WORDS BONES GENES TOOLS
Tracking Linguistic, Cultural, and Biological Trajectories of the Human Past

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THE ROLE OF CULTURE IN EARLY EXPANSIONS OF HUMANS

Assessing tool complexity

Combining approaches from Cognitive Archaeology and Information Theory

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Introduction

Assessing tool complexity in archaeology remains a controversial issue, as past hominins' cognitive capacities to engage with objects and materials from their environment cannot be measured directly from the artefacts. Therefore, we propose a novel method to evaluate complexity in tool-behavior based on so-called cognigrams and their information-theoretic evaluation. We measure subtle differences observed between hammer stone techniques used by capuchins, chimpanzees and humans [1].

Adopted from Proffitt et al. (2016) [2]

Entropy

The compositional elements of cognigrams are translated into code-strings with a specifically developed syntax. Comparative evaluation is carried out by an information-theoretic account based on estimating Shannon entropy [4], i.e. the average information content of elements in cognigrams.

Cognigrams

Observed and reconstructed production processes are coded into cognigrams. These reflect cognitive performance during the production and use of tools by reconstructing the different attention foci (raw materials, tools), required action steps, and resulting effects that in turn demand behavioral readjustments [3].

Use of anvil by capuchins pounding stones

0. Perception of basic need: aggressive display or hunger for mineral nutrients by pounding stones
0a. Perception sub-problem 1: need of stones to be pound
0b. Perception sub-problem 2: need of stones to be pound on, anvil/embedded stone

PHASE I: Approaching raw material site
1. Moving to conglomerate bed

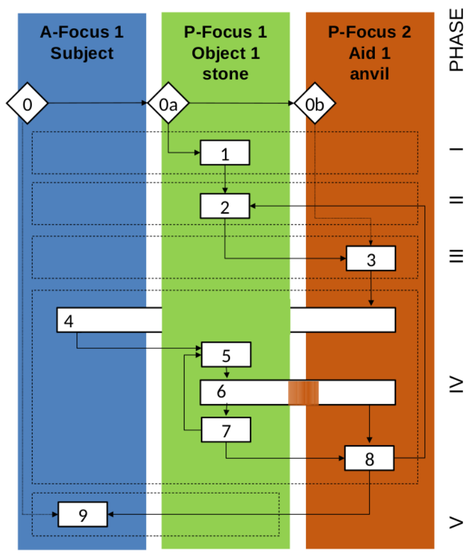
PHASE II: Search for objectl 1
2. Search for stone to be pound

PHASE III: Search for aid 1
3. Find embedded stone to be pound on

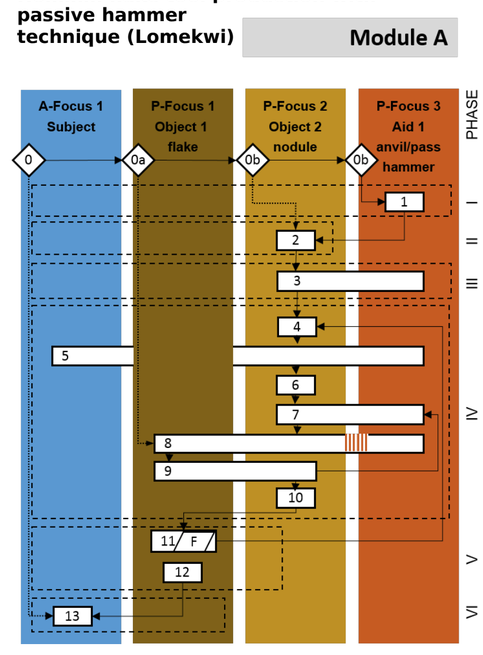
PHASE IV: Manipulating items object 1/free stone by pounding on aid 1, anvil/embedded stones
4. Positioning of individual
5. Gripping of free stone
6. Pounding (several times)
7. Optionally: perception of result (sniffing, licking)

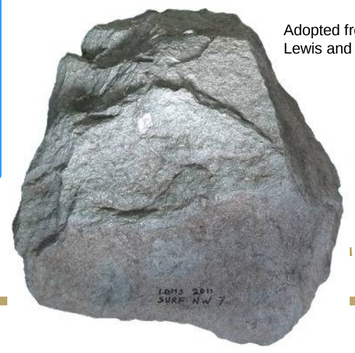
If necessary: Repetition of actions 5-7
8. Putting free stone aside
If necessary: Repetition of phases II-IV with actions 2-8

PHASE V: Satisfaction of need
9. Aggressive display/consumption of mineral nutrient



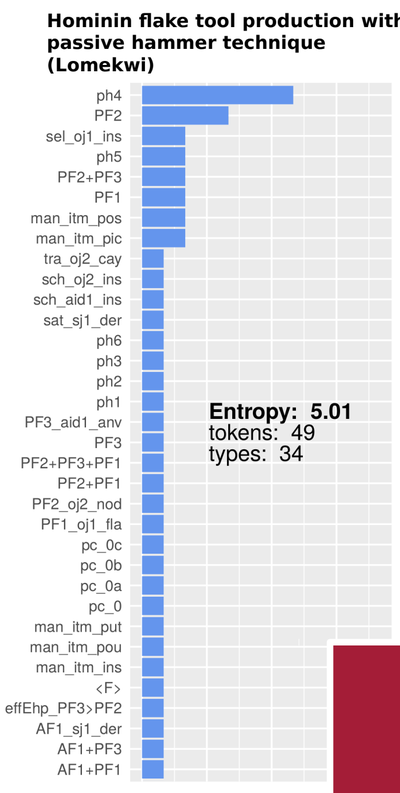
Hominin flake tool production with passive hammer technique (Lomekwi) — Module A → **Use of flake for dissecting carcass** — Module B





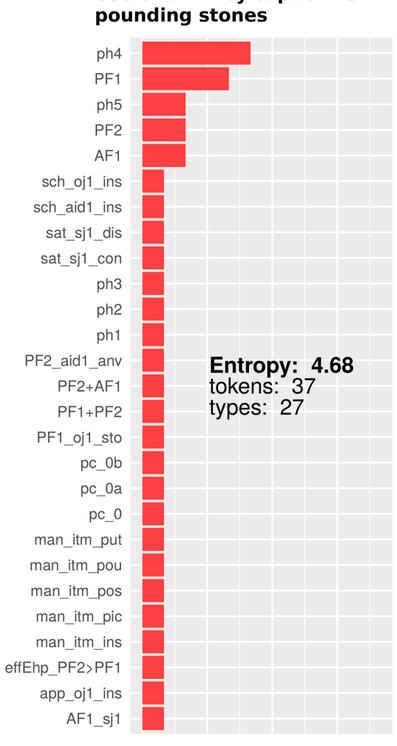
Adopted from Lewis and Harmand (2016) [5]

Hominin flake tool production with passive hammer technique (Lomekwi)



Entropy: 5.01
tokens: 49
types: 34

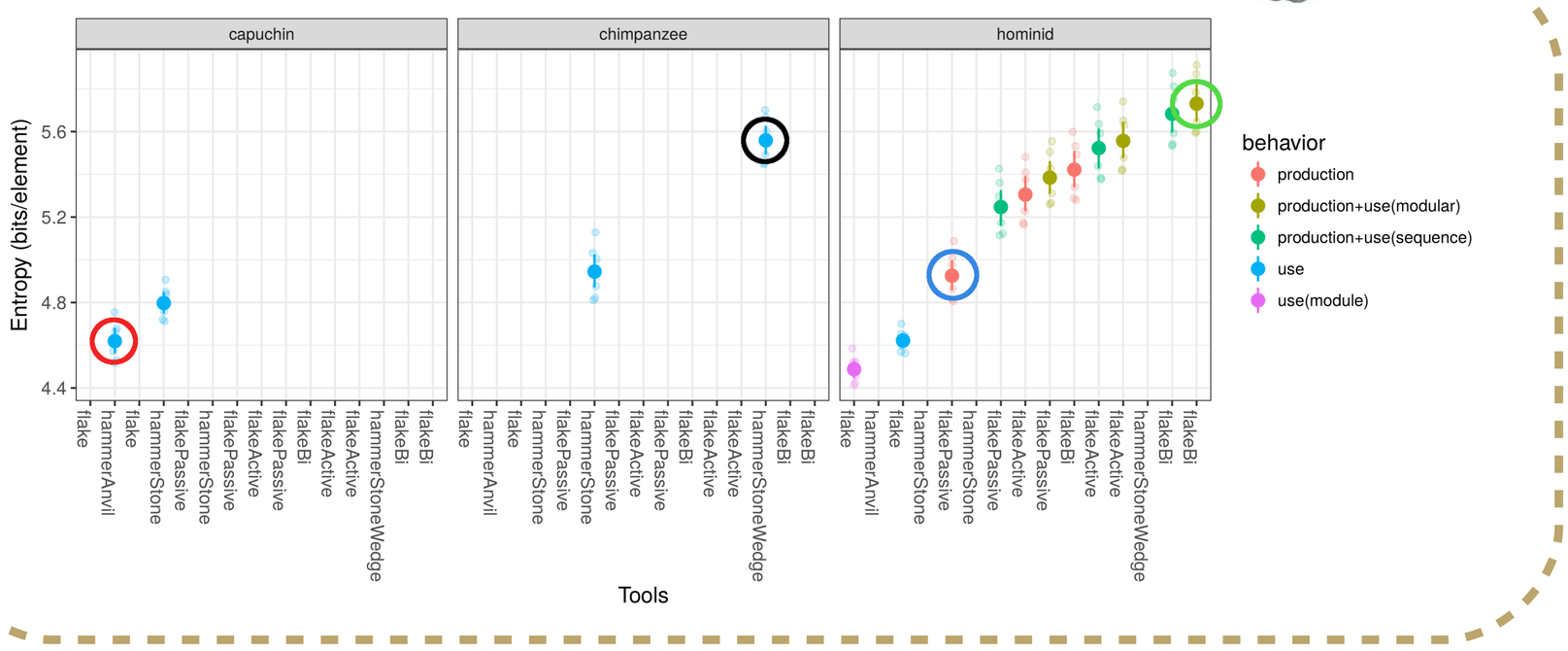
Use of anvil by capuchins pounding stones



Entropy: 4.68
tokens: 37
types: 27

Results

Capuchin stone crushing has a mean entropy (bits/element) of **4.62 (SD=0.09)**, and is less complex than **chimpanzee nut cracking (M=5.56, SD=0.1)**, with a wedge to stabilize the anvil. In fact, the latter is even more complex than early hominin stone tool production, such as the **passive knapping technique (M=4.93; SD=0.11)**, as represented in the Lomekwi finds (ca. 3.3 M years old) [5]. Hominin behavioral complexity reaches and surpasses that of chimpanzees with the modularization of tasks. For example, the combined production and use of **flakes with bipolar percussion techniques (M=5.73; SD=0.13).** Modularization also renders more sophisticated composite technologies such as wooden spears thinkable.



References

[1] Lombard, M., Högberg, A., Haidle M.N. in prep. Primate thinking: from capuchin rock pounding to Lomekwian flake production.
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Acknowledgements

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