

Evaluating Cultural Transmission in Bronze Age burial rites using radiocarbon data

github.com/nevrome/cultrans.bronzeageburials.NASHH2019

Clemens Schmid

@nevromeCS

github.com/nevrome
clemens@nevrome.de

Symposium

*New Approaches to
the Science
of Human History II*

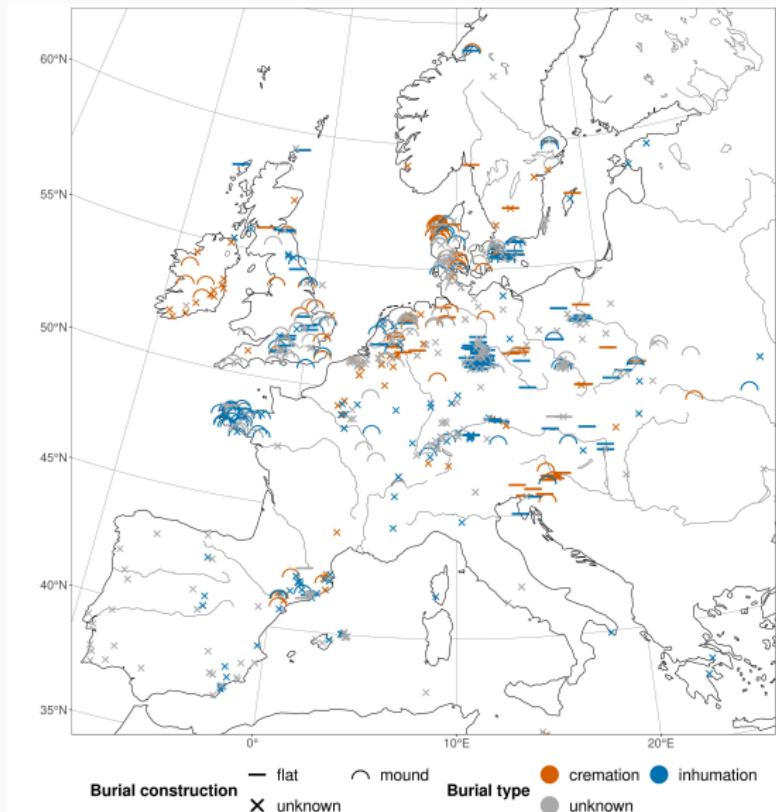
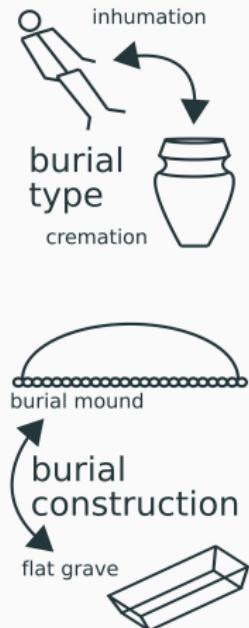
Max Planck Institute
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Introduction

Radiocarbon dates on graves with context information (2200-800 calBC)



Radon-B:
Database of ^{14}C dates for the European Bronze Age

^{14}C dating is an important absolute dating method: One date equals a fuzzy point in space and time with context information

Figure 1: Radon-B ^{14}C dates of graves 2200-800 calBC (Albers Equal Area Conic).

Dates on graves through time

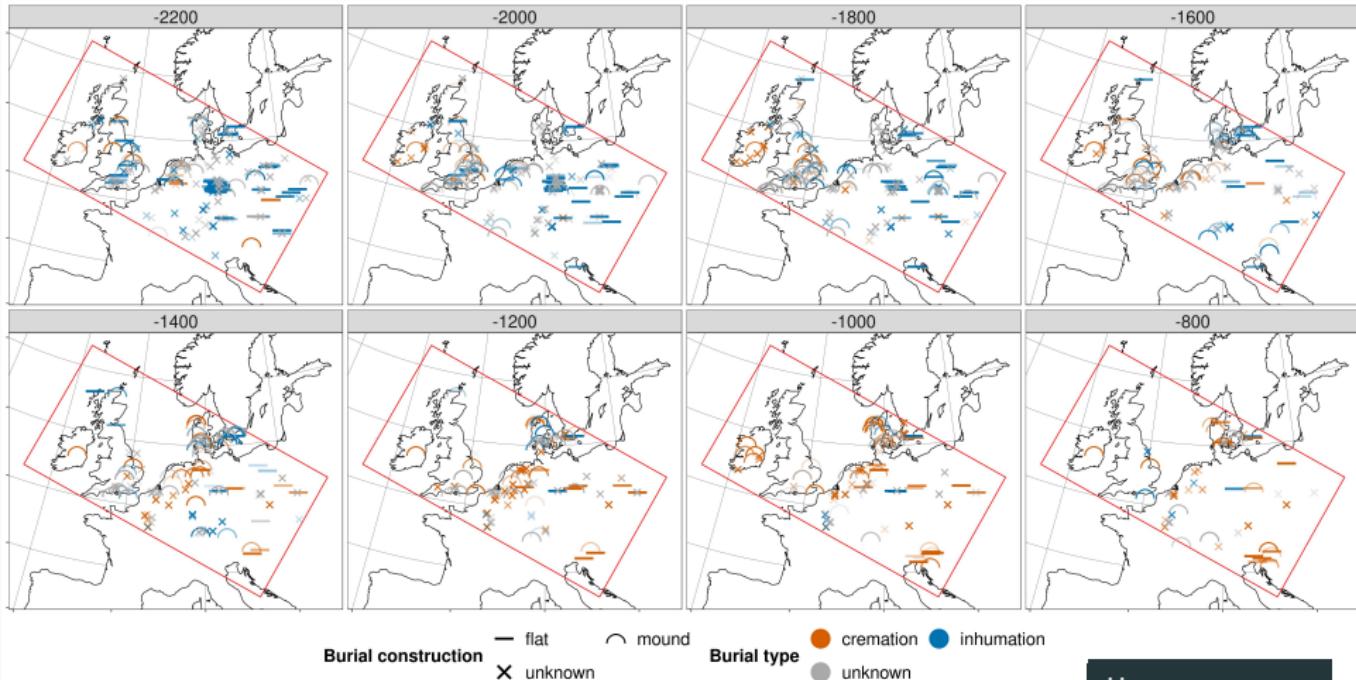


Figure 2: Plot matrix of radiocarbon dates on graves through time.
200 years time slices.

Heterogeneous
information
density in space
and time

Regional time series of Bronze Age burial rites

Artificial macro-regions

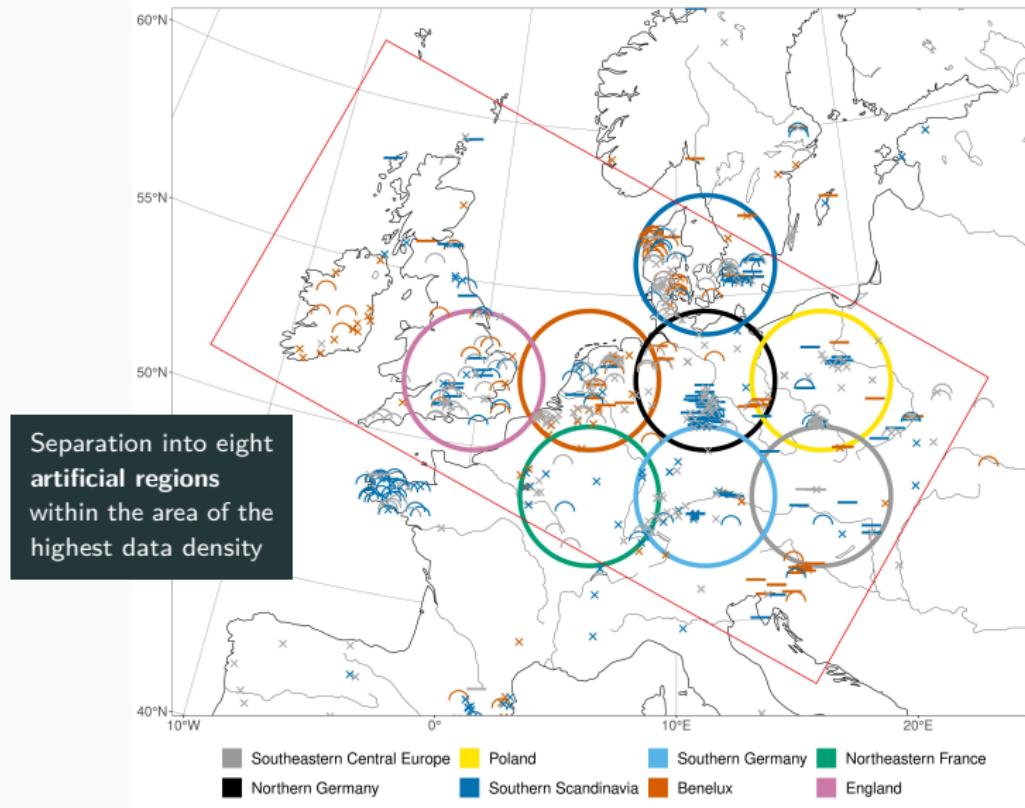


Figure 3: Artificial Regions: 400km distance, 240km radius, ≥ 70 dates.

Burial Rites: Development in absolute numbers

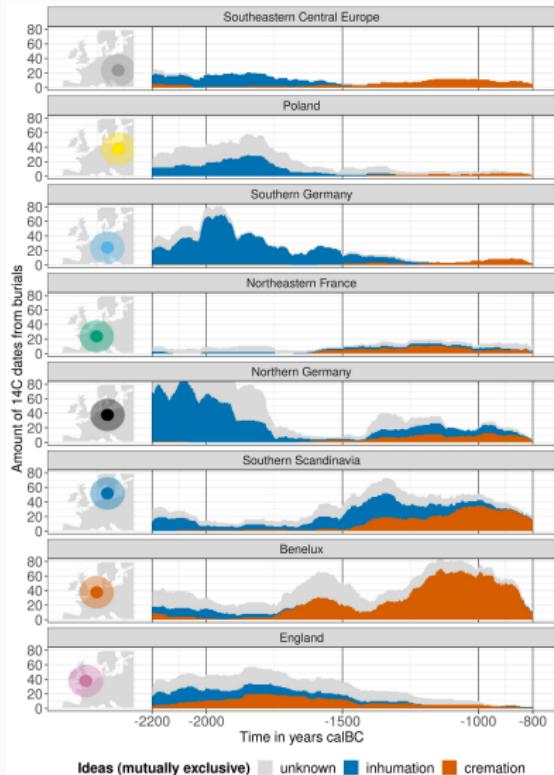


Figure 4: burial type development: Sum of ^{14}C dates whose 2σ range cover the respective year.

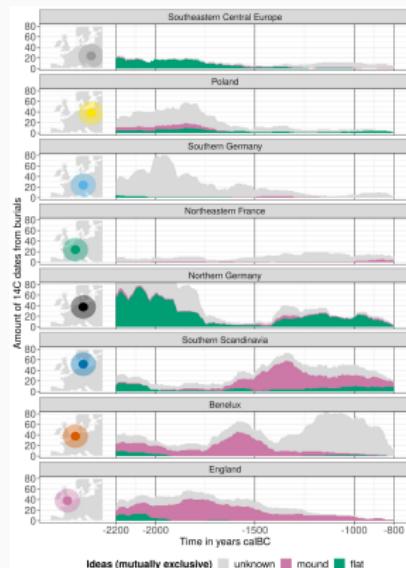


Figure 5: burial construction

Data structure transformation:
Individual ^{14}C dates to region wise
time series of burial rite presence

Burial Rites: Development in relative proportions

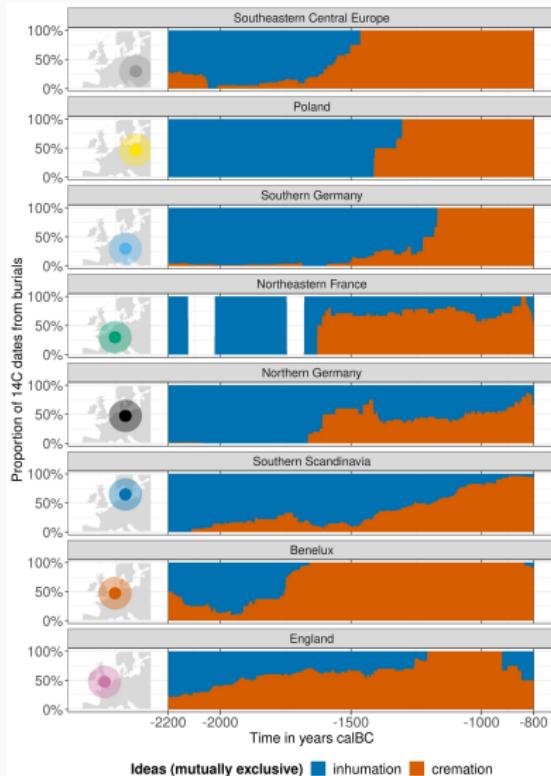


Figure 6: burial type development: Year wise proportions of dates. *unknown* is filtered out.

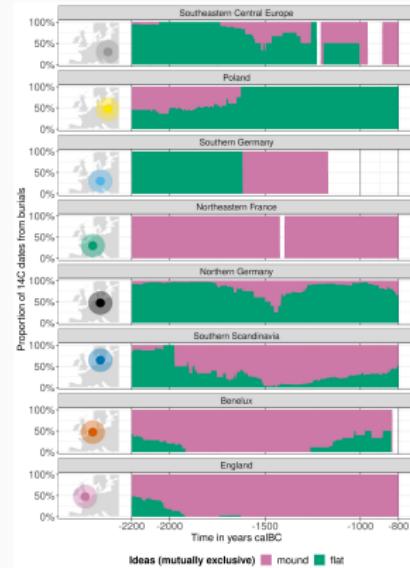


Figure 7: burial construction

Data structure transformation:
Time series of absolute appearances
to time series of burial rite
proportions – burial rite proxy

Cultural and spatial distance

Measuring cultural distance

How do the developments in these regions for **burial type** and **burial construction** relate to each other? Which regions behave alike? Can we measure spatial **interaction intensity**?

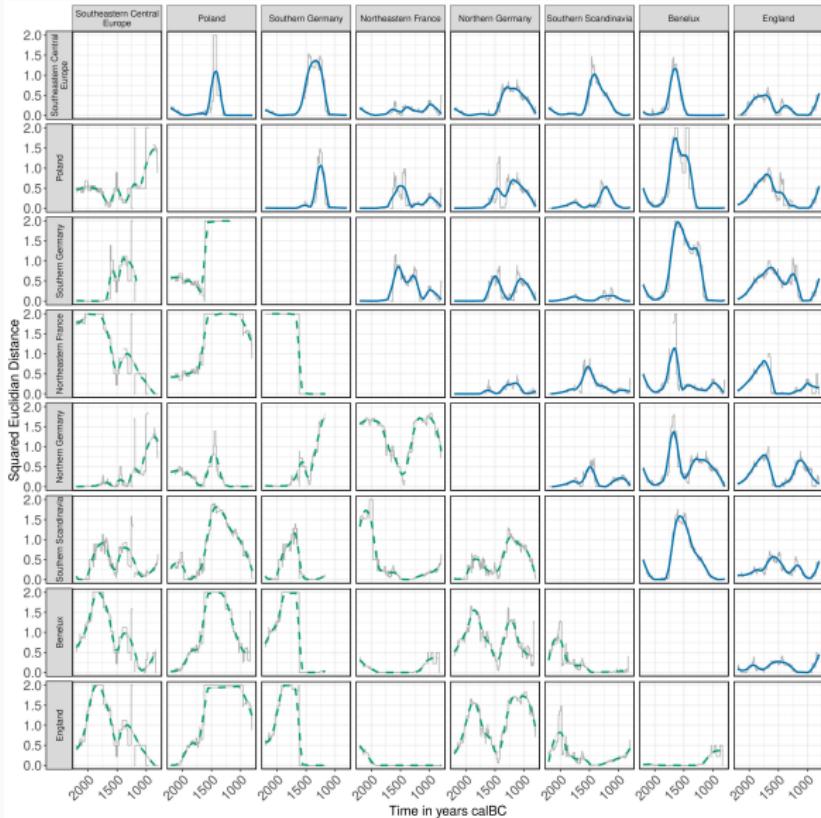
The **Squared Euclidian Distance** is a simple **measure of between-group similarity** that can be applied to the **burial rite proxy** data.

$$d_{ij}^2 = \sum_{k=1}^n (p_{ik} - p_{jk})^2$$

- d_{ij}^2 : Squared Euclidean Distance between two groups i and j
- k : Variant counter
- n : Total amount of variants in a population
- p_{ik} : Relative frequency of the k 'th variant in population i
- p_{jk} : Relative frequency of the k 'th variant in population j

Two matrices of cultural distance development

The SED can be calculated for every year of every one of the $8 \times 8 = 64$ region relationships



burial
construction:
Heterogeneous
distance
development

burial type:
Low distance at the start and end due to the universal shift from inhumation to cremation (Urnfield culture)

Figure 8: SED timeseries for each region relationship. Approximated with LOESS. **burial type** on top, **burial construction** in the bottom left corner.

Spatial distance

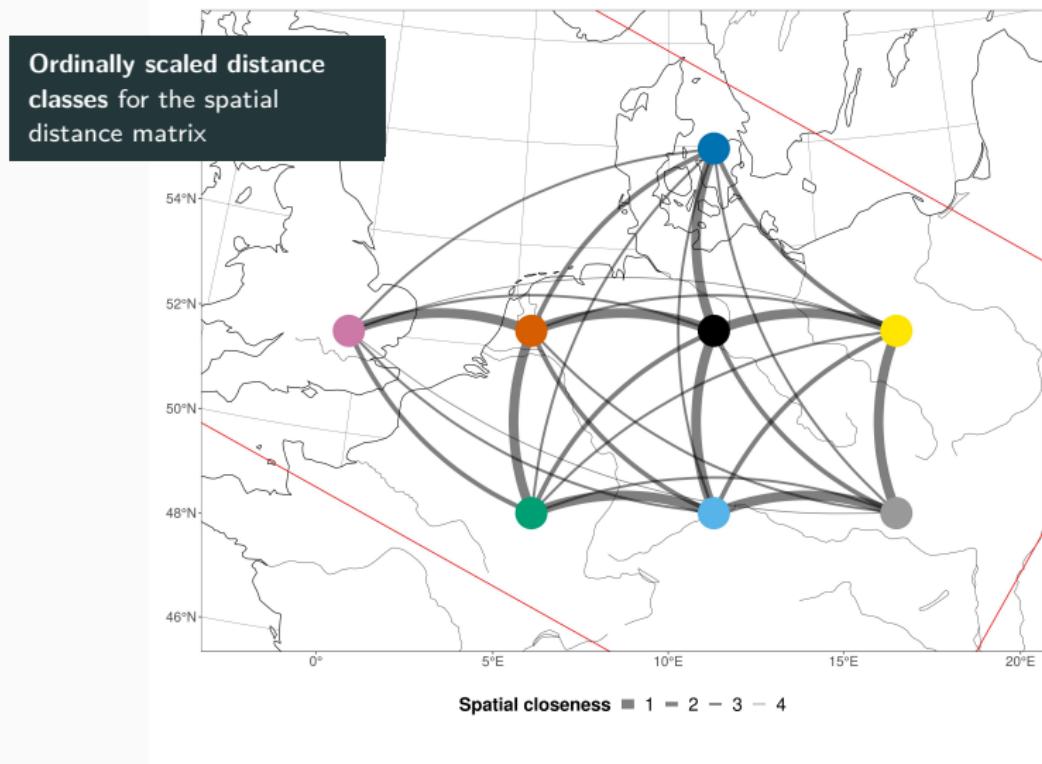


Figure 9: Spatial distance network and definition of distance classes

The complete distance network: Correlation of cultural and spatial distance

C&D: burial type & burial construction distance

No significant correlation

B: burial construction & spatial distance

Weak correlation in the EBA, no correlation in the LBA

A: burial type & spatial distance

Weak correlation in the EBA, negative correlation from the MBA

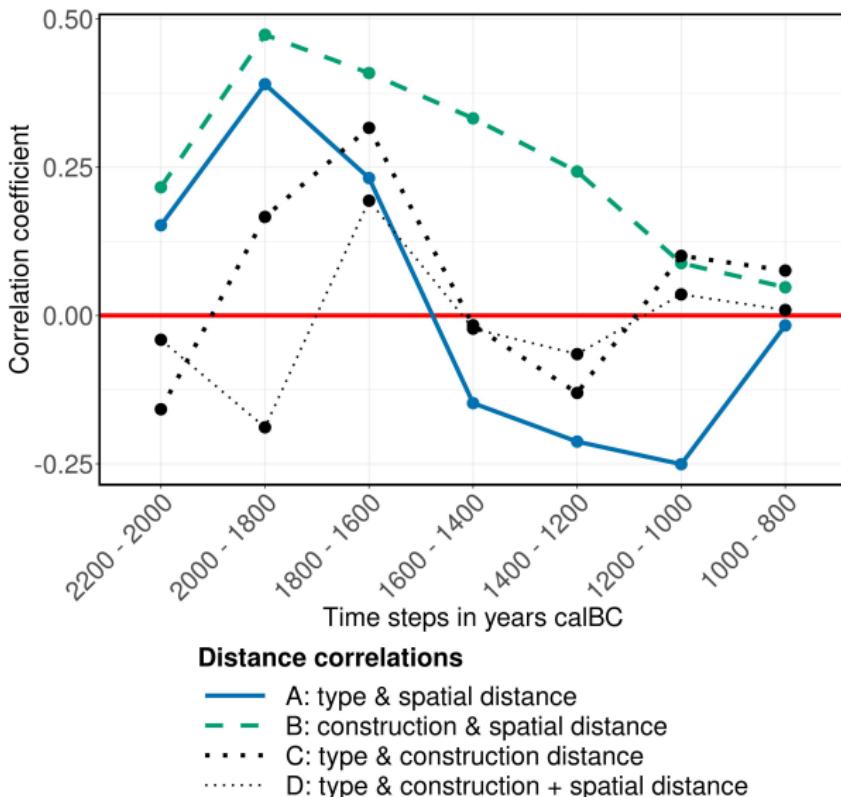


Figure 10: Time series of cultural and spatial distance correlation. 200 years time slots. Mantel statistics with Pearson correlation coefficient and Spearman's rank correlation.

Conclusion

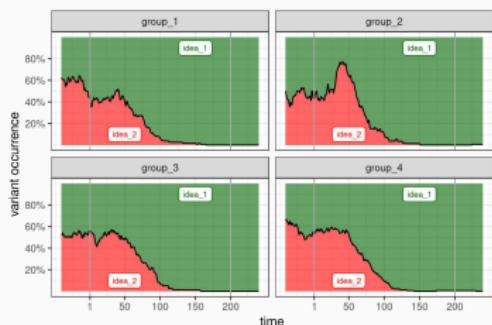
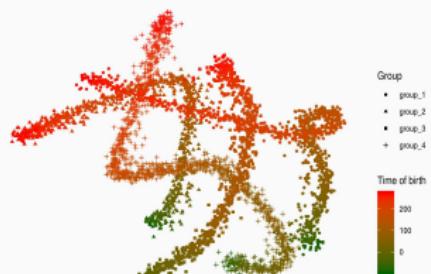
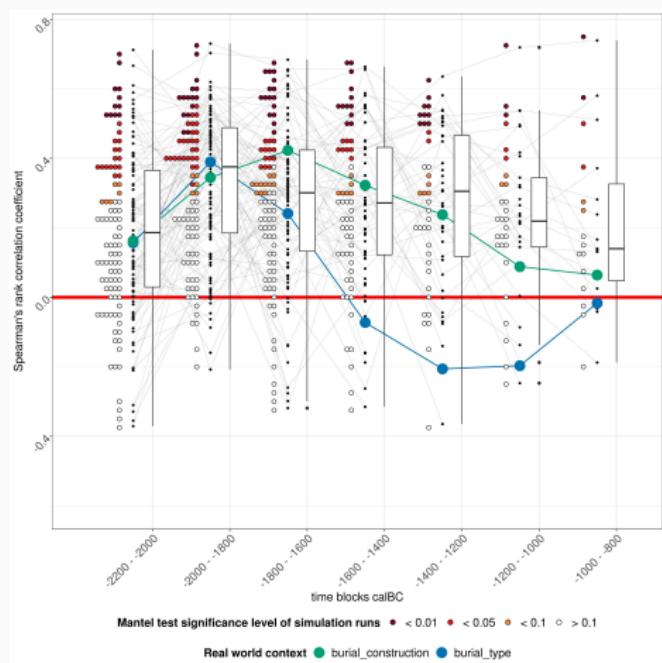
Observations and hypotheses

- The **main trends** in the distribution of burial rites in Bronze Age Europe can be detected in **bulk radiocarbon data**
- The diffusion of the **cremation funeral tradition** and **traditions of flat vs. mound graves** are **mostly independent**
- Both processes are **mostly independent of spatial distance**, except for some time periods in the Early Bronze Age
- **Big phenomena** like the ones initiated by **Tumulus culture** and **Urnfield culture** do not spread in simple diffusion processes
- **Other interaction networks** could yield better predictions: Elite Networks, Religious superstructures, ...

Outlook: Simulating Cultural Transmission

A Population Graph based Style Transmission model in R and C++

github.com/nevrome/popgen.styletrans.saa2019



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