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## **Emergent properties of the corded ware culture: an information approach**

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# 6 EMERGENT PROPERTIES OF THE CORDED WARE CULTURE: AN INFORMATION APPROACH

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## 6.1 Introduction

How do virtually identical burial rituals and worldviews emerge among widely dispersed communities? Five thousand years ago, preliterate Corded Ware communities throughout Europe achieved this remarkable feat. For half a millennium, these communities performed near-identical burial rituals in an area that extends from the Volga to the Rhine. What processes shaped such durable uniformity?

The emergence of the Corded Ware culture is a defining moment in European prehistory. It is hailed as the first pan-European network, which facilitated the spread of technologies such as the wheel and metallurgy. Furthermore, the advent of the Corded Ware culture is thought to mark the introduction of Indo-European languages into Western Europe (Kristiansen et al. 2017).

Following recent publications of aDNA (notably Allentoft et al. 2015; Haak et al. 2015; Olalde et al. 2018) and isotope analyses (Price et al. 2004; Sjögren et al. 2016), mobility has become a crucial factor in explaining the emergence of the Corded Ware culture, be it at the level of populations or individuals (cf. Furholt 2017; Vander Linden 2016). However, mobility in itself does not explain the emergence or upkeep of uniform practices. Therefore, we advocate a complementary approach to these issues: an archaeology of information exchange.

We argue that at the heart of the Corded Ware phenomenon is a distinct idea of a proper burial of the dead. The longevity and widespread distribution of Corded Ware practices result from the dissemination, agreement upon, and reiteration of this idea between past agents. The material legacy of this reiteration is recognizable to us in the archaeological record as the Corded Ware culture. In other words, the Corded Ware culture is an emergent property of an information-sharing system. Consequently, we argue that a study of information exchange is crucial to understanding the instigation and upkeep of the Corded Ware culture.

Our approach is based on two assumptions:

First, the more strongly two graves resemble each other in their dressing of the dead (i.e. which artifacts were placed in the grave in which positions relative to the dead), the

more likely shared notions of the appropriate dressing of the dead existed among mourners.

Second, we assume that the similarity between graves is influenced by physical distance. The dissemination of information in the third millennium BC will have relied on human mobility. Therefore, the greater the distance between any two graves, the more effort would be needed for information to travel between the two events and therefore the less likely they are to be similar. Thus, the combination of similarity and distance reveals a core property of the Corded Ware culture.

Building on these assumptions, our analysis indicates that Corded Ware communities shared notions about the dressing of the dead within limited geographic ranges (ca. 200 km). Moreover, this pattern is strongly pronounced in left-flexed burials, but not in right-flexed burials, for which similarities frequently occur at ranges in excess of 400 km. This disparity suggests a social practice in which notions of dressing the male dead were shared efficiently across large distances.

Therefore, these results fit well with mounting evidence for a male gender bias in Corded Ware society and might be linked to social institutions such as *Männerbunde*: an initiation rite in which young men from various communities convened in roaming bands where they learned the cultural practices of Corded Ware society (Cf. Anthony & Brown 2017; Kershaw 2000; Kristiansen et al. 2017). The nature of these bands could make them a crucial means by which particular notions of burial rites spread, ultimately giving rise to the homogeneous cultural phenomenon we observe in the archaeological record.

## 6.2 Similarity and Death in the Corded Ware Culture

Understanding similarity in material culture has long been one of the crucial pursuits of archaeological research. Indeed, one of the core tools in the archaeologist's toolkit – typochronology, or simply typology – aims to create a culture-historical framework of the archaeological record through similarities in material culture and practices. And although this method is not without its problems, the fact that it often *works* is in and of

itself revealing and informs us of critical social processes (Sørensen 2015).

With regard to the Corded Ware culture, its homogeneity is arguably most evident in the highly similar and far-flung Corded Ware burial ritual. This uniformity is such that almost identical burials can be found in, for example, the Netherlands, Denmark, and Poland (Fig. 6.1). As such, these uniform burials are also the defining element of the Corded Ware culture as an archaeological phenomenon (Furholt 2014; Kristiansen et al. 2017).

The similarity of Corded Ware burials involves three elements: specific funerary architecture, distinct semi-flexed positions of the dead, and a restricted set of grave gifts.

The first element of the uniform Corded Ware burial ritual is funerary architecture. Corded Ware burials commonly consist of grave pits intended for a single person. Above-ground elements created during the funerary ritual, such as a palisaded ditch surrounding a barrow covering the burial, were also shared across the vast distribution of the Corded Ware culture (Bourgeois 2013; Hübner 2005; Pospieszny et al. 2015; Smejda et al. 2006).

Secondly, the deceased are placed in specific positions inside the grave pit, with gender in a crucial role (Furholt 2014; Turek 2017). The bodies of the deceased were placed in a flexed position and oriented along cardinal directions. The majority of the men were placed on their right side, facing south and with the head pointing toward the west. By contrast, women

were interred on their left side, head in an easterly direction, but also facing south. As such, men and women's graves feature the dead in mirrored positions. Note that the exact orientation may vary from region to region, but the dichotomy in orientation and gender opposition is generally maintained.

The third element in the uniformity of Corded Ware burials is the grave goods. The dead are provided with selections from a specific range of items, which are also stylistically similar throughout the distribution of the Corded Ware culture. This includes, among others, flint axes, battleaxes, beakers, amphorae, a range of ceramic vessels, flint blades/daggers, amber beads, and copper and amber ornaments (Furholt 2014).

Yet the similarity in Corded Ware burials extends beyond the abovementioned elements. As we have demonstrated previously, Corded Ware burials also exhibit strong preferential placement of the grave gifts within the burial pit (Bourgeois & Kroon 2017). This suggests that the uniformity of the Corded Ware culture cannot be reduced to the similarity in objects, but also entails conventions about the use of these objects in the burial ritual. Similar to the pose of the body, these conventions can be shown to relate to the gender of the deceased. For example, a persistent pattern in left-flexed burials is the placement of ceramic vessels behind the upper part of the body. Right-flexed burials may also exhibit this practice, but more commonly contain a flint dagger/blade in the pelvic area in combination with a battleax or flint ax in front of the body. We have previously argued that these distinct patterns are different

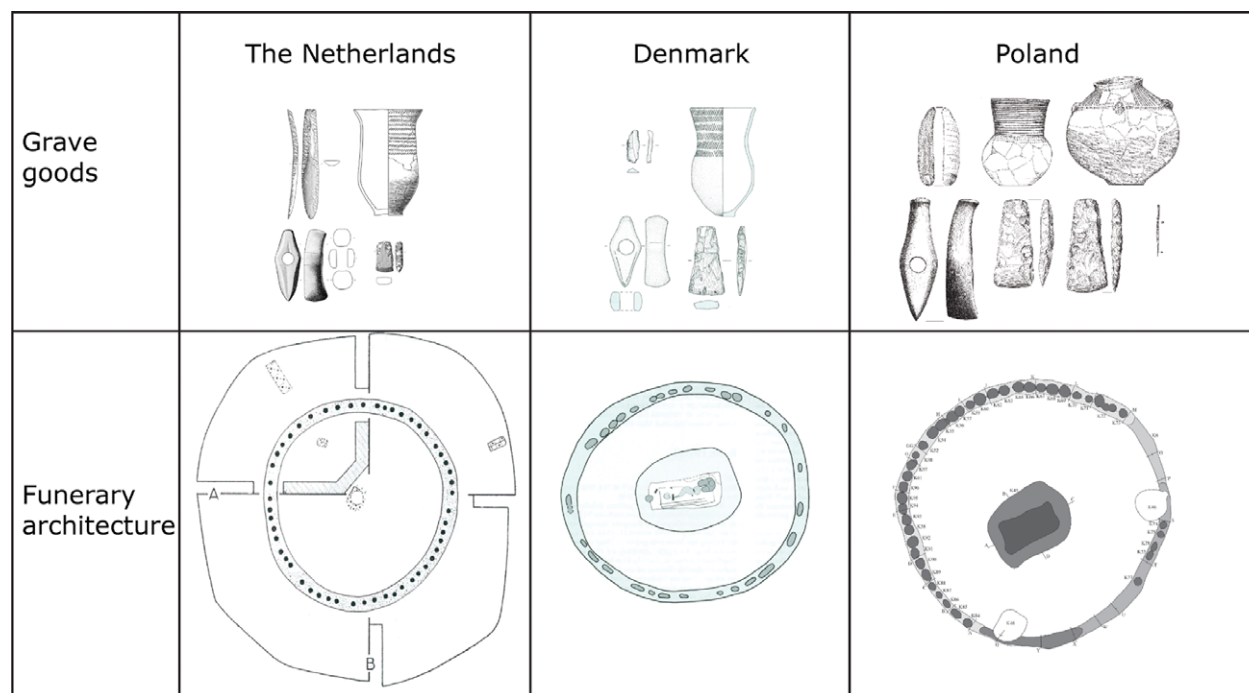


FIG. 6.1. Identical Corded Ware grave sets and graves from the Netherlands (Drenth & Lohof 2005; Van Giffen 1935), Denmark (Hübner 2005), and Poland (Pospieszny et al. 2015)(not to scale). Upper half: the grave sets include the eponymous Corded Ware culture beakers, as well as flint axes, battleaxes, and flint blades/daggers. Additionally, the grave from Poland features an amphora, a second flint ax, and a copper awl. Lower half: similarities in Corded Ware burials extend beyond the grave goods. The three graves from the same regions all feature a palisaded ditch surrounding a low mound, and a central grave pit.

ways in which specific Corded Ware communities dressed their dead for the afterlife (Bourgeois & Kroon 2017).

### 6.3 Understanding Corded Ware Similarities

The similarity of Corded Ware burials has been the subject of intensive debate. This debate essentially boils down to two questions. First, what process(es) gave rise to the Corded Ware culture? Second, how was such uniformity maintained over such a vast area and time span?

Early examples of the debate include the A-horizon hypothesis or *Einheitshorizont*. This hypothesis proposes that the Corded Ware culture started out as uniform and diversified over time as migrating communities slowly lost contact after a single migration event (e.g. Buchvaldek 1986; Furholt 2014).

The advent of new analytical techniques such as aDNA and isotope analysis has recently given the debate on the similarity of Corded Ware burials new impetus. Recently, two new positions have emerged in the debate about the homogeneity and emergence of Corded Ware culture. The first position revolves around aDNA analysis and population mobility. The second position emphasizes patterns of local variation and individual action. We argue that both explanations ultimately fall short of explaining these phenomena.

The first position related to the explanation of Corded Ware is largely based on recently published aDNA analyses (notably Allentoft et al. 2015; Haak et al. 2015; Olalde et al. 2018). These analyses demonstrate that Corded Ware (and later Bell Beaker) individuals exhibit stronger genetic links with Yamnaya culture individuals than individuals associated with earlier Neolithic cultures in Europe. Based on these findings, the Corded Ware culture is argued to be the product of a massive migration into Europe (Kristiansen et al. 2017).

In parallel (and slightly before the aDNA analyses), discussion of the nature of the Corded Ware culture has emphasized the dimension of local and individual variation within the Corded Ware culture (Furholt 2014; vander Linden 2004). Recently, the same authors expanded their position to include a critique on aDNA analyses (Furholt 2017; Heyd 2017; vander Linden 2016). They argue that Corded Ware culture should not be interpreted as a single entity, but rather that interpretations of this culture should emphasize the importance of individual mobility and its impact on local contexts, contrary to an invasion-like mass migration as a root cause for the Corded Ware culture.

Both approaches provide an interesting perspective on Corded Ware culture and there is clear-cut evidence backing arguments on both sides. On the one hand, the significant genetic change must have come about through a large-scale demographic event, regardless of whether it was caused by an actual mass-scale migration *sensu strictu* or by a more complex social phenomenon. On the other hand, focusing on individual and personal mobility clearly highlights the complexity of the Corded Ware phenomenon and its problematic, multifaceted nature.

Notwithstanding the validity of both perspectives, there is an underlying issue that remains unaddressed. Neither approach provides a mechanism by which the fundamental factors it proposes, be it individual actions or genetic change, result in the overarching phenomenon that we observe in the archaeological record: widespread and durable similarity in the shape of Corded Ware cultural practices. How does a migration lead to the instigation and, more importantly, the upkeep of similarity for several centuries? And, vice versa, why is the Corded Ware culture immediately recognizable as an entity if it consists of small-scale variability?

We argue below that we need to return to the most basic conceptualization of similarity in order to answer these questions. Similarity in the archaeological record results from past agents deciding to act in a similar fashion (Sørensen 2015). Returning to the Corded Ware burial ritual, we have argued that it is defined by a commonly shared idea of dressing the dead. Consequently, information on this idea must have circulated and – as is the nature of all information exchange – been modified through time and space. We argue that studying this information exchange and its properties is crucial to understanding the Corded Ware phenomenon.

Seen in this light, burials are ideal for reconstructing the transmission of information and comparing the flow of information between different regions. First, burials are closed events that represent discrete activities. Second, they are the material remnants of the acting out of (parts of) worldviews and ideas of the afterlife by mourners (Oestigaard & Goldhahn 2006). Third, burials result from conscious, emotionally charged choices and acts by mourners and can be considered fundamental rituals of society (Barraud & Platenkamp 1990) which are deeply rooted in worldviews (Metcalf & Huntington 1991). As a result, close resemblance in burials is therefore indicative of (particular elements of) shared worldviews. It is critical to emphasize that similarity in burials does not signify, *per se*, similar meanings attributed to these elements, but rather a similar conceptual framework in which these elements are employed.

Below, we detail this approach to Corded Ware culture that centers on information exchange and emergence. Furthermore, we argue that this approach can be a valuable complement to contemporary approaches such as aDNA analysis and small-scale processes.

### 6.4 Emergence and Information Sharing in the Corded Ware Culture

At the heart of the Corded Ware culture as an archaeological phenomenon are similar practices and material cultures. In the first place, these practices result from countless deliberate, informed choices by agents to act in a particular manner in the past (Sørensen 2015). These agents entered into meaningful negotiations with other agents on the proper course of action.

The outcomes of these negotiations contributed to the agent's own notions of proper action, which, in turn, were drawn from and reiterated in subsequent negotiations (cf. Lave & Wenger 1991; Wenger 1998). The uniformity observed in the archaeological record is the emergent outcome of countless such interactions in which information was shared, agreed upon, and put into practice (cf. Centola et al. 2007; Centola & Baronchelli 2015).

Returning to the Corded Ware culture itself, what we define as Corded Ware culture is an emergent property of countless events during which past agents shared information, agreed on a proper course of action, acted out this agreement, and ultimately left a material legacy in the archaeological record. As such, the properties of Corded Ware culture as a whole cannot be understood from the actions or the DNA of the individual agents alone, but rather require an understanding of the relations and of information sharing between these agents. These properties are systemic and are not recognizable at the level of agents.

This redefinition has an important corollary, as we explore in this article. Due to the central role attributed to interactions between agents in the distribution of information, one would expect the resulting agreements to be bound by distance. During the third millennium BC, the spatial distribution of

information was strongly bound by the physical distance agents had to cross. Therefore, distance must have had a significant impact on the emergence and upkeep of Corded Ware culture. We refer to this corollary as “distance decay” and demonstrate its existence in Corded Ware burial ritual. Moreover, we show that right-flexed burials are less affected by distance decay than left-flexed burials.

## 6.5 Data and Method

This paper builds on the data set we presented previously (Bourgeois & Kroon 2017), which encompasses data on 1161 Corded Ware burials from the Netherlands, Denmark, Germany, and the Czech Republic (Fig. 6.2).

For each burial, we collected data on the orientation of the body, various categories of artifacts present (such as beakers, flint blades, and amphorae), and the position of these artifacts in the grave according to a predefined scheme (Bourgeois & Kroon 2017).

The number and position of artifacts were combined into a compound variable and attached to the graves as a string. Subsequently, we calculated the cosine similarity of each individual grave to every other grave in the data set. All input

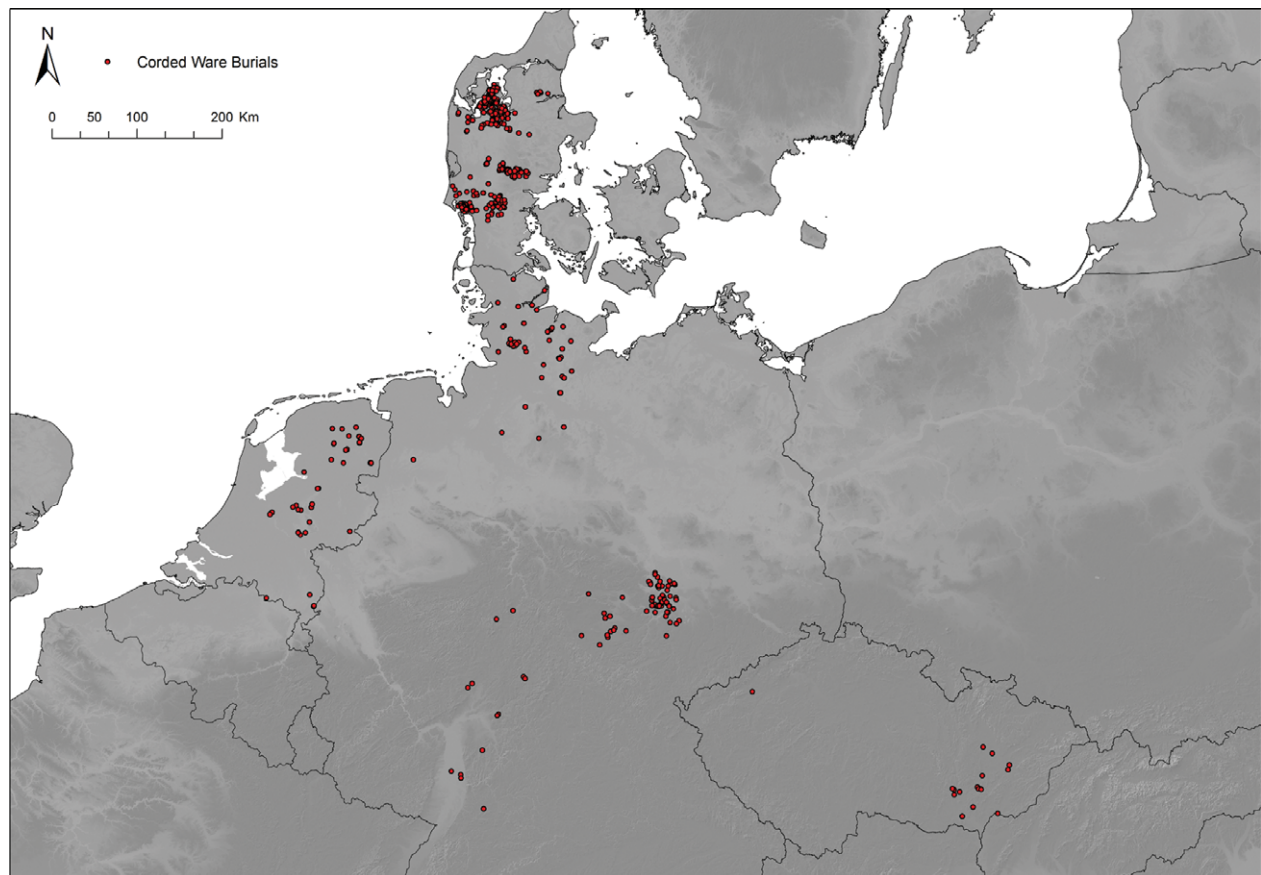


FIG. 6.2. Geographical distribution of Corded Ware ( $n = 1161$ ) burials in the data set.



values were normalized prior to analysis to prevent a bias based on the number of objects. The cosine similarity index represents strings of variables as coordinates in a multidimensional space; the similarity of two strings is then calculated as the angle between lines from the origin to these coordinates (Salton & McGill 1983). For a more detailed discussion on the data and methodology, we refer to our previous work (Bourgeois & Kroon 2017).

In order to add a spatial dimension, we computed the distance (as the crow flies) between every possible pair of burials for the entire data set ( $n = 1161$ ). Subsequently, we appended this data to a matrix with the similarity value for each pair of burials and removed all ties for which the similarity value equaled zero. The resulting data set contains 99,741 ties.

Each tie has four attributes: (1) the source burial for the comparison; (2) the target burial for the comparison; (3) the geographical distance separating these burials in kilometers; and (4) an expression of the similarity between source and target burials as a cosine similarity score between 0 and 1.

Among the 1161 burials in the entire data set, there are 281 burials in which skeletal remains were preserved and definitive observations about the orientation of the deceased can be made. This high-quality sub-data set contains 169 right-flexed and 112 left-flexed burials. We extracted all these burials and their ties to other burials in their respective group to compare patterns in the overarching data set to patterns in this high-quality data set.

## 6.6 Results

A preliminary analysis of the distances between target and source readily reveals a number of patterns, as well as a disparity between right- and left-flexed burials (see Fig. 6.3; Table 6.1).

Fig. 6.3 shows the percentage of target nodes (i.e., similar burials) that fall within specific ranges of their sources.

The values derived from the entire data set show a clear drop-off beyond 200 km: nearly 65% of all similar graves can be found within 200 km of their sources. This number steadily increases to ca. 94% at ranges of 700 km.

However, the plots for connections among right-flexed and left-flexed burials differ in their relation toward this pattern for the entire data set. Among left-flexed burials, almost 86% of all similar burials can be found within 200 km of a burial. At ranges of 700 km, as much as 99.5% of all similar burials is accounted for. By contrast, right-flexed burials have close to half of their ties within a range of 200 km. This number steadily rises to roughly 92% at a range of 700 km.

It follows that uniformity in Corded Ware burial rituals is often found within a couple of hundred kilometers. This is particularly true for left-flexed burials, but not for right-flexed burials, for which similar targets frequently occur well beyond 400 and even 600 km. This finding corroborates the observation made previously, namely that right-flexed burials make an important contribution to the uniformity of the Corded Ware culture (cf. Bourgeois & Kroon 2017).

Fig. 6.3 captures the number of similar burials at given ranges but does not account for the actual similarity between these burials (all burials are presented as equally similar). Potentially, long-range targets could be significantly less similar than close-range targets (i.e. the further away two burials are from one another, the lower their similarity score). To compensate for the actual strength of the similarity between source and target, we summed the cosine similarity values (which are numeric values between 0 and 1) of all links within distance bins of 100 km and plotted a cumulative frequency distribution of the resulting values (see Fig. 6.4; Table 6.2). The numbers were converted to percentages to facilitate comparison between

TABLE 6.1. Background data for Fig. 6.3 From left to right: the upper boundaries of the distance bins, the number of targets in each bin for the entire data set, left- and right-flexed burials, and the cumulative percentage of targets by distance for the same categories.

Bins	Count of target burials			Cumulative percentage of target burials		
Upper boundaries	All burials	Right-flexed burials	Left-flexed burials	All burials	Right-flexed burials	Left-flexed burials
<i>km</i>	<i>N</i>	<i>N</i>	<i>N</i>	%	%	%
100	42072	1074	655	42,18	29,39	57,71
200	22604	680	320	64,84	48,00	85,90
300	4912	364	60	69,77	57,96	91,19
400	4054	264	26	73,83	65,19	93,48
500	5588	362	42	79,44	75,10	97,18
600	7226	376	13	86,68	85,39	98,33
700	7378	240	13	94,08	91,95	99,47
800	4178	140	1	98,27	95,79	99,56
900	816	82	2	99,09	98,03	99,74
1000	876	72	3	99,96	100,00	100,00
1100	36	0	0	100,00	100,00	100,00

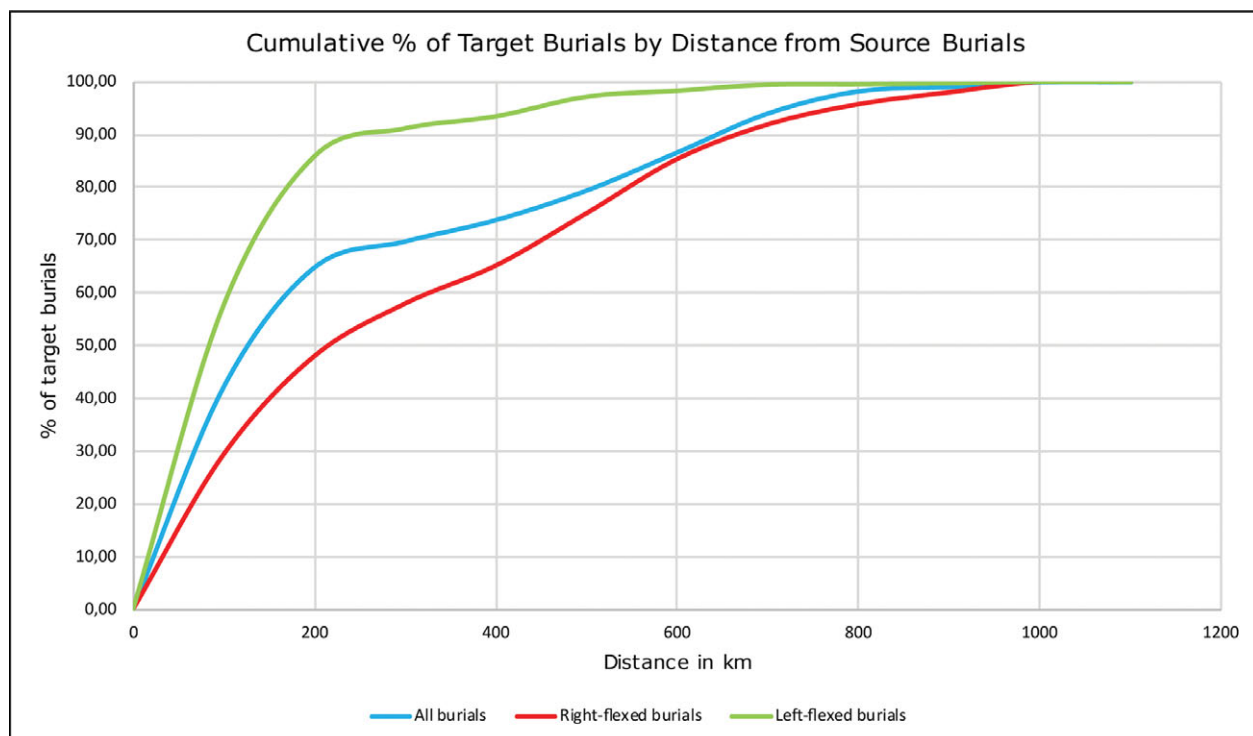


Fig. 6.3. Cumulative percentage of similar burials (i.e. target nodes) across all relations that occur within a specified distance (in km) of the source (see Table 1). The graph shows a steep decline in similar graves beyond 200 km for the entire data set and left-flexed burials in specific, while right-flexed burials feature a steady increase in the number of targets as distance increases.

all burials, and right- and left-flexed burials in particular. Note that Figs. 6.3 and 6.4 should be understood in conjunction, as Fig. 6.4 cannot distinguish between numerous targets with low similarity and single targets with high similarity (i.e. two burials with a similarity of 1 have the same weight as ten burials with a low value).

Fig. 6.4 effectively shows the percentage of the total similarity of all graves that occurs within specific ranges. It corroborates the trends initially observed in Fig. 6.3. For the entire data set, approximately 78% of the total similarity can be found within a range of 200 km, whereas ca. 97% of all similarity occurs within ranges of 700 km. The increase relative to the actual count of similar graves (65% to 78% respectively) further indicates that connections at short ranges represent more of the overall similarity than those at ranges beyond 200 km (i.e., the closer two burials are to each other in space, the more likely they are to be similar).

Fig. 6.4 also confirms the difference between left-flexed and right-flexed graves relative to the entire data set. The total similarity for left-flexed burials at a range of 200 km is almost 90% and shows an asymptotic increase toward 99.7% at 700 km (both values are close to the absolute counts in Fig. 6.3).

By contrast, right-flexed burials only exhibit ca. 54% of their total similarity at ranges below 200 km and gradually build toward 95% at ranges of 700 km. Contrary to the overall data set, these values are closer to the actual count of targets, which implies a more equal contribution of every target to the similarity overall. In other words, similarity is relatively unaffected by distance in right-flexed burials. A two-independent-sample

Kolmogorov-Smirnov test confirms the significance of these differences between left- and right-flexed burials at 2sigma for a p-value smaller than 0.000.

The pattern for the entire data set demonstrates that the majority of similar graves in Corded Ware culture can be found at intervening distances of less than 200 km, but that significant similarities persist up to 700 km. Moreover, these graphs highlight the differences between left- and right-flexed burials. Left-flexed burials display this trend more extremely, with only 10% of similarity between graves at ranges in excess of 200 km. By contrast, the right-flexed burials are significantly less impacted by intervening distance.

### 6.6.1 A Network Perspective

To visualize the trends in similarity and distance visible in left- and right-flexed burials, we plotted both the right- and left-flexed data sets as networks (see Fig. 6.5 and 6.6). The distances between connected nodes (graves) in these networks are proportional to the geographical distance between these graves, whereas the strength of the ties is dependent upon the similarity between these graves (i.e., the color of the tie between them).

The network for left-flexed graves (Fig. 6.5) mirrors the patterns observed in Figs. 6.3 and 6.4. The strong ties in this network occur predominantly between burials with short intervening geographic distances. As a result, nodes cluster in groups that lie within the same or adjacent regions. A number of long-distance connections is also visible, but

TABLE 6.2. Total similarity by distance from Corded Ware source burials.

Bins	Summed similarity values of target burials			Cumulative percentage of similarity of target burials		
	Upper boundary	Right-flexed burials	Left-flexed burials	Right-flexed burials	Left-flexed burials	
	All burials	Similarity value	Similarity value	All burials	Similarity value	Similarity value
km				%	%	%
100	24213,95	428,49	278,29	50,78	36,15	59,51
200	12893,83	212,90	137,54	77,82	54,12	88,92
300	1907,98	119,80	20,91	81,82	64,23	93,40
400	1294,18	78,15	9,49	84,53	70,82	95,43
500	1644,03	95,39	12,80	87,98	78,87	98,16
600	2017,68	104,39	4,52	92,21	87,68	99,13
700	2073,01	84,18	2,80	96,56	94,78	99,73
800	1129,87	29,56	0,15	98,93	97,28	99,76
900	249,71	20,27	0,76	99,45	98,99	99,92
1000	249,00	12,02	0,35	99,97	100,00	100,00
1100	13,70	0	0	100,00	100,00	100,00

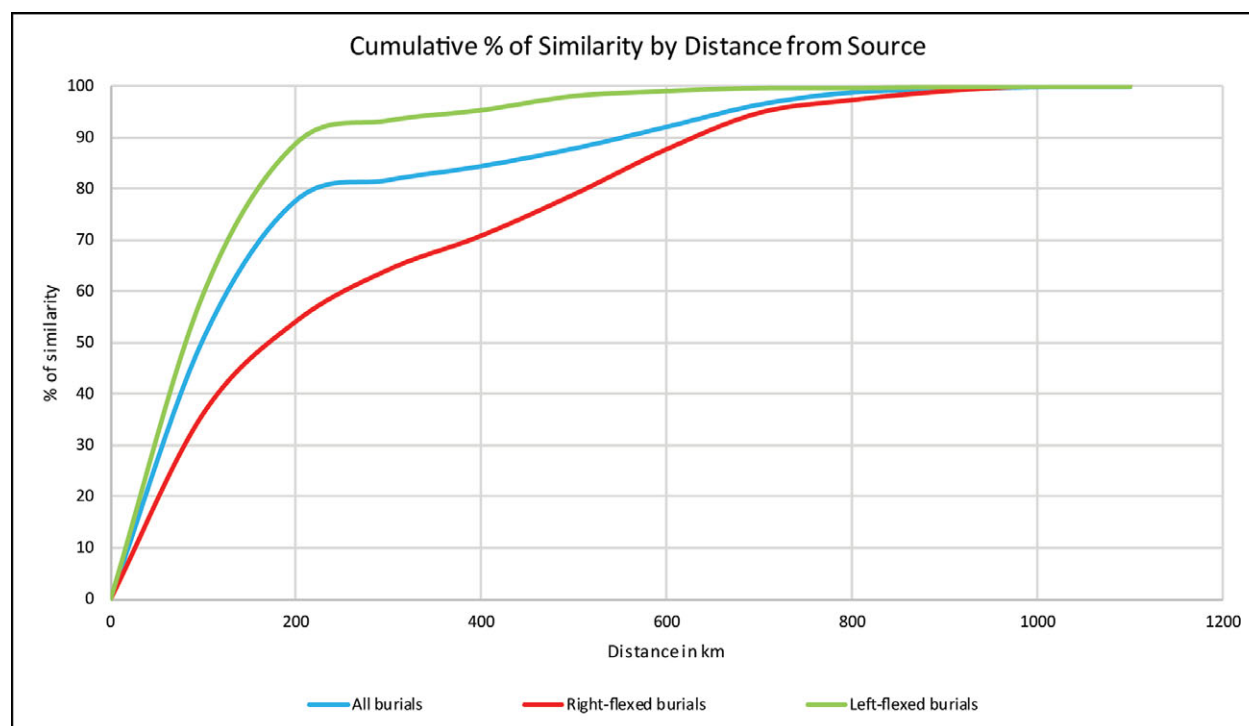


FIG. 6.4. Cumulative percentage curve of the total similarity within specified distances of the source for the entire data set, left-, and right-flexed burials. This graph shows the similarity between any two pairs of burials, summed by distance, and recalculated as percentages to facilitate comparisons (see Table 6.2). The entire data set exhibits a drop-off in similarity beyond 200km, followed by a steady increase toward 100%. However, left- and right-flexed burials show contrasting patterns. An asymptotic trend is visible for left-flexed graves: a sharp increase to 89% at a range of 200km, followed by minute increases toward 100%. By contrast, the curve for right-flexed burials exhibits a sharp increase to 36% at 100 km but follows a near-linear increase until 700 km (95%). A Kolmogorov-Smirnov Z test shows that the difference between these cumulative percentage distributions is significant at  $p < 0.000$  for 2sigma.

these connections generally exhibit low similarity values (see, for example, the cluster of Danish burials at the bottom right).

When compared to Fig. 6.5, Fig. 6.6 shows a different pattern of overall connectivity for right-flexed graves. Graves

from various regions are placed close together due to their small relative distances, but ties with high similarity values cut across these spatial separations, while strong internal connections are present as well.



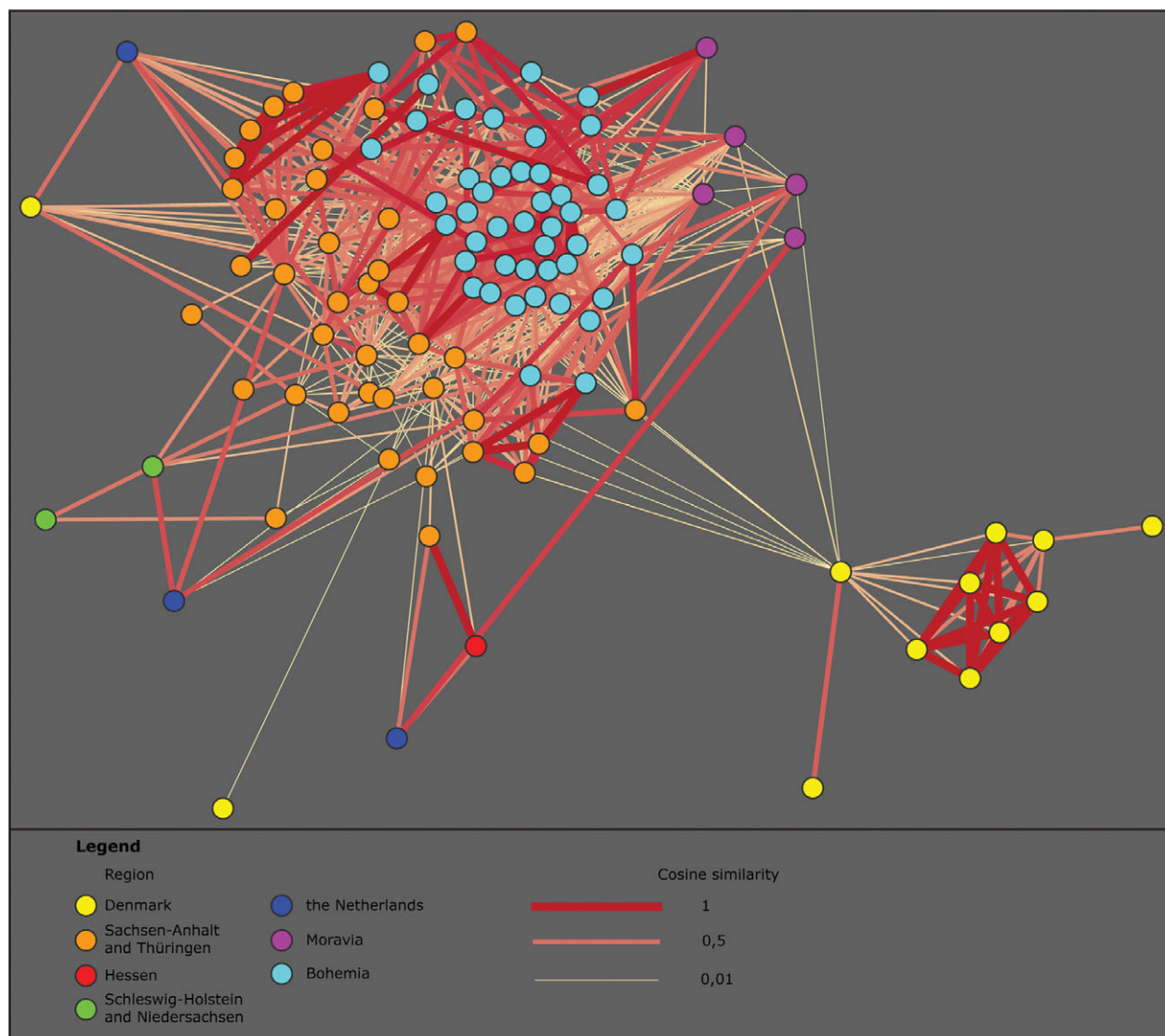


FIG. 6.5. Network representation of the distance and similarity between left-flexed burials in the data set. The similarity is indicated by the thickness and redness of the tie, whereas the length of the tie is proportional to the distance (as the crow flies) between the burials it connects. The strongest similarities in this graph are mostly found in graves within the same, or adjacent regions, resulting in several clusters of graves at short spatial distances.

## 6.7 Discussion

The results outlined above provide clear evidence for the existence of information decay within the Corded Ware culture. A general trend exists with regard to the occurrence of similar graves in which the number of similar graves and the relative similarity of graves decreases as distance increases. The basis for the observed similarities between graves is the presence and placement of objects in the burial pit with the deceased. These actions reflect deeply seated worldviews and are the outcomes of meaningful negotiations between mourners about the perceived proper way to dress the deceased for the afterlife.

### 6.7.1 Information Exchange in Corded Ware Culture

Our analysis of distance decay for the entire data set demonstrates a decline in similarity between burials at ranges of ca. 200 km. This pattern is emphasized in left-flexed burials, whereas it is less pronounced in right-flexed burials.

The 200 km range is grounded in the meaningful negotiations mourners undertook to determine the proper manner in which to bury deceased individuals in their communities: actions that are deeply rooted in the fundamental worldviews of societies. Therefore, the drop-off in similarity at ranges of 200 km suggests that such negotiations and interactions

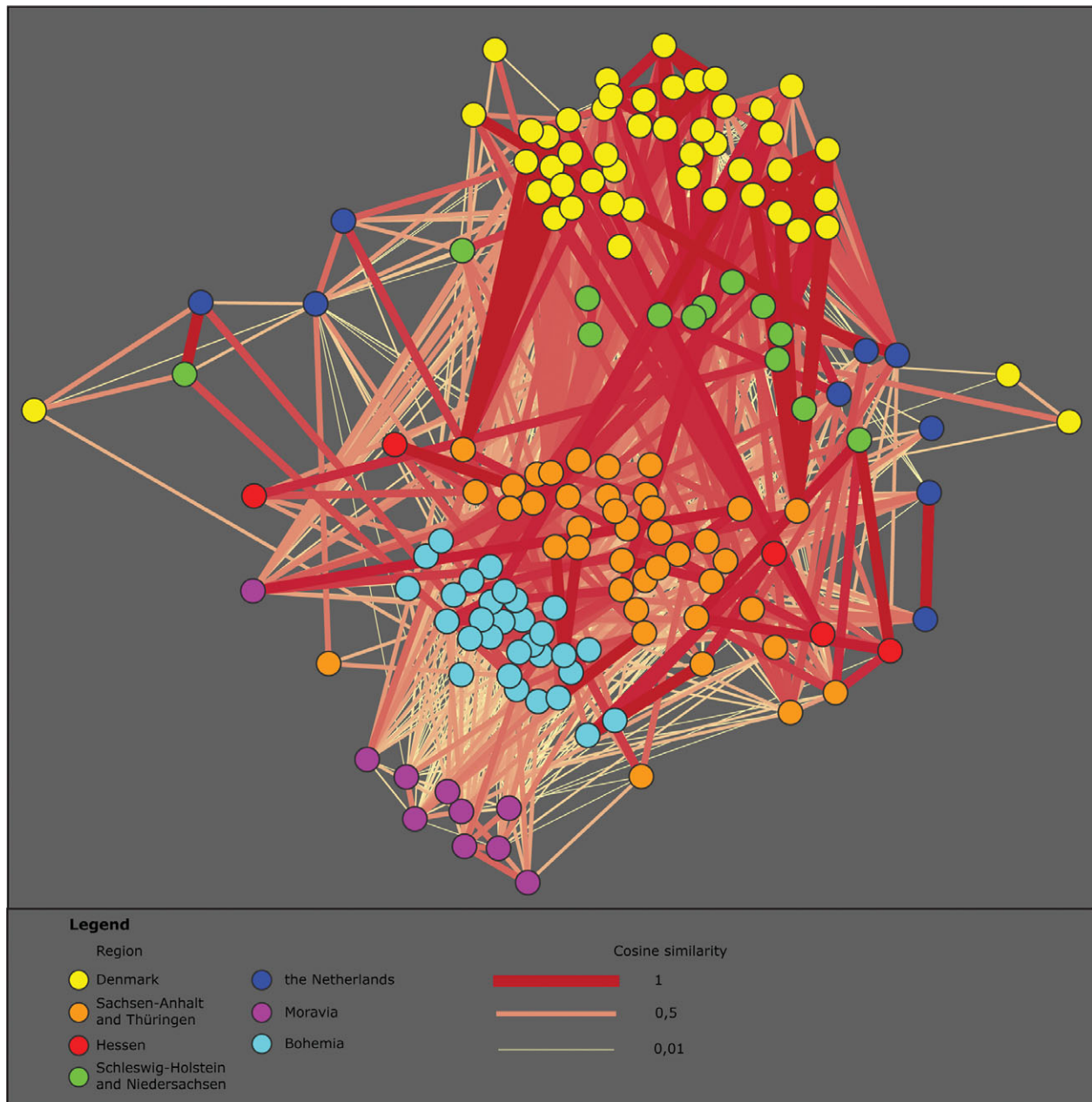


FIG. 6.6. Network visualization of the distances and similarities between right-flexed burials in the data set. Right-flexed burials show significantly more strong links across large distances when compared to left-flexed burials (Fig. 6.5), which is represented by the thick, dark red lines between regions. The strength of the ties is indicated by the thickness and redness of the lines. The length of a tie between two burials is proportional to the geographic distance (as the crow flies) between these burials.

themselves occurred at limited ranges. These ranges could be the boundaries of *communities of practice*: groups of people formed around a shared notion of the proper course of action (Lave & Wenger 1991; Wenger 1998). Following these inferences, the total distribution of the Corded Ware culture would be constituted by several such communities that represent the small-scale variability observed in Corded Ware culture (Cf. Furholt 2014). An interesting avenue of research would be to cross-reference such ranges in other practices,

forms of material culture, or even dialects and mobility patterns.

If we accept the 200 km drop-off as the baseline distance for interactions within communities, then it is clear that right-flexed graves frequently cut across these communities. It should be noted that the same ranges do occur in left-flexed graves, but are less common. Therefore, right-flexed graves might constitute important connective events for different communities and as such have a profound impact on the

spread of similar practices. In other words: these burials would have a crucial role in instigating and maintaining the overall similarities within Corded Ware culture (Centola & Baronchelli 2015).

### 6.7.2 Connections with aDNA, Isotope Analysis, and Linguistics

The exceptionally long-range similarities of right-flexed graves (sometimes well beyond 700 km) versus the tendency toward regionality in left-flexed burials highlight the important role of gender in the social conventions on dressing the dead. This outcome corroborates recurrent evidence for gender-related social phenomena visible in aDNA and isotope analysis.

Analyses of aDNA have pointed out substantial differences in continuity of sex-specific genetic material during the third millennium BC. These differences hint at a male sex bias in the migrations from the Pontic–Caspian steppes that is more pronounced in Western than in Eastern Europe (Brandt et al. 2013; Goldberg et al. 2017; Juras et al. 2018). Separately from aDNA analysis, isotope analyses have demonstrated high mobility in adolescent males of the Corded Ware culture, but strikingly also in females (Knipper et al. 2017; Sjögren et al. 2016).

The abovementioned aDNA and isotope evidence has been used to support linguistic evidence for the existence of so-called *Männerbunde* in which young men gathered and traveled around as a form of initiation (cf. Anthony & Brown 2017; Kershaw 2000; Kristiansen et al. 2017), as well as archaeological evidence for an exogamous marriage system among Corded Ware communities, in which wives were obtained from contemporary Neolithic groups (Kristiansen et al. 2017).

We argue that the observed differences in distance decay best fit a phenomenon such as the *Männerbunde* if considered against male sex bias in migration or an exogamous, patrilineal marriage system. The relatively small distance decay of right-flexed burials – of which the majority are male burials – as compared to left-flexed burials suggests that information on male burial practices traveled more widely. It seems unlikely that a male sex bias in migration alone gave rise to this pattern, as the differences are kept up over time. Simple movement of groups who take along burial practices is in itself insufficient to explain long-term homogeneity: such a feat requires continued interaction and negotiation of practices. Therefore, it is more likely that male mobility specifically occurred in a manner that facilitated the spread, and therefore homogenization, of practices of burial ritual. As such, the highly mobile and connective nature of *Männerbunde*, but also their role as “educative events,” is an attractive hypothesis to explain the higher similarity in right-flexed burials. The coming and traveling together of young males from various areas in a social setting meant to transform

them into adult members of society would be particularly suitable for the far-flung and diverse patterns of interaction required for the emergent uniformity of the Corded Ware culture.

Whereas isotope analysis also yields evidence for mobility in females, the homogenizing effect that mobility seems to have on male burial practices is absent in female burial practices. It is unclear why female mobility was not a vector for information on burial practices. We suggest that this is due to the nature of male vs. female mobility in the third millennium BC, which is possibly intertwined with conceptions of gendered mobility. An alternative explanation would be an exogamous patrilineal system in which women are integrated into male lineages and conform in terms of burial practices. However, we would argue that this was at least combined with an institution like *Männerbunde*, as it can be hypothesized that male burials would likely also develop localized practices in such a scenario (and the data does not bear this out). Apparently, notions of dressing the male dead were shared more efficiently over larger distances, suggesting a homogenizing social process that is absent in the female burial ritual.

Regardless, the differences we observe in distance decay between male and female burials as well as the results from aDNA and isotope analysis hint at a real-world social system in which information sharing was structured along gender. Corded Ware culture itself is an emergent property of this social system.

## 6.8 Concluding Remarks

How did preliterate Corded Ware communities initiate and maintain their strikingly uniform burial ritual for nearly five centuries, despite being dispersed across hundreds of kilometers of continental Europe?

We have argued that such similarities should be studied from the perspective of emergent social conventions and information exchange. These practices result from events in which agents shared, agreed upon, and put into practice information about the proper course of action. The Corded Ware culture is the emergent result of the material reflections of countless such events in the archaeological record.

We have studied the relation between intervening distance and the similarity of burials for a data set of 1161 Corded Ware burials. The similarities are grounded in the presence and placement of artifacts in the burial pit; factors that reflect meaningful decisions on the part of the mourners to dress their dead.

We have demonstrated that such notions exhibit distance decay: for the vast majority of graves, similar graves can be found within ranges of 200 km. We propose that this range reflects the baseline for interactions and is likely to be the limit of distinct communities of practice within Corded Ware culture. A patchwork of such communities constitutes the Corded Ware



culture in its entirety and underlies its so-called multifaceted nature. The similarities of right-flexed graves frequently extend far beyond this 200 km range. Therefore, these burials may be events that bring together members of different communities of practice. As such, the meaningful negotiations among mourners for these particular burials contribute to the spread of highly similar notions of the proper manner to bury deceased individuals. Corded Ware culture as a whole encompasses several distinct communities organized around particular practices but connected through significant events.

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