

INVESTIGATING THE CULTURAL EVOLUTION OF THE BLOMBOS AND DIEPKLOOF ENGRAVINGS

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1. Introduction

The empirical study of language evolution either studies the sparse material remains of past expressive behaviors (archeology) or humans (genetics and cranial casts), or experimentally tests modern humans in simple laboratory experiment. A concern could be if our laboratory investigations are sufficiently connected to the phenomenon they are intended to investigate. Here we attempt to bridge this epistemic gap by using archeological items directly as stimuli in an experiment.

Dating back as far as 100 ka, the South African Blombos ochre and the Diepkloof ostrich egg engravings are considered among the earliest fossilized evidence of human symbolic behavior and have thus informed discussions about early language evolution (Henshilwood, d'Errico, & Watts, 2009; Hodgson, 2014; Texier et al., 2013). Of special interest is the temporal trajectory spanning more than 40 thousand years from earlier simpler parallel line patterns to later complex cross-hatchings (see figure 1A).

We hypothesize that this development is indicative of a cumulative adaptive evolution of engraving practices refining them over generations through

processes of reproduction, transmission and learning to become increasingly adapted for their symbolic functions.

In order to investigate if the temporal development of the patterns indeed can be associated with mechanisms of cultural transmission, we first extracted a number of measures characterizing the compositional development of the original patterns, such as Kolmogorov and perimetric complexity (Kolmogorov, 1963; Tamariz & Kirby, 2015), Shannon entropy (Shannon, 1948), and symmetry (Kovesi, 1997). Generally, we observe that patterns become more symmetrical and more complex over time, however with a quadratic trend for complexity (intermediate period patterns are more complex). We then conducted an experimental simulation in the lab. Eight transmission chains of eight generations reproduced patterns in a digitized experimental environment. We seeded each chain with stylized outlines of engraved patterns from the earliest period of the Blombos or Diepkloof collections (see figure 1B). After a brief presentation (3 s) of a pattern the participant was instructed to reconstruct it from memory by placing and rotating lines using the computer mouse. The resulting figures were passed down as training stimulus for participants of the next generations etc. (Kirby & Hurford, 2002).

We then apply the same analytic metrics used to quantify the development of the original patterns to analyze the compositional development of the experimentally derived patterns. While data collections are still under completion, preliminary analyses suggest that indeed the developments of the experimentally derived patterns correlate with corresponding measures of the original patterns indicating that the Blombos and Diepkloof engravings could be the product of cumulative cultural transmission processes.

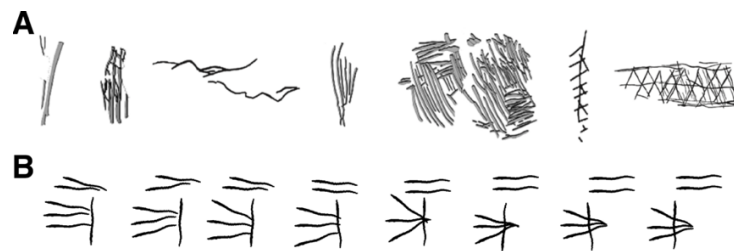


Figure 1. **A:** organization of the Blombos engravings as a function of time with the older items to the left dating to ~100 ka and the more recent to the right dating to ~60 ka. **B:** example of data from the iterated learning experiment. From left to right is the reproduction from generation 1-8.

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References

- Henshilwood, C. S., d'Errico, F., & Watts, I. (2009). Engraved ochres from the middle stone age levels at Blombos Cave, South Africa. *Journal of human evolution*, 57(1), 27-47.
- Hodgson, D. (2014). Decoding the Blombos engravings, shell beads and Diepkloof ostrich eggshell patterns. *Cambridge Archaeological Journal*, 24(01), 57-69.
- Kirby, S., & Hurford, J. R. (2002). The emergence of linguistic structure: An overview of the iterated learning model. In *Simulating the evolution of language* (pp. 121-147): Springer.
- Kolmogorov, A. N. (1963). On tables of random numbers. *Sankhyā: The Indian Journal of Statistics, Series A*, 25(4), 369-376.
- Kovesi, P. (1997). *Symmetry and asymmetry from local phase*. Paper presented at the Tenth Australian joint conference on artificial intelligence.
- Shannon, C. E. (1948). A mathematical theory of communication. *Bell system technical journal*, 27(3), 379-423.
- Tamariz, M., & Kirby, S. (2015). Culture: copying, compression, and conventionality. *Cogn Sci*, 39(1), 171-183.
- Texier, P.-J., Porraz, G., Parkington, J., Rigaud, J.-P., Poggenpoel, C., & Tribolo, C. (2013). The context, form and significance of the MSA engraved ostrich eggshell collection from Diepkloof Rock Shelter, Western Cape, South Africa. *Journal of Archaeological Science*, 40(9), 3412-3431.