Least-Effort Knapping as a Baseline to Study Social Transmission in the Early Stone Age

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Introduction

- There is much debated about the meaning of technological variability Early Stone Age (ESA)
- Early studies sorted cores into typological categories, which implies intention and cumulative culture (1)
- The Acheulean industry (~1.76 Ma to ~0.3 Ma) has often been assumed to be a product of intention, but that status has been questioned (2)
- Through least-effort reduction and 3D Elliptical Fourier Analysis (EFA), we created a null baseline of lithic variation and tested two Acheulean assemblages against it. We clarified the cultural and cognitive capabilities of Pleistocene hominins and described the origins of the modern human cultural suite.
- **We asked the question: "what would a lithic assemblage look like in the absence of intention and cumulative culture?"**
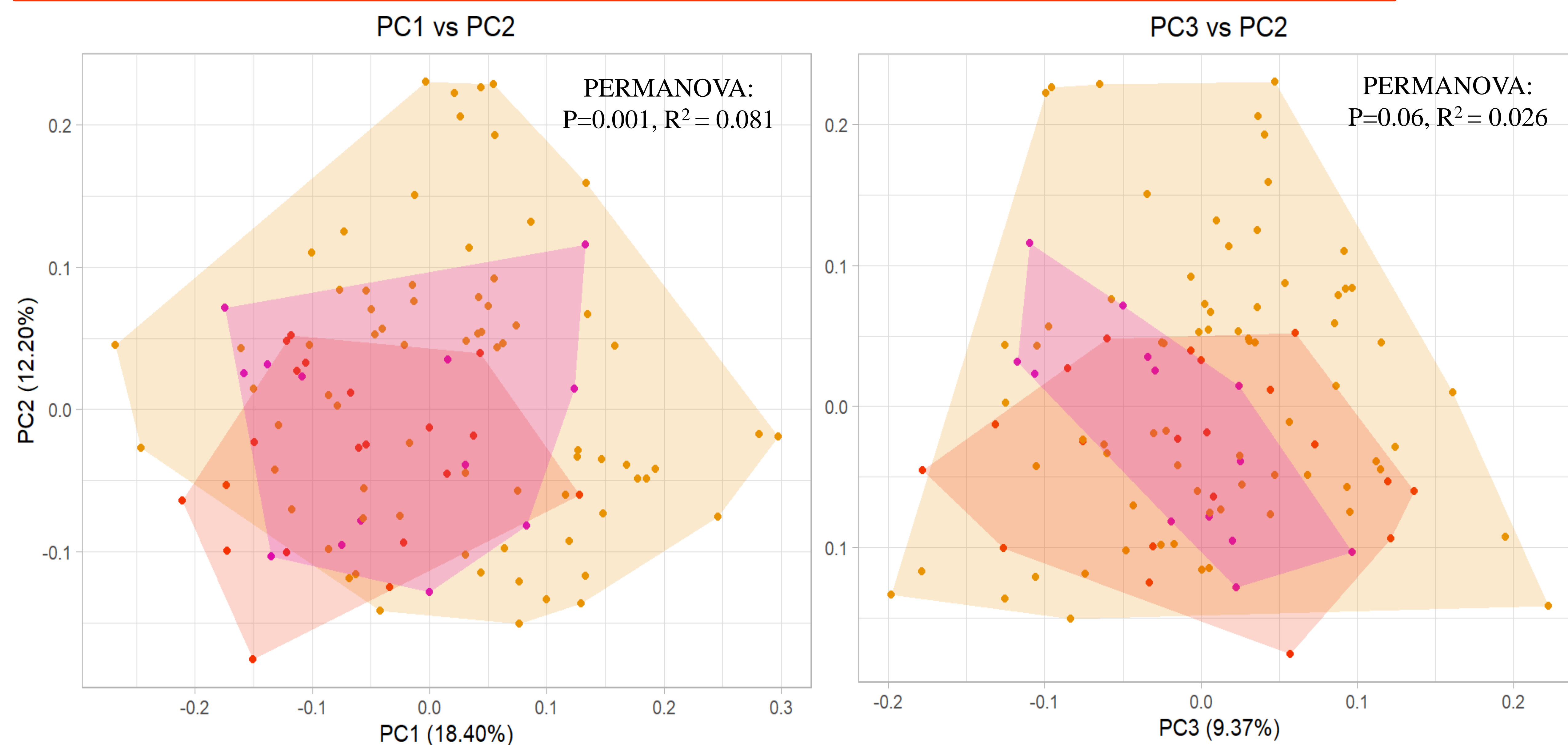
Materials and Methods

- 19 blanks were reduced by 3 knappers (LR, JR, and MD) via a random number generator selecting one of all possible 2x2cm platforms; the largest flake was then removed from that platform
- The blanks (like the one shown at right) were 3D scanned with an Einscan Pro 2X every 3 removals producing 72 cores
- 2D EFA uses Fourier transforms to represent a closed outline as a sum of cosine and sine functions; by slicing our 3D scans into 50 2D outlines, running 2D EFA in R v4.2.2, and then reassembling, we were able to resolve the 3D shape in a novel approach to 3D EFA, shown bottom left (3)
- We applied our 3D EFA approach to the experimental lithics and archaeological lithics from FxJj 31 (n=20) and FxJj 63 (n=13), both sites in the Koobi Fora Formation

Above left: a least-effort handaxe showing the numbered 2x2cm platforms
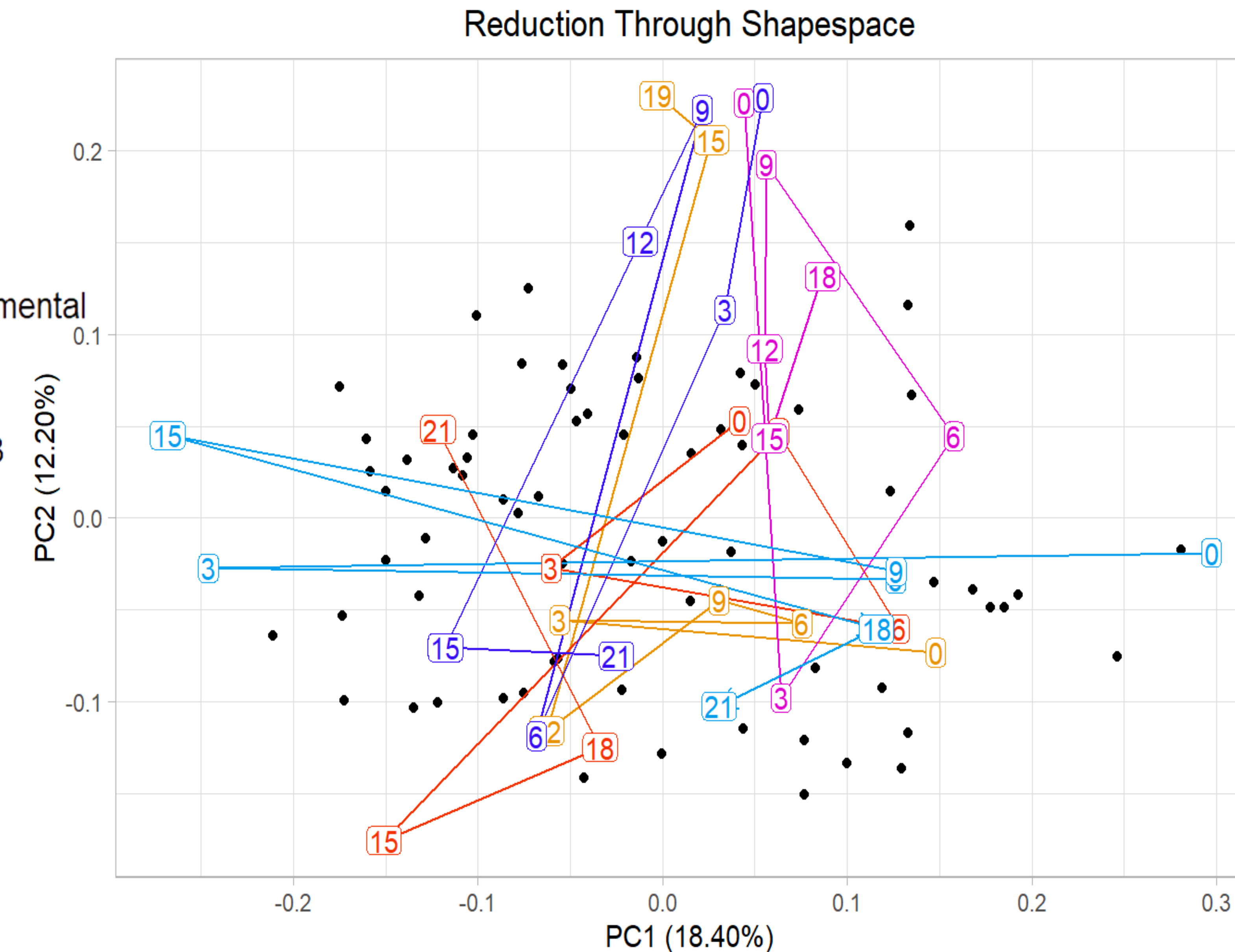**Above right**: LR demonstrating the freehand knapping utilized

Above: yellow is the raw 3D scan data red overlay is the EFA shape data
Below: the 50 slices of just the EFA shape data showing the faithful shape reproduction with this method

PC1 vs PC2
PERMANOVA: P=0.001, R^2 = 0.081

PC3 vs PC2
PERMANOVA: P=0.06, R^2 = 0.026

Class
- Experimental
- FxJj 31
- FxJj 63
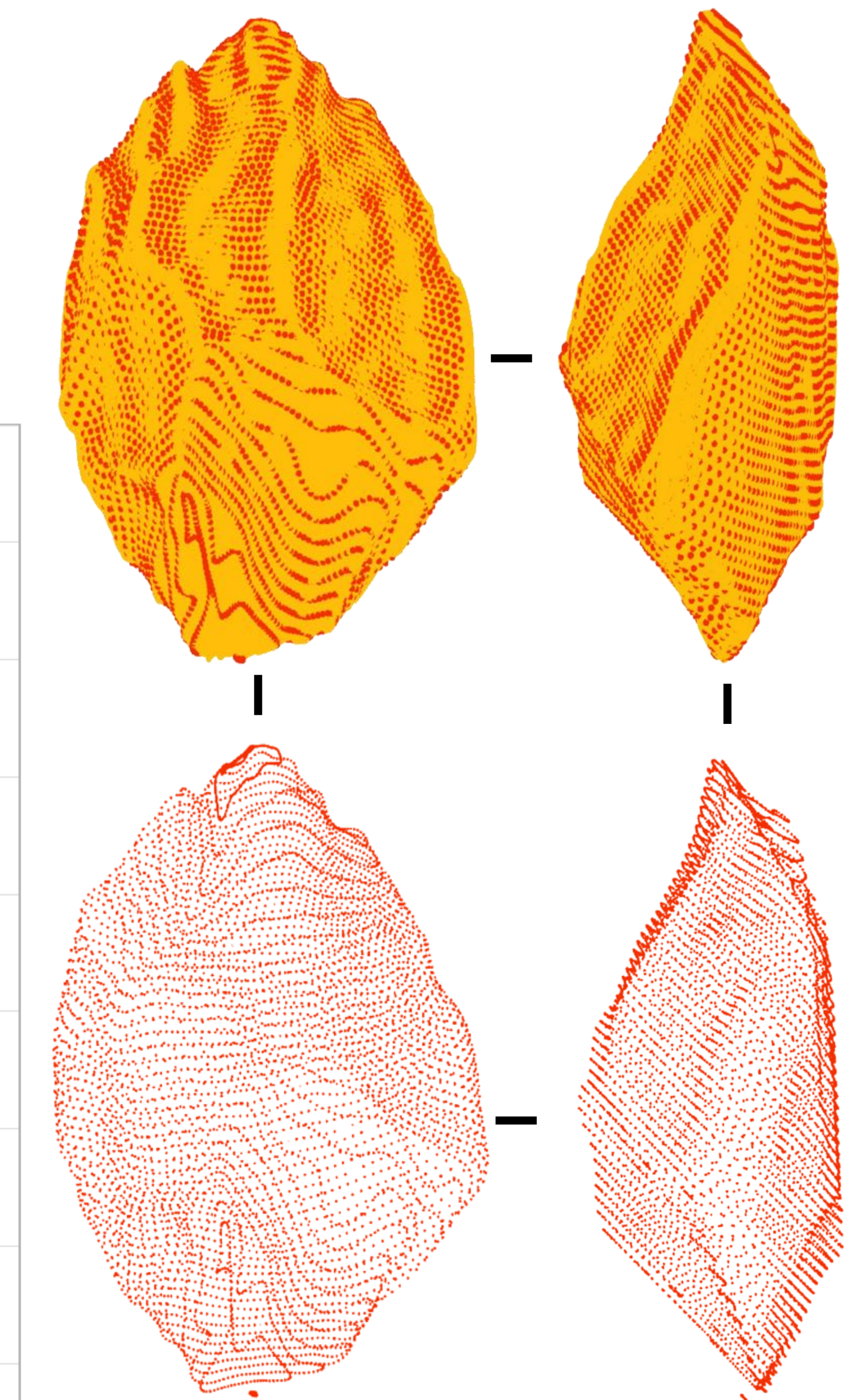
Reduction Through Shapespace

- The least-effort shape space almost completely encompasses the area occupied by the two archaeological samples
- PERMANOVA (999 permutations) showed that while class (archaeological or experimental) does significantly predict PC1-3 scores, the amount of variation explained by class is miniscule

These 5 examples of experimental lithics show both how rapidly reduction can affect morphology and that there is no convergence on a specific morphology throughout reduction
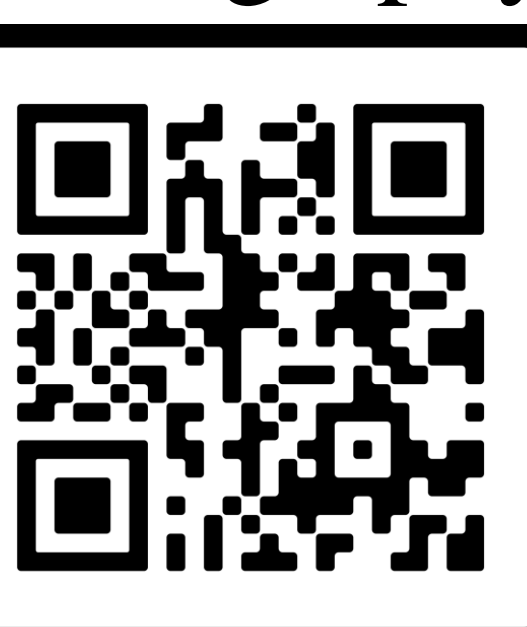
Results

- Least effort knapping produced all possible the variation seen in the Acheulean, though the archaeological sample does represent a significant subsample
- This discrepancy is potentially explainable as FxJj 31 and FxJj 63 representing a specific stage in the lithic life history, but the amount of variation explained by the PERMANOVA did not change when the experimental sample was limited to reductions 6 through 15.
- Holistic 3D GM methods may not be as able to target relevant shape variation as landmark-based methods

Conclusion

- The Acheulean assemblages occupy a statistically significant subset of variation possible, but is too varied to differentiate from a least-effort assemblage
- Through future work, if the Acheulean was shown to be a flake-core technology, assumptions about mental templates, hierarchical thought, and social learning are unsupported. The only difference between the Oldowan and the Acheulean may be material choice.

QR to R code and bibliography

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