et al. (2003). Procrustean analysis of fluctuating asymmetry in the bulb mite *Rhyzoglyphus robini* Claparede (Astigmata: Acaridae). Biol J. Linn. Soc. 80, 499-505.
2 Kölliker-Ott et al. (2003). Are wing size, wing shape and asymmetry related to field fitness of *Trichoramma* eg parasitoids? Oikos 100, 563-573.
3 Pflüger et al. (2012). Cues to fertility: Perceived attractiveness and facial shape predict reproductive success. Evol. Hum. Behav. 33, 708-714.
4 Baken et al. (2021). geomorph v4.0 and gmShiny: enhanced analytics and a new graphical interface for a comprehensive morphometric experience
5 Adams et al. (2021). Geomorph: Software for geometric morphometric analyses. R package version 4.0.2

Acknowledgements and Contact

Funding for this project comes from:
- CPRC via the Office of Research Infrastructure Programs (ORIP) of the National Institutes of Health (NIH) through Grant Number 2 P40 OD012217
- University of Arkansas Department of Anthropology
- University of Arkansas Fulbright College of Arts and Sciences (ARSC)

Thank you to Terry Kensler and the University of Puerto Rico's Caribbean Primate Research Center for access to their collection at the Laboratory of Primate Morphology.

Email: anromero@uark.edu

Scan the QR code to be directed to Ashly's website where you can find a pdf of this poster under the "Conference Abstracts" tab.

SCAN ME