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Did Neanderthals grip tools in the same way as us?

Potential insights from bone functional adaptation in the distal capitate

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Introduction

Although the hand is highly dexterous, only a small number of grips are frequently used when living *Homo sapiens* make and use Lower Palaeolithic stone tools [1,2] [Fig.1]. These grips confer precision and force to tool manufacture and use, and the morphology of the *H. sapiens* wrist is thought to have evolved in adaptation to them. It has been hypothesised that Neanderthals, who have more *H. sapiens*-like hand morphology compared with earlier fossil hominins, and habitually used stone tools, would have used similar grips and experienced similar wrist loading to *H. sapiens* [2].

However, due to differences in capitate-metacarpal articulations between Neanderthals and recent *H. sapiens* [Fig.2], others have suggested that Neanderthals may have habitually gripped tools and loaded their hands differently to fossil and recent *H. sapiens* [3].

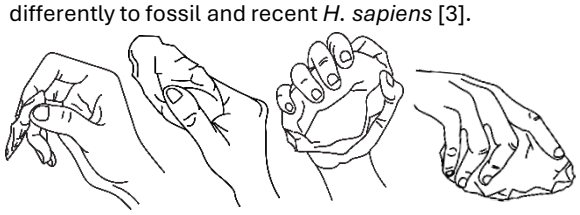

Figure 1 (left). A sub-sample of grip types frequently used by living *H. sapiens* during Lower Palaeolithic tool use [2]. From left to right: two-jaw chuck pad-to-side, three-jaw buttressed pad-to-side, cradle grip, three-jaw chuck pad-to-side.

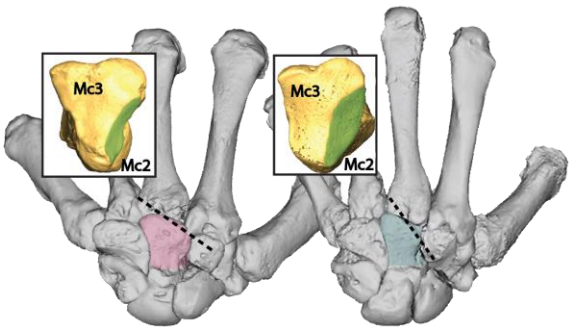

Figure 2. Wrist and palm of Neanderthal (left) *H. sapiens* (right). The distal capitate is coloured. The angle of the capitate-metacarpal 3 styloid process articulation is shown by a dotted line. The inset boxes show the distal capitate and angle of the Mc2 facet (highlighted green).

Methods

We tested whether **Neanderthals (n=4)** have a mean relative total bone volume (trabecular and cortical) to total volume (**rTBV/TV**) distribution that differs from **recent (n=28) and fossil (n=4) *H. sapiens*** using canonical holistic morphometric analysis (cHMA) [4]. We conducted a Principal Component Analysis (**PCA**) on the rTBV/TV distribution within each distal capitate and compared group differences using permutational **MANOVA**s on PC 1-3 and report the Euclidean distances between group centroids.

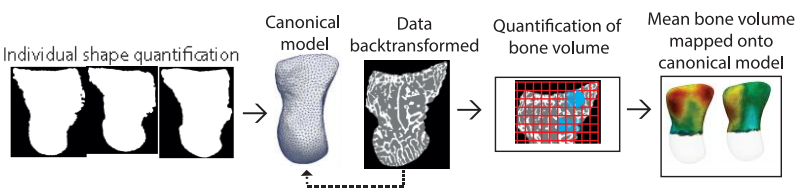

Figure 3. Workflow of the cHMA method. cHMA builds a canonical capitate model onto which each individual is deformed, allowing statistical comparisons of the rTBV/TV distribution between sample groups.

Results

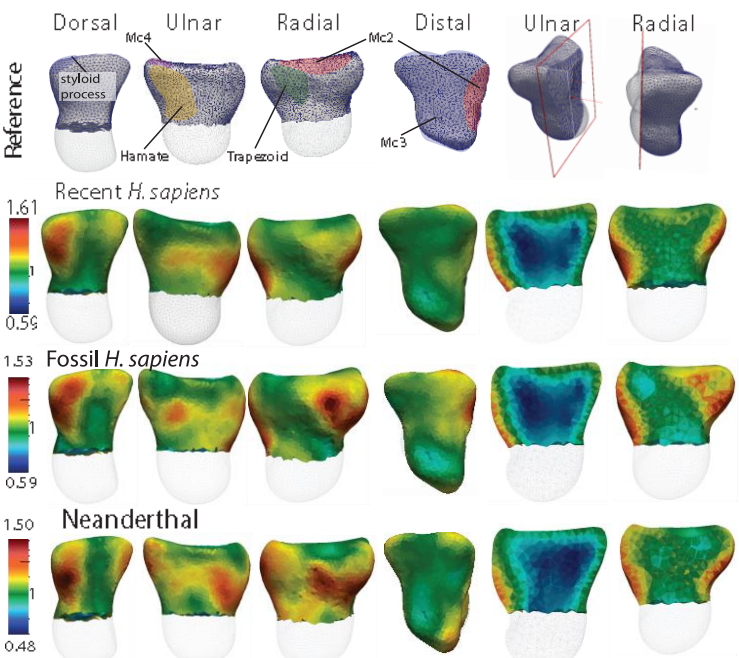

Figure 4. Distribution of mean rTBV/TV in each group. **Green is average relative bone volume**. Warmer colours are greater than average, and cooler colours are lower than average.

The distribution of rTBV/TV for each group is in Fig. 4. The centroids of fossil *H. sapiens* and Neanderthals both fell within the range of variation of recent *H. sapiens*, while there was no overlap between the two fossil groups [Fig.5]. The permutational MANOVA was not significant (p=0.082).

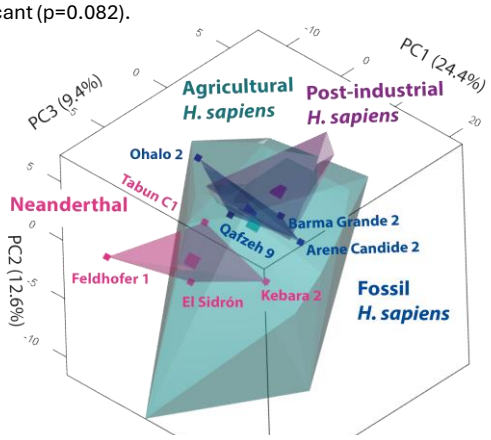

Figure 5. 3D PCA. Recent *H. sapiens* were pooled for analysis, but post-industrialised (purple) and agricultural (green) populations are visualised separately.

The smallest Euclidean distance was between recent and fossil *H. sapiens* (3.169), then between Neanderthals and fossil *H. sapiens* (6.343), with the biggest distance between Neanderthals and recent *H. sapiens* (8.764).

Discussion and Conclusions

GRIP DIVERSITY

The Neanderthal centroid fell within recent *H. sapiens* variation but was separated from fossil *H. sapiens*. This potentially suggests that **recent *H. sapiens* are employing greater grip diversity compared to the Neanderthal or fossil *H. sapiens*** included here. Neanderthals and fossil *H. sapiens* potentially use more limited or specialised grips, which are different from one another.

DIRECTION OF HAND LOADING

Although no statistical differences were found, the mean rTBV/TV distribution for each group suggests subtle loading differences between Neanderthals and *H. sapiens*. Higher rTBV/TV at the radial and ulnar aspects of the capitate in **Neanderthals may suggest greater transverse loading across the wrist compared to more oblique loading in *H. sapiens***.

NEXT STEPS

Further research is required to substantiate these conclusions. The **inclusion of *H. sapiens* with known occupation** would help to determine whether grip type was more restricted in Neanderthals and fossil *H. sapiens*, or an **artefact of small sample size**.

References: [1] Marzke, M. W., 1997. Precision grips, hand morphology, and tools. Am. J. Phys. Anthropol., 102(1), 91-110. [2] Key, A., Merritt, S. R., & Kivell, T. L., 2018. Hand grip diversity and frequency during the use of Lower Palaeolithic stone cutting-tools. J. Hum. Evol., 125, 137-158.. [3] Niewoehner, W. A., 2001. Behavioural inferences from the Skhul/Qafzeh early modern human hand remains. PNAS, 98(6), 2979-2984. [4] Bachmann, S., et al., 2022. A computational framework for canonical holistic morphometric analysis of trabecular bone. Sci. Rep., 12(1), 5187. This research was supported by a 50th Anniversary Research Scholarship, University of Kent and the Calleva Foundation (EEB), FP7 European Research Council Starting Grant #336301, European Union's Horizon 2020 research and innovation programme Grant #819960 and the Max Planck Society (TLK). **Acknowledgements:** For providing access to the specimens, we would like to acknowledge: Bavarian State Collection of Zoology; Berlin Museum für Naturkunde; University of Cambridge; Frankfurt Senckenberg Museum; Georg-August-University Goettingen, the Mary Rose Trust; Max Planck Institute; Powell-Cotton Museum; Royal Museum for Central Africa; Tel Aviv University; University of Florence; Vienna Natural History Museum. For technical support we thank S. Bachmann, TU Wien.