

# Evaluating Cultural Transmission in Bronze Age burial rites using radiocarbon data

[github.com/nevrome/cultrans.bronzeageburials.NASHH2019](https://github.com/nevrome/cultrans.bronzeageburials.NASHH2019)

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Symposium

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## **Introduction**

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# Radiocarbon dates on graves

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

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

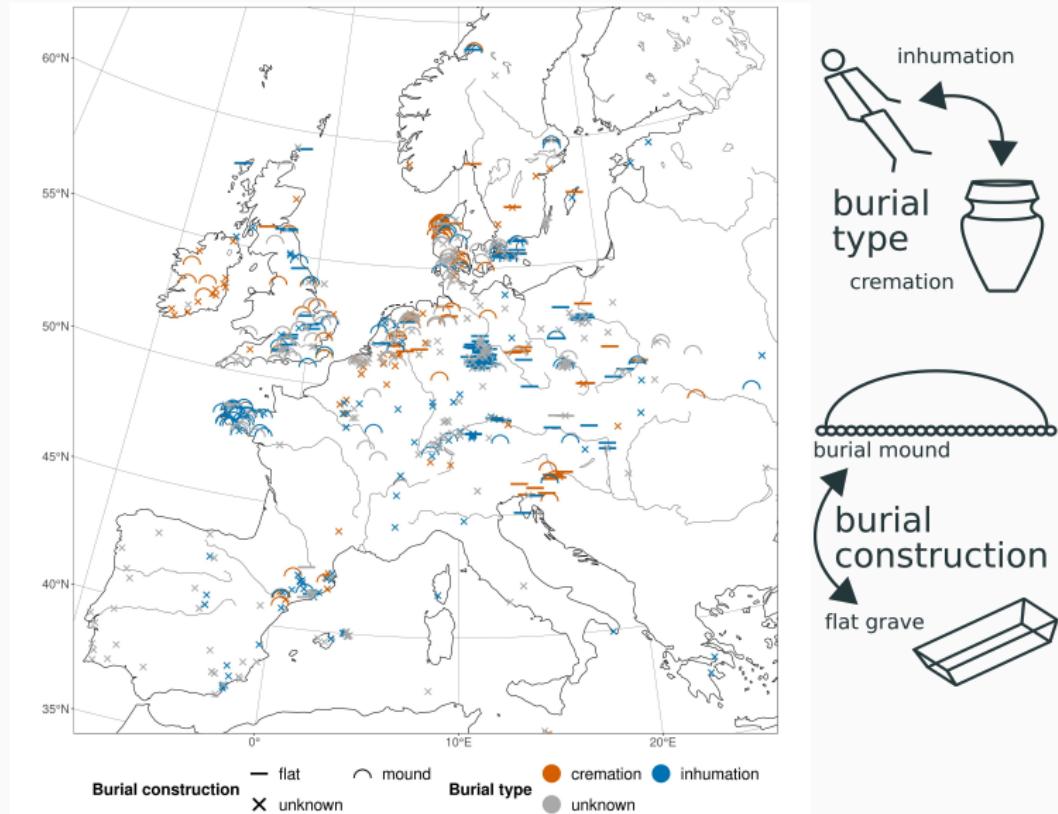


Figure 1: Radon-B  $^{14}\text{C}$  dates of graves 2200-800 calBC (Albers Equal Area Conic).

# Dates on graves through time

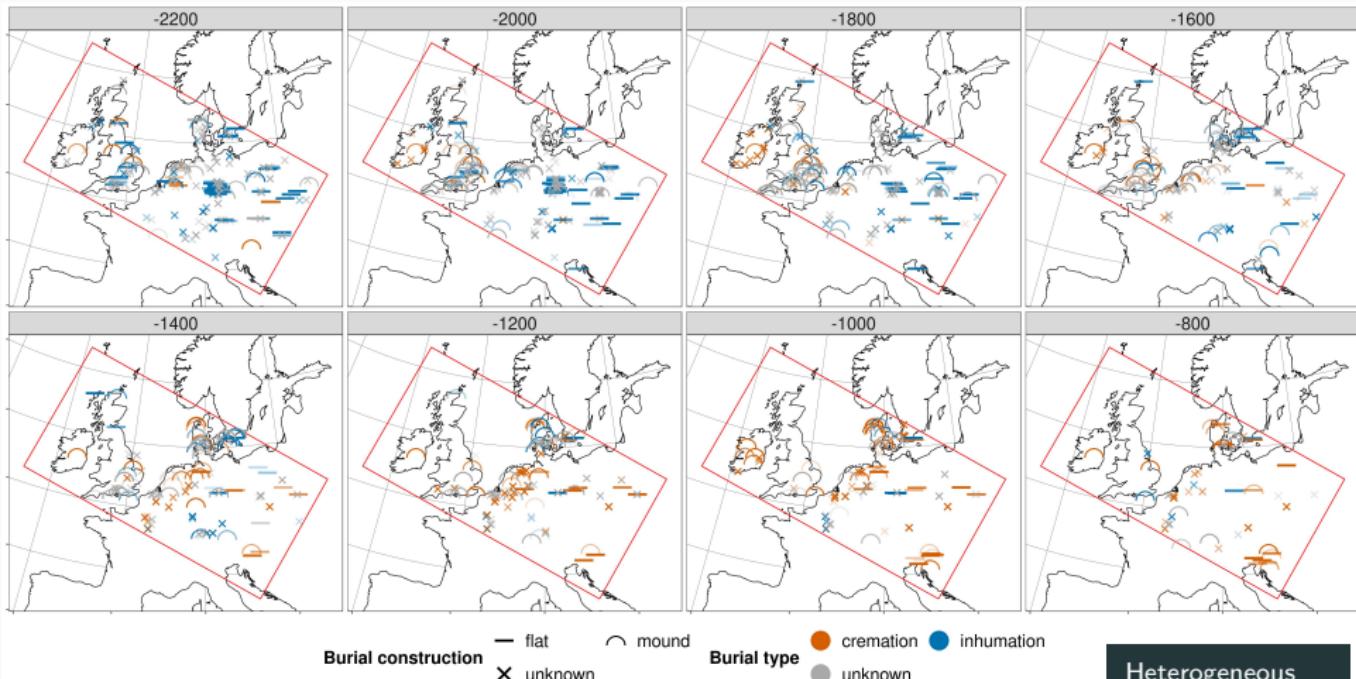


Figure 2: Plot matrix of radiocarbon dates on graves through time.

Heterogeneous  
information  
density in space  
and time

## **Regional time series of Bronze Age burial rites**

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# Artificial macro-regions

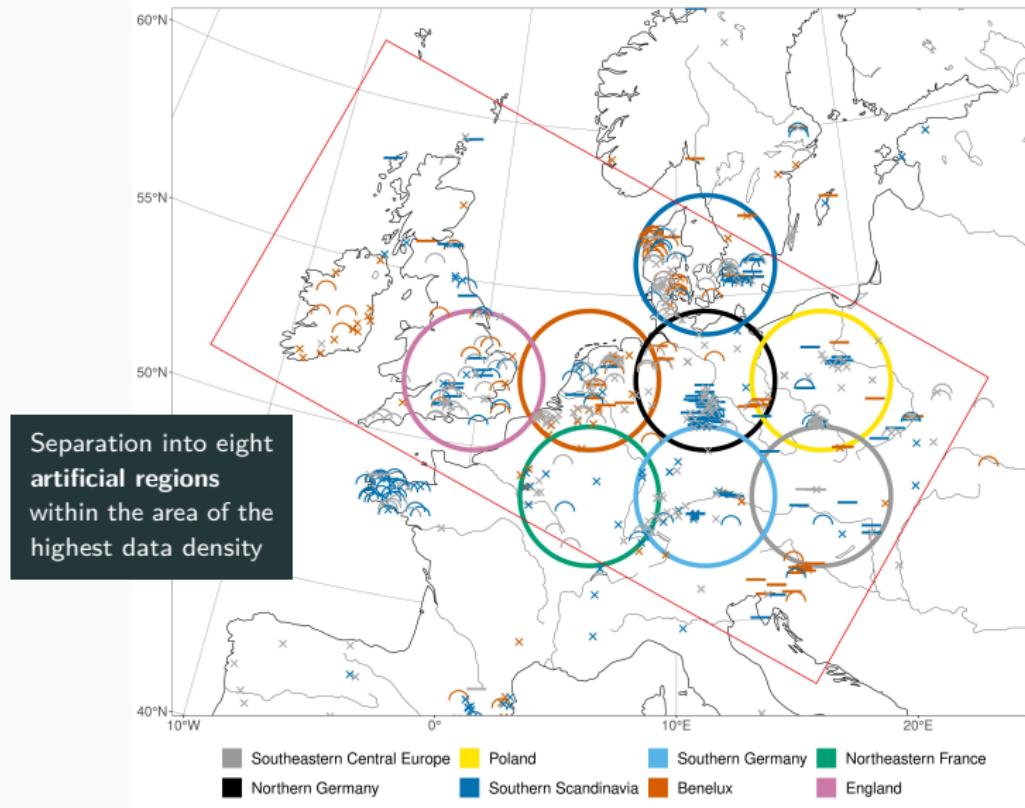
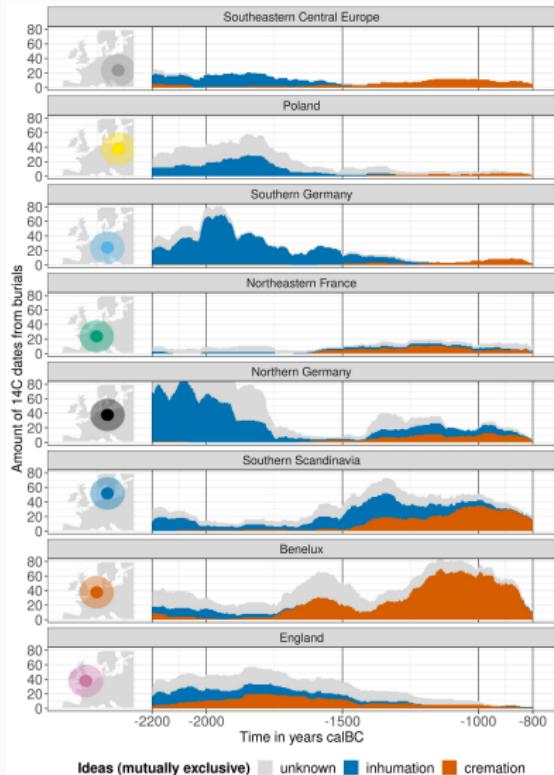
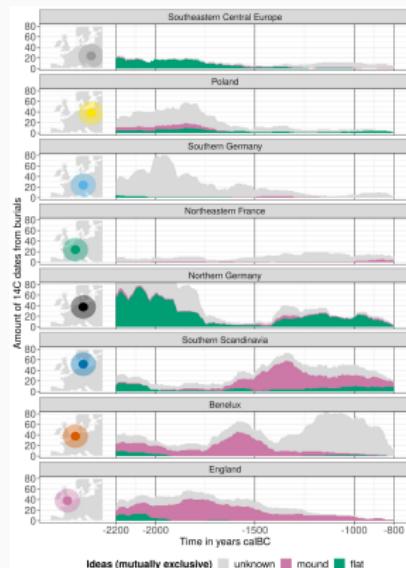


Figure 3: Artificial Regions: 400km distance, 240km radius,  $\geq 70$  dates.

# Burial Rites: Development in absolute numbers



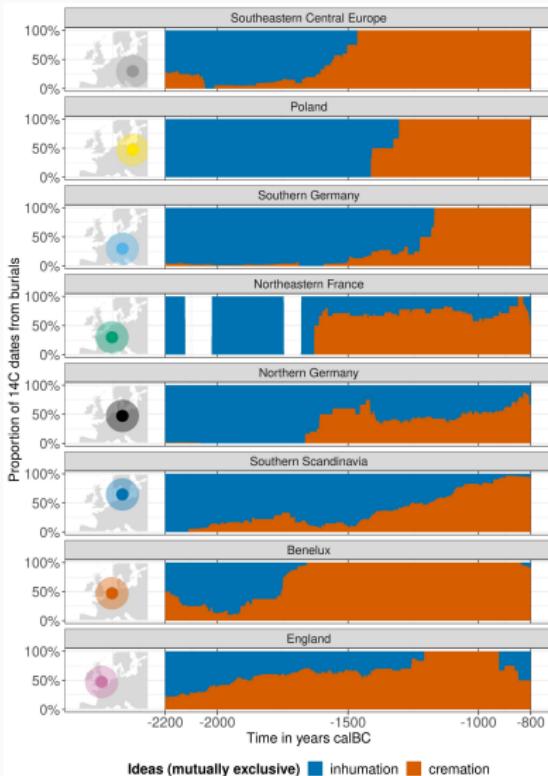
**Figure 4:** burial type development: Sum of  $^{14}\text{C}$  dates whose  $2\sigma$  range cover the respective year.



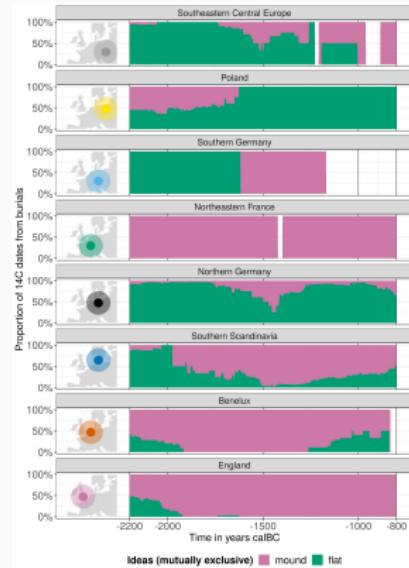
**Figure 5: burial construction**

Data structure transformation:  
Individual  $^{14}\text{C}$  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**

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## 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**?

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

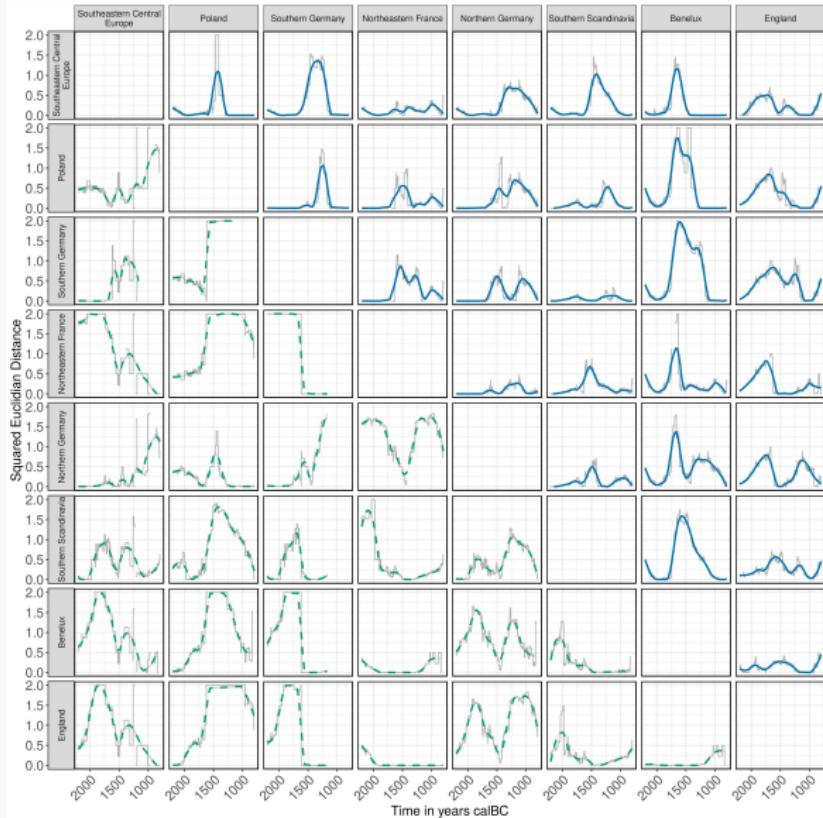
$$d_{ij}^2 = \sum_{k=1}^n (p_{ik} - p_{jk})^2$$

- $d_{ij}^2$ : 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  $j$

# Cultural distance matrix

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

burial construction:  
Heterogeneous  
distance  
development



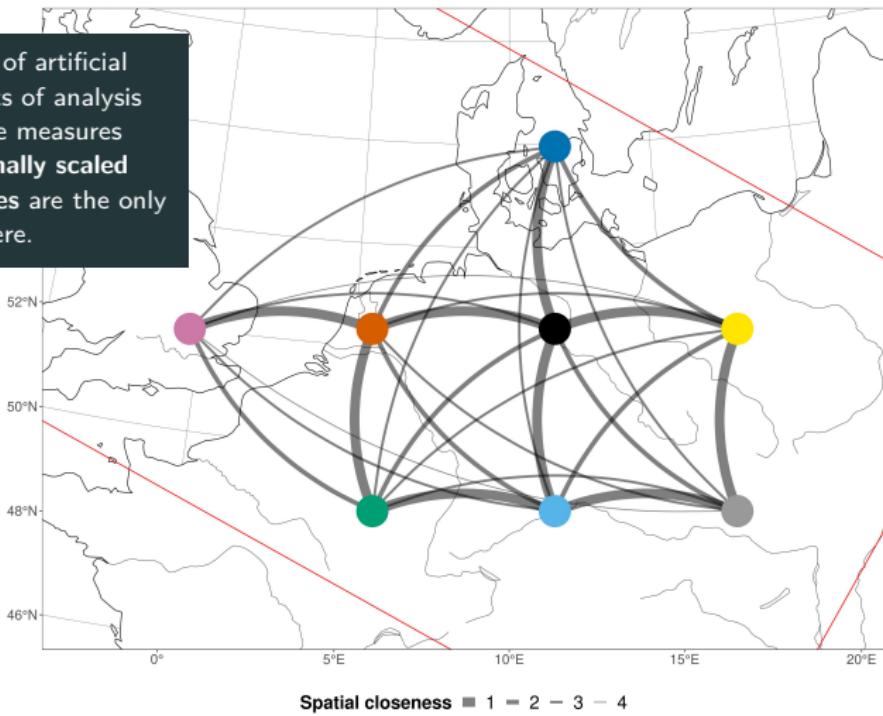
burial type: Low distance at the start and end due to the universal shift from inhumation to cremation with rise of the Urnfield culture

The different adoption rates are visible as peaks of cultural distance

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

## Spatial distance

The definition of artificial regions as units of analysis makes distance measures difficult. **Ordinally scaled distance classes** are the only valid option here.



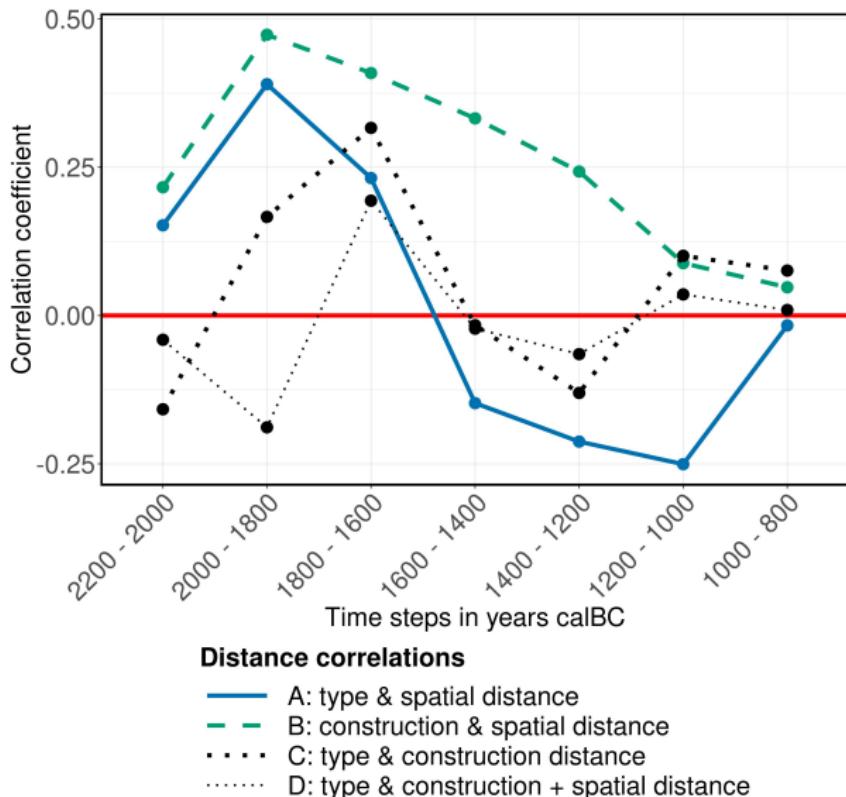
**Figure 9:** Spatial distance network and definition of distance classes

# Correlation of cultural and spatial distance

**A:** Weak correlation in the EBA, negative correlation from the LBA

**B:** Slightly stronger correlation in the EBA, no correlation in the LBA

**C&D:** No significant correlation



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

## Conclusion

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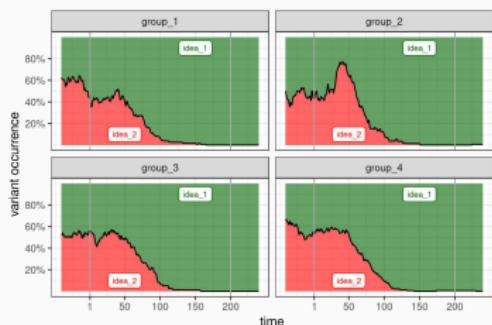
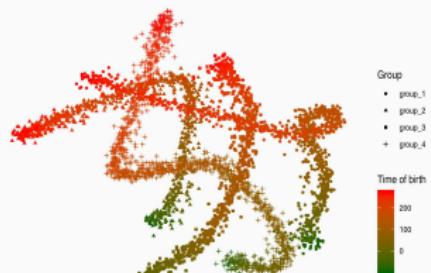
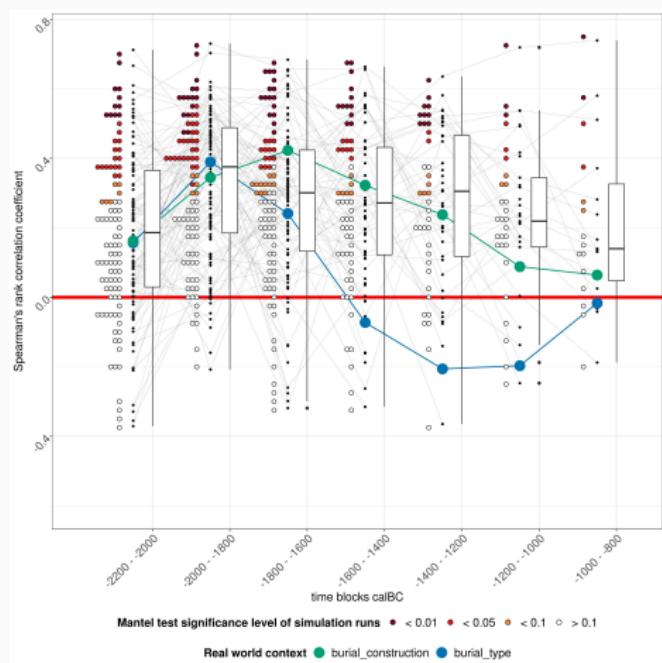
## Observations and hypotheses

- 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](https://github.com/nevrome/popgen.styletrans.saa2019)



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