An Easy Framework to Organize Complex Data

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Abstract. The holistic and multidimensional nature of anthropological research results in an enormous amount of data, but the problem is how to organize it in such a way as to be useful for identifying complex patterns across different fields. This paper proposes a basic Framework for organizing metadata into categories: Space (where), Time (when), Matter (who and what), and Energy (how), and then separates these into two categories: empirical data and ideational data. This method reduces preconceptions by separating out the tangible evidence from the intangible and allows evidence to be understood and tested from different perspectives.
Keywords: cross-cultural comparison, cognitive framework, data analysis, scientific method, social science, etic and emic perspectives.

Problem

Anthropology is the study of humans, and our closest primate relatives, from all times and places. It is an expansive subject because everything we know has a human component to it, from how we understand 'science' and the workings of the natural world to the programming of computers because these are all rooted in culture. Humans also vary in their biology and as individuals; but our primary aim in this chapter is cultural variation. There are features which everyone shares and there are those which seem to be unique. The amount of variation produces a great deal of information or data, but the problem lies in how to best use these data across disciplines.

The holistic and multidimensional nature of anthropological research results in an enormous amount of data, but the problem is how to organize the evidence in such a way as to be useful for identifying complex patterns across different fields. The lack of a systematic approach to organizing data into testable evidence in archaeology has been argued since the 1980's (Dunnell 1980), but this problem spans all the sciences (Munafò et al. 2017). O'Brian and Lyman (2000) give three reasons for this lack of a systematic approach: 1) it is tedious to teach, 2) it requires learning precise terminology, and 3) it addresses theoretical issues of ontology, epistemol-

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ogy, and the nature of metadata. The need for a method of data collection that is transparent, compatible, comparable, expandable, and that inherently allows for different approaches is necessary to move the discipline forward.

In 1979 Carl Sagan wrote an essay titled *Can We Know the Universe?* in which he asks what limitations Nature plays on what is knowable and what is not. A similar argument can be made about the ability of humans to really understand or define 'humanity'. Nevertheless, the extent that the Universe can be 'known' has not stopped scientists from exploring, and anthropology is the same. "The search for rules, the only possible way to understand such a vast and complex universe, is called Science" (Sagan 1997). All science has inherent biases, and complete objectivity is a noble but impossible goal, yet steps can be taken to mitigate its negative effects. The standard way of reducing bias is to use the *Scientific Method*. "The real purpose of the Scientific Method is to make sure Nature hasn't misled you into thinking you know something you don't actually know" (Pirsig 1974).

Science is a way of knowing, and knowledge is culturally dependent. Even after a cursory investigation into cognitive anthropology and what people 'know', it is obvious that what is 'logical' or rational to one group of people can be the opposite for another group: Are bugs pests or food? When a person chooses what to eat, is it the physical appearance of the food that matters or the process that went into its production that is more important to the decision-making process? The idea that humans are so very different from other biological species is more a reflection of cultural beliefs rather than 'nature'. The problem with this focus on differences is that it does not allow comparisons with other natural phenomena, and it hinders the identification of 'rules' that may or may not apply to other phenomena as well.

The need to use a scientific approach and apply the Scientific Method is stressed in anthropological research, and numerous publications outline various methods and approaches. For instance, there is H. Russell Bernard's (2011) comprehensive book *Research Methods in Anthropology*, and Ember and Ember's book *Cross-Cultural Research* (2009) for more specific research methods for cross-cultural comparisons. The scientific method is the process of repeatedly creating and testing hypotheses and theories against observable data. Like other sciences, "Modern anthropology is built on the work of earlier generations of researchers" (McGee and Warms 2020, 1). Much groundbreaking research had been conducted in the past, which has led to insight into the variety of human cultures. Just as Darwin and Wallace's travel across the world and their observation of different species and habitats led to the development of the *Theory of Natural Selection*, anthropologists travelling the world observed how different cultures adapted to their surroundings, both natural and socially constructed environments. However, unlike in the Natural Sciences, some anthropological research seems to place a larger emphasis on

the creator of the theory, almost a cult of personality, rather than the evidence or the theory itself. The theory of Natural Selection has undergone revisions since the times of Darwin and Wallace, but this does not take away from their original insight. Furthermore, scientific research does not use the creator of the theory as 'evidence' for the theory's validity, but this does seem to creep into some anthropological research. Perhaps, the reason for this deserves some anthropological research of its own, but it simply may be due to the way the discipline has been taught. Regardless of the historical reasons for the current state of the discipline, there is room for new methods and perspectives. It must be remembered that "Science is based on experiment, a willingness to challenge old dogma, on an openness to see the universe as it really is […] the courage to question the conventional wisdom" (Sagan 1997). While it is important to acknowledge past research, it is equally important to reassess the work of earlier generations when new information and methods become available. However, it is also important to be able to separate the data and conclusions from the personality of the researcher – because the researcher might have had manifest or latent prejudices; this does not automatically invalidate their contributions to the subject.

Theories are inherently rooted in an 'etic' perspective, that is, the perspective of the researcher. Consequently, anthropological research stresses a deductive approach and begins with a theory, and then data is collected and analyzed, often with statistical methods, to determine if the theory is valid (McGee and Warms 2020; Ember and Ember 2009). This method is particularly useful when the researcher has a specific aim or question in mind and at least some prior knowledge of the culture. The downside of this deductive approach is twofold. Firstly, there is the risk of inherent bias because theories are preconceived beliefs. Secondly, two other levels of subjectivity are included as the researcher chooses their sampling methods and the type of data to be collected. Our culture, education, life experiences and the academic discipline we are a part of are filters which we use for all stages of any research project.

Some of these issues were addressed in an earlier paper outlining a version of 'the Framework', which was aimed at facilitating the study of material culture and technology (Feuerbach 2013).

Methodology and framework

The purpose of the Framework is to help researchers think about anthropological issues in new ways and make better use, and reuse, of diverse types of data. It is not intended to replace the current research methods but rather to complement

the already existing ones, particularly cross-cultural research methods. This is because "Human experience – the way real people experience real events – is endlessly interesting because it is endlessly unique, and so, in a way, the study of human experience is always exploratory, and is best done inductively. On the other hand, we also know that human experience is patterned" (Bernand 2011, 7). This method begins with an inductive approach by reassessing the testable evidence in search for patterns and is intended to help narrow down the variables to find those which are most useful for the particular research question. Beginning with data collection, rather than a theory, is not free from problems and biases, but these can be mitigated by using the proposed Framework. "A hallmark of scientific creativity is the ability to see novel and unexpected patterns in data" (Munafo et al. 2012). But, when using data without an initial theory, there is the danger of apophenia (seeing patterns in random data), so deductive methods are then needed to test if the observed patterns support or refute a theory.

The Framework provides a 'home' for data in a way intended to be a more objective way of classifying and analyzing data. This method is for thinking around a subject and exploring different possible paths to help answer questions. It is primarily aimed at two types of researchers: those who are new to the subject and want to conduct exploratory research; those who are well familiar with their subject but want to look at questions from different perspectives or to test a theory. The Framework was initially developed for exploring archaeological topics using inductive reasoning, utilizing different databases, for testing some already existing theories, and reducing the observer expectancy bias and preconceptions, but it can be adapted for other types of anthropological research. It merges the quantitative and qualitative measurements to get a fuller picture of the observed phenomena.

Framework for Classifying Data				
Questions	**Laws of Nature**	**Tangible/Empirical Measurement**	**Intangible/Ideational 'Rules of Culture'**	
Variations	$E= mc^2$ Physical Reality	*'Objective' Measurements = Data*	***Etic perspective*** *(Researchers' Cultures)*	***Emic perspective*** *(Target Cultures')*
Where?	**Space**	Latitude/Longitude Inclination/ Declination	Nation-states Cultural /Ethnic Borders	Spatial Orientation Place
When?	**Time**	Chronometric Dating	'Ages'; Years; BCE/ CE	Solar/lunar/ seasonal
What?	**Matter:** 'Things' Ecofacts Artifacts Buildings	Material Characterization Stylistic Classification Textual Analysis	Current 'scientific' understanding and classification of 'things'	Target populations understanding and classification of 'things'

Framework for Classifying Data				
Who?	**Matter**: 'People' Groups Individuals	Genotypes (DNA) Phenotypes (observable)	How we classify people People's relationships	How they classify people People's relationships
How?	**Energy** Behaviors Actions	**Life History of Matter** • Conception • Production • Distribution • Consumption • Elimination	Researcher's rational *(Cosmology, Worldview, knowledge)*	Target's rational *(Cosmology, worldview, knowledge)*

Methods which detectives use to solve crimes can also be applied to solving questions about human behavior. This is because archaeological science uses the same methods that forensic scientists use to solve crimes (Heron and Pollard 1996). The process begins by gathering the primary evidence whenever possible or extracting information from secondary sources if primary evidence is not available or accessible. Depending on the research question, anthropologists have additional methods at their disposal, such as textual analysis, visual analysis, archaeology, ethnographic methods, and primatology. There are many strategies and methods for deciding on sampling, including methods for data collection that can be found elsewhere, as suggested by Russell Bernard (2011). Physical evidence can be determined and characterized by using comparatively objective methods, such as morphological characteristics, including the type of material used, shapes, form, and decoration. Material characterization can offer objective evidence of the exploitation of resources and the methods used to process the raw materials into finished objects.

The research method begins by brainstorming all the possible evidence that could potentially be used, and it includes all the 'things' and actions that the researcher can think of which relates to the problem, whereas the data that is gathered will depend on the research question. The Framework considers all provenanced primary evidence as archival testimony without judgement to its accuracy. Whether the primary evidence is an object, textual account, first-hand observation, or human biological remains, it is considered to be archival testimony of someone's creation at a specific time and place and for a 'reason'. Historical documents are also treated as archival testimony and mined for their data by using textual analysis (Belsey 2013). They also serve for extraction of cultural information (Carley 1994).

Some evidence is stationary, such as buildings and features, yet some evidence is portable, such as artefacts (things) and documents, while other evidence is contained within individuals. Biology can tell us information about the life of a person, including how different people are related to each other. Other evidence recorded in the bodies includes information regarding disease, how far they travelled, the physical activities they engaged in, the age at death, for example. What we cannot tell with certainty is the ideas that were in their mind, their worldview and the knowledge they gained over their lifetime. But people do not live in isolation, and while the thoughts of the individual can escape us, the likely reason for certain decisions can be deduced when looking at society as a whole. For example, we might not know the beliefs or what was important to an individual, but we do have evidence of what others deemed important to give the deceased, what rituals were performed, and this can give insight into the practices at that time and place. Furthermore, ethnographic research and cross-cultural studies can also suggest why certain actions may have been performed, but it is important to note whose perspective it is.

After the primary evidence has been collected, it needs to be 'mined' for information that can be converted into data. The Framework provides a place for the data but is flexible enough to allow for different types of data depending on the problem. For example, the time period when an activity took place could be recorded as the millennia or to the second, or the place could be a large ecological area (a natural environment), a nation (cultural construction), or as small as a particular spot in a room (latitude/longitude/inclination/declination). What data should be used is one of the most important questions a researcher needs to ask because the quality of the research and outcomes are wholly dependent on the quality and appropriateness of the data.

The Framework divides evidence (data) into those factors that are tangible from those that are intangible. Tangible evidence, also called empirical or phenomenological, follows the Laws of Nature. These Laws put us on an equal footing with people from another place and time. While time can change things, their properties can often be deduced by methods of material characterization. These are the same for everyone, in the past, the present, and for the foreseeable future; the sun rises and sets, the moon affects the tides, and water is wet. A gold coin is still a gold coin, and a ceramic vessel does not change into an iron sword. While time does change the physical world, the original characteristics can usually be deduced with a reasonable amount of certainty. The intangible aspects, also called ideational or cognitive**,** are the way things are conceived of in our minds. The ways something is perceived by the researcher (the emic perspective)

versus that of the target individual or culture (the etic perspective), can be very different, and this must always be kept in mind.

The information that is 'mined' is placed into one of four categories; the Space (Where), the Time (When), Matter (Who and What), and Energy (How), can be determined from the tangible evidence. This leaves the intangible question of 'Why' as the fundamental anthropological research question. If the 'Why' is not solely due to our understanding of the Laws of Nature, then it is because of the Rules of Culture, and this allows us to study the question from different perspectives. Cultures are synchronistic, building upon earlier entities, so the data is sorted following the 'life history' of an object, person or people.

The first category is Space, defined here as a tangible place on Earth. Space can be objectively recorded using latitude and longitude points, and ecological environments can also lineate space. The physical places on the earth also have intangible components, including the delineation of Nation-States, sacred spaces, and places that only certain people have access to for cultural reasons. The same physical space can be understood or conceived of differently depending on the culture. Who can or cannot access or occupy a particular space is a cultural construction and the reasons differ. Some places are public and shared by the group, while some are sacred and only for religious practitioners, and some areas are strictly for males, females, or people of a particular age. These allowances and prohibitions can reveal information about the culture's concepts of inclusion and exclusion, endogamy and exogamy, in addition to their spatial orientation and their understanding of their place in the world, their cosmology or worldview.

The next category is Time, defined here as when an action occurred. People have been tracking time for millennia and different cultures have their own particular temporal orientation. There are many ways people track time, from water clocks to the atomic clock and calendars. Some cultures use a lunar calendar and others use the sun, while others use seasons or a combination of methods for different purposes. Whether the new day starts at midnight, sunrise, or sunset, is also culturally dependent. There are also different concepts of time, such as the Aztecs needing to help the time pass. For archaeological artefacts, two methods can be used to assign a date, Relative and Absolute dating; however, they are placed into different categories in the Framework. Absolute or Chronometric dating methods, such as dendrochronology and radio-carbon dating, can date material using scientific methods. In contrast, Relative dating relies on a classification system developed by a researcher; therefore, it is considered an intangible factor from the etic perspective.

The next category is Matter. Science defines Matter as a physical material that has mass and occupies space. The matter has measurable Attributes, and whether an Attribute is considered favorable or not is culturally dependent (Feuerbach 2013). For the purpose of the Framework, Matter is divided into 'people' and 'things'. People can be represented as individuals and as groups. While groups are composed of individuals, everyone is unique and might not be representative of the population, but they will still share certain requirements based on the Laws of Nature. From individuals, it is often possible to deduce elements of their Lifestyle. Lifestyle can be defined as what someone has and what they do, and these can be observed from ethnographic research or deduced from evidence in the archaeological record.

People need access to resources, whether they collect them directly from nature, through trade or other means. Food is needed for life, and the primary subsistence strategy can often be deduced from various sources, including environmental studies, human bodies, texts, or observations. Since there are correlations between adaptive strategies, theoretically, the subsistence strategy may be the factor that most influence the form of other adaptive strategies. The technology people use to make 'things' from natural resources can also be deduced because the materials and the processes leave traces either within the artefacts, in the by-products, or indirectly from use. Things can also tell us what people value and their knowledge of the workings of the physical world.

The last category is Energy. Whether it is the conversion of food for energy, life requires the exchange of energy in one form or another. Energy is also needed for the conversion of natural resources into useful products. Actions are defined here as changes that produce and affect (Feuerbach 2013) the transfer of Energy. Each Action overlaps with the other categories. Actions are undertaken by individuals and groups, they take place at a location (Space) during a period of Time, with the use of certain things. For example, a Priest (individual) speaks (Action) to the parishioners (people) at a Church (space/thing) on Sunday morning (time). This systematic method allows for gathering data that is objective, reliable, transparent, and testable.

These Actions are subdivided into groups that can be compared to the 'Product' life history and also a person's life history. The first of the group is 'Conception' and this can be an idea, the beginning of a person, or a product. The way in which a new idea occurs to an 'inventor' mirrors their worldview. In Western culture, ideas are often said to "just appear out of thin air", mirroring the Abrahamic belief of humans being created out of nothing by an invisible all-powerful creator. Just as a new life form is created from a preexisting life

form, a new idea originates from the knowledge of the innovator. The second group is Production. In a person's life history, this relates to the time between initial conception to becoming an adult. For a product, it is the steps needed to transform an object from natural resources to the end product. The third group is Distribution. This is when an adult 'leaves the nest' to go out in the world. For a product, it is how the product gets from the producer to the consumer. The fourth group is Consumption, this is the use of the product but it can also be the 'purpose' of the individual, such as their occupation. The final group is Elimination. This group includes how a person is treated after death and how products are disposed of when they are thought to no longer be of use.

Data analysis and theory

After converting the primary evidence into data, the data is repeatedly filtered and sorted, and then Cluster Analysis and Venn Diagrams are created to see if any patterns are observed. There are many other methods of data analysis, but these are the easiest to start with. The purpose of data mining is to obtain new knowledge and it achieves this by analyzing data to identify patterns and correlations. These patterns are then visualized to assist with the interpretation of the evidence and to identify the underlying mechanisms that are responsible for the observed phenomena. Then we asked if the observations could be explained by any known theories or do they suggest another explanation. Using this method, the data 'speaks' before the theory (inductive research), and then the theory is tested against a new set of evidence (deductive research).

Many studies focus on how humans differ from other life forms and each other, but understanding the reasons for the similarities is more useful in determining if there are particular 'Rules or Laws' of Culture. By focusing on similarities, any outliers and differences can become apparent. This can also help identify mistakes or misinformation because these could form their own group. Ideally, patterns in the evidence will be observed, with or without the use of a computer, and these can be used to construct new hypotheses or test existing theories. Three anthropological premises are that cultures are holistic, synchronistic, and there are positive correlations between adaptive strategies. If these premises are true, they are a powerful yet underutilized theory for understanding cultural dynamics. Cross-cultural comparisons that span different places and times, can help to determine aspects of culture that do not leave clear remains in the archaeological record. This means that, at least in theory, if one of

the adaptive strategies is known, the others can be deduced. Research can then focus on the presumed correlated strategies to see if there is evidence for them in the archaeological record. This information can be used to better understand the 'black box' of the past, such as religious, economic and kinship systems.

Examples of the application of the framework

The Framework was used to explore archaeological artefacts to discover what cultural information could be gained from them and to test existing theories regarding the nature of these artefacts. The first example is the 'Anglo-Saxon' Mappa Mundi, and the second is a group of 'Viking' period swords called 'Ulfberht'. The full research has been published elsewhere, so a summary of the findings is presented below.

The so-called Anglo-Saxon Mappa Mundi is the earliest known map of the Old World from England and the map's provenance and authenticity are secure. The date of the map's creation is firmly placed prior to the Norman conquest of 1066 CE. Rather than understanding the map as an imaginative view of the world as many scholars have previously assumed, it was viewed as archival testimony, without judgement of its accuracy, but as a tool to help us learn about people who lived in past times. The map is very detailed, with written descriptions of places, sketches of buildings, green mountain ranges, red rivers, and straight lines that are strategically placed on the map. All map makers have the challenge of representing a 3-dimensional earth in 2 dimensions and this can cause a map to look 'wrong' to some viewers when an unfamiliar projection is used. However, a different projection does not make a map inaccurate. Map-making was an expensive and time-consuming activity. Manuscripts were created in monasteries and were the 'textbooks' of the time, used to educate the clergy and aristocracy, including future kings, knights and noblemen. It was not a frivolous pastime for bored, drunk monks, as some publications would lead the reader to believe.

The research began by examining the places mentioned on the map and comparing them with historical and geological information and archaeological sites. There are approximately 150 places designated on it. Some of the text is difficult to read and others are based on biblical information and would be the topic of future research, but it quickly became apparent that the buildings had physical counterparts that existed in the 10^{th}-11^{th} century. The cities mentioned on the map, such as London in England and Armagh in Ireland, would be expected on a map associated with the Anglo-Saxon court, but it also recorded

places much further afield. The location and descriptions accompanying the text show that specific information about these places was known to the map makers. Rome and other religious places in Italy are listed, which is not particularly surprising, but there are other places depicted that give us some idea of the extent of their knowledge of the 'known' world. For example, in the location of China, there is an accurate sketch of a Tang period lion with the words, 'here abundant lions'. The sketch resembles 10th-century artefacts, commonly made of copper alloys, that are often associated with Buddhist temples. Another example can be found in southern India, where the text reads 'Golden Mountain'. During the 10-11th century, the Chola temples of southern India were covered with gold, thus appearing as a golden mountain. In the region of south-western Africa, there is a sketch of a building and the words, 'stone or volcano'. Even today, the stone ruins of Great Zimbabwe resemble the shape of a volcano. Other places do not have a known physical counterpart but rely on biblical history, such as the location of Noah's Ark. Other descriptions are tantalizing, such as the mention of dog-headed people in a location in Africa where people practiced cranial deformation. Thus, the conclusion was that the map was not a figment of monks' imagination but an accurate and usable map of the known world (Feuerbach 2020).

The research then looked further afield to find out what other information is known about the people from this time period. There is a clear religious component of the map, not only because of its presumed place of creation, in a monastery, but because of the biblical references and the religious places depicted on the map. By the 10th century, Christianity had already spread and was known in India as well as in China. There were many Christian sects and the Benedictine movement sought to unite the different versions of Christianity. In the ruins of an early Medieval Benedictine church in Greenland, a disk was discovered for navigation via the sun (Bernáth et al. 2013). When taken together with the Mappa Mundi, it became clear that the map uses the sun for navigation (Feuerbach 2020) and that these places were known to people who were affiliated in some way with the church.

During the research, it became apparent that previous researchers' etic perspective, including latent biases and prejudices, clouded their view of the accuracy and educational value of the map. The use of this Framework reduced these biases because it treated the artefact as archival testimony. By populating the Framework with evidence-based information: the description of buildings (Matter: Things), the location (Space), during that period (Time), we can gain more information about the person (Matter: People) who created the map (Emic perspective), and the knowledge that was available to some groups of people,

1000 years ago. The evidence is presented in a transparent way so that the claims can be easily tested by other scholars. The result is a greater appreciation of the extent of their knowledge of the 'known' world. While this does not in any way prove they travelled to all of these places, it does show that they knew more about these places and people than has been previously considered by many scholars.

The second example is the study of a group of 'Viking' swords called 'Ulfberht'. In Europe, the sword is strongly associated with the Medieval period, the time when the Roman occupation ended (around 700 CE) and before the formation of Nation-states around the 11th -12th century. It is one of the most tantalizing periods of history because the rationale for the events, such as the so-called Anglo-Saxon migrations and Viking attacks, is debatable. While there is a wide range of artefacts and burials, there is less written documentation about everyday life than from the earlier Roman or later Medieval Periods. From an anthropological view, it is particularly interesting because it witnesses a major shift in adaptive strategies that still resonates today. Monotheism, particularly Christianity, replaced polytheism, the creation of Nation-states replaced kinship loyalties, coins for the market economy replaced methods of redistribution as the primary sources of trade, and the other correlating changes can be seen to increase during this time until the 'old ways' virtually disappear. The problem seems to be that many scholars of history are unaware of anthropological theories that could help explain events and other phenomena from that time.

Perhaps the most representative artefact from this period of time is the sword. The production of swords requires specialized knowledge and access to resources, so they have the potential to elucidate a variety of social relationships and organizations because they can link people through both peaceful and forceful means. From the miners of the ore to the smelters, the sword producers, the distributors, the eventual end users, and the final burial place, a sword can travel over long distances via merchant and military action and, thus, can shed light on the movements of people and ideas that are the core of understanding culture change.

There is a group of about 200 swords that are referred to as 'Ulfberht'. The Attributes, or characteristics of the swords vary in the type of steel used, the characters that 'spell' 'Ulfberht', the inlay method, the material and shape of the pommel and hilt, in addition to the context and the location of the finds. These observable characteristics provide data that could be used to understand various Actions that occurred during the sword's 'Life history'. The variations make these particular swords well-suited for understanding this period of time because their overlapping similarities and differences allow for data mining, analysis and visualization.

Common questions asked about these swords include the meaning of 'Ulfberht' and the reason why the swords are found in so many places across Europe and into Western Asia. At the start of the study, the researchers had only fundamental knowledge about the history of these cultures, not about particular swords from the area. Rather than a disadvantage, this reduced expectancy bias and preconceived ideas. Some current theories claim that Ulfberht was a superior blacksmith who worked along the Rhine in Germany, that the swords were produced over centuries, and the variations in spelling and steel quality are due to some being fakes and forgeries or made by illiterate smiths. The explanation for their high frequency in Norway is that 'Vikings' took them as booty during raids. There are problems with these existing theories, primarily the lack of supporting evidence and the anachronistic nature of some claims, such as the desire of a blacksmith to imitate a blade for the purpose of financial gains.

The Framework helped to identify additional issues. The first problem was the proposed time period of production, typically between the 10th and 12th centuries, based on pommel typology. The dating of the swords by typology is misleading because typology (groups of a similar type) is not the same as the relative dating method of typological seriation (the use of a diagnostic type to give a relative date to associated material). At this stage, pommel styles are an unreliable method of dating unless the style is supported by methods of Absolute or Chronometric dating. Looking at the distribution pattern of where the swords were found, together with the different types of inlay designs and the discovery that some of the swords were made of crucible steel (Williams 2009), we concluded that the Ulfberht swords found in Norway should be associated with the reign of Hakon 'the Good' (920-961 CE, *aka* Hakon Haroldsson) during the mid-10th century (Feuerbach and Hanley 2017). This controversial theory needed to be further tested by using different data and from different perspectives to determine its validity.

Using the Framework as a guide, the majority of data was mined from Stalsberg's (2008) published research on Ulfberht swords. She had undertaken the monumental task of tabulating the characteristics of the swords from museum collections. She recorded the variations of the 'spelling' of Ulfberht on the Obverse side of the sword, the marks on the Reverse, the country where the sword was found, and the Pommel type. This data was filtered to include only those with known data points and sorted according to the presumed 'Life History' of the sword. The inlay would have been applied during the swords production and the find location would have been the last place travelled to in the 'Life' of the blade. During its 'life', a pommel and guard will have been added before the

sword travelled to its final resting place. Due to the variations, the data formed different groups, and these groups were then examined alongside historical evidence from the time period. The historical documents were translations of the Icelandic Sagas, Anglo-Saxon Chronicles, and other manuscripts, as well as contemporary and related artwork and artefacts. They provided information that was then used to link the various groups of people and the events that occurred, and then the anthropological theory was used to better understand the various ideologies and cultural practices from that period. For example, in Christian areas, swords were to be returned to the church, but in regions where people practiced other religions, they could accompany the dead. This would account for the high frequency of swords in pagan burials.

The Framework facilitated pattern identification, and then the historical evidence and anthropological theory helped to explain the observations. During this time in Europe, swords were not purchased but rather, kings and nobles distributed swords to their supporters. The organization of these supporters varied from the clan-based aett of the Norse, the Anglo-Saxon land-owning thegns, to tribal households in Ireland, and the Ottonian tripartite system consisting of professional military, clergy, and layman. The swords distribution patterns and the intended recipients should be linked by one or more of these documented social networks and this had the potential to be identified. All of these are rooted in land, family, and social responsibilities, so the research began with the assumption that the data visualized groups linked by different forms of social organization.

The research concluded that there are positive correlations between the swords obverse marks that 'spell' out a version of 'Ulfberht', the runes or knot reverse marks, burial locations, and the order in which the saga's document Hakon 'the Good's' sequence of eliciting allies as was recorded in the sagas (Feuerbach, 2023). The saga reports that Hakon first went to his homeland, then to his uncle-in-law, and then visited his nephews. The correlation between the reverse mark and people is remarkable because the 'reverse marks' are runes or knots that can now be linked with specific family groups. Furthermore, the frequency of uncle/nephew relationships and fostering in the saga is apparent. Avuncular fostering is common in cultures where the men are away for extended periods of time, trading, hunting or raiding, all common activities of so-called 'Vikings'. Hakon 'the Good' is often mentioned as King Athelstan's foster son, and it has been claimed that his father sent him to Athelstan's court to keep him out of harm's way, but it is just as likely it is because King Athelstan was his matrilineal uncle. This information has been erased from history, but it fits the kinship pattern and

there is further support for this discovery. The other members who accompanied Hakon at the court when he was growing up were the future kings Louis the IV of France, and Olaf III Sigtryggson of Scotland and Ireland, who are documented as being paternal nephews of Athelstan. Thus, by using the Framework to investigate these kings' parents (Conception), where they grew up (Production), where they travelled to (Distribution), where they ruled (Consumption) and eventually were buried (Elimination), it was easy to see that they all were brought up together (Time) in their uncle's court in England (Space). Athelstan was known as the 'giver of swords', and that he sent the young men off with weapons when they set out to be kings. The ability to link the swords with specific people, events, and places clarifies personal connections between previously legendary and known historical figures and begins to increase our understanding of the social, biological, economic, religious, and military connections with a new theory that stands up to the physical and documentary evidence.

Conclusion

To conclude, the simple Framework has shown to be useful for organizing complex data, reevaluating previous theories, and discovering new patterns of behavior. The method reduces bias and preconceptions by separating out the data that is tangible and measurable from that which is intangible or cognitive. While the Framework was developed for archaeological questions, it can be adapted for other anthropological questions.

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