UNIVERSITY OF LIVERPOOL

DEPARTMENT OF ARCHAEOLOGY, CLASSICS & EGYPTOLOGY

An Anthropological Assessment of Neanderthal Behavioural Energetics.

Thesis submitted in accordance with the requirements of the University of Liverpool for the Degree of Doctor in Philosophy by **Andrew Shuttleworth**.

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ABSTRACT

The debate on Neanderthal social and symbolic capabilities is one of the fundamental issues of Palaeolithic archaeology, with the archaeological record suggesting that Neanderthals did not display the same range and variability of behaviours as anatomically modern humans (AMH). This lack of evidence has often been attributed to the cognitive superiority of AMH over Neanderthals. The reliance on the material record alone, however, neglects a range of non-material behaviours that are arguably of equal importance to understanding the cognitive abilities of this species, but which leave no archaeological traces.

This thesis presents an alternative approach to the interpretation of Neanderthal social behaviour that is based on ethnographic modelling drawn from contemporary hunter-gatherers and applied to the archaeological records of Neanderthals and AMH living in Europe during Oxygen Isotope Stage 3 (60-30ka). The aim of this thesis is to highlight Neanderthal behavioural responses to fluctuations in environmental productivity and to compare these to the behaviours of AMH in the earlier Upper Palaeolithic to determine if any significant differences existed between the two species.

The thesis employs a range of ethnographic and archaeological data which relate to a range of material and non-material social and symbolic behavioural expressions, such a rites of passage, cooperative hunting, care for the elderly, and prestige hierarchies that are not typically inferred from the archaeological record. The ethnographic record allows for the quantification of such behaviours so that correlations can be made between social expressions (cohesion, control etc) that can then be inferred from the material record. Statistical tests, including General Linear Modelling, were employed to determine the robustness of these correlations. The ethnographic model was applied to the archaeological record of the Upper Palaeolithic prior to its being applied to the Neanderthal record of OIS-3 to determine the suitability of applying it to prehistoric contexts.

Results show that both Neanderthals and AMH employed similar behavioural mechanisms for coping with resource stress in relation to social cohesion, though individual expressions varied between the two species depending on their environmental contexts. Analysis suggests that the Neanderthal capacity for spiritual and material expression was hindered by demographic and physiological constraints rather than any differences in cognitive capacity. Finally, analysis shows that Neanderthals employed optimal behavioural capacities throughout the Middle Palaeolithic and were a much more behaviourally variable hominid than previous interpretations of the archaeological record have suggested.

1. INTRODUCTION

1.1 Introduction

This thesis aims to apply ethnographic analogy to the Middle Palaeolithic archaeological record of Oxygen Isotope Stage-3 (OIS-3), between 60,000 to 30,000 years ago, to infer Neanderthal social behavioural responses to fluctuations in environmental productivity and compare these to modern human hunter-gatherers of the Middle to Upper Palaeolithic Transition. The reasons for this analysis are twofold: (1) to determine the full range of Neanderthal behavioural expressions and (2) to highlight the behavioural differences or similarities between the Neanderthals and Anatomically Modern Humans (AMH). A more detailed statement of the aims of this work can found in Section 1.2.

The primary source of data for behavioural interpretation has been archaeological, but this restricts behavioural interpretations to those expressions which produce material proxies; such as beads, burials and mobilary art which likely represent kin and spiritual associations (Shea, 2012). As a result, a range of non-material behaviours such as dance, rites of passage ceremonies and other behaviours that promote social cohesion are often overlooked. It is only when we consider both material and non-material expressions of cohesion together that we will have a better understanding of human behaviour and adaptive capacity. The works of Oswalt (1976); Roscoe (2002, 2004, 2006), Grove (2009) and Grove et al (2012) exemplify this methodological approach, whilst Binford (2001) and Murdoch (1967) have provided the quantitative data required to implement such analyses on a scale larger than previously envisioned.

Initially, ethnographic models based on measuring human responses to ecological constraints were limited to behaviours that could be identified by material proxies (Oswalt, 1976; Binford, 1986), but more recent models have employed data to identify a range of complex, non-material expressions (Roscoe, 2004; Grove et al, 2012). It is only recently that these interpretations have been applied to the archaeological record.

The Middle Palaeolithic is represented by one general tool industry characterised by the dominance of side-scrapers, points and denticulates: the Mousterian. Once considered distinctly uniform, the Mousterian has been shown to be a highly variable and adaptive industry (Ruebens, 2012) with the culture also being the first to deliberately inter the dead through a range of burial practices including caching and complete burial (though these do not display the same material variability and definition of the succeeding burials of Modern Humans in the Upper Palaeolithic).

Although the Middle and Upper Palaeolithic both contain similar tools and features as described above, the industries of the Upper Palaeolithic (the Aurignacian, Gravettian, Solutrean and Magdalenian) display substantially more variability in their style, function, and typology. Further, the greater production of non-utilitarian symbolic artefacts adds to the overall variability of the Upper Palaeolithic compared to that of the Middle Palaeolithic.

It is apparent, therefore, that the archaeological record of the Upper Palaeolithic provides a greater range of material behavioural proxies than the Middle Palaeolithic. As discussed later, this difference does not necessarily mean that the Neanderthals were not a symbolic species. The behavioural attributes of modern humans have been well studied (Barnard, 2011; Binford, 2001;Panter-Brick et al, 2001 and references therein) but those of the Neanderthals have been dismissed due to a research bias that has focussed on the interpretation of certain classes of artefacts that are considered to be markers of behavioural modernity. The Middle Palaeolithic archaeological record therefore needs to be analysed to determine if these artefacts could represent behavioural proxies that could provide information on the full range of Neanderthal social behaviours. In addition, inferences about Neanderthal behaviour need to be compared to those of modern humans to determine if there are any significant similarities or differences between the two species. These points represent the core analytical goals of this thesis.

1.2 Aims and Objectives

The fundamental aim of this thesis is to identify Neanderthal behavioural responses to variations in environmental productivity throughout Oxygen Isotope Stage-3 (OIS-3) between 60-30 kya, to compare these behaviours to those of modern human foragers of the Upper Palaeolithic, and to highlight probable factors which may have hindered Neanderthals from producing a richer material record of their behaviours. This thesis therefore addresses these specific issues: What are the contemporary human responses to variations in environmental productivity? What was the importance of these behavioural responses in the context of the Neanderthal way of life? Do these responses produce material proxies that could be observed within the archaeological record? Do these behavioural responses remain consistent throughout the prehistory of modern human hunter-gatherers in Europe? Do Neanderthals display these same behavioural responses? Were there physiological and demographic factors which may have hindered the Neanderthal expression of these behaviours?

In order to understand human behavioural responses to environmental productivity a dataset of 55 contemporary hunter-gatherer societies and their respective behavioural expressions was collated. The dataset is representative of hunter-gatherer behavioural responses to various degrees of resource availability across all habitats from the topics to the arctic. The information from this dataset was analysed using a combination of statistical tests to see if any behavioural patterns emerged. This analysis will focus on the Middle Palaeolithic of OIS-3 (c.60 – 30 kya) for two reasons: (i) there is an abundant Neanderthal archaeological record for this period which is securely dated, and (ii) there is a large body of environmental data available for this period thanks to significant research and statistical modelling conducted by the Stage Three Project (van Andel and Davies, 2003a).

I am not specifically addressing questions concerning the Neanderthal contribution to the modern human genome, their contribution to the so-called transitional industries, or Neanderthal extinction (though the latter is touched upon). This work aims to test the hypothesis that Neanderthal behavioural responses were similar to those of Modern Humans when it came to living in a variable environment and as such attempts to address the issue of why Neanderthals did not create an abundance of material symbolic artefacts but also illustrate that Neanderthals may have been capable of a range of non-material expressions which can nevertheless be considered symbolic. The importance of this research is apparent in that it could fundamentally alter our perception of Neanderthal behaviour in relation to Modern Humans or consign them to a behavioural backwater.

This thesis analyses one of the largest collations of ethnographic data compiled from the literature and is broadly representative of all climatic/environmental zones currently occupied by contemporary hunter-gatherer societies. I have not extended the archaeological analysis beyond OIS-3 as doing so would present methodological issues as noted throughout various chapters.

1.3. Thesis Format

Since the approach of this thesis is broadly methodological, chapters are presented in order of the analytical goals of the thesis. Chapter 2 introduces aspects of Neanderthal and Middle Palaeolithic background information relevant to the goals of this thesis, notably Neanderthal morphology, chronology, a description of the Mousterian industry and an overview of climatic conditions of OIS-3. Further detail on the specific environmental conditions of OIS-3 are also mentioned throughout Chapters 4 – 7 to provide further context for the specific periods (Upper Palaeolithic, Early Upper Palaeolithic and Middle Palaeolithic) addressed in these chapters. The chapter concludes with a brief summary of the two current Neanderthal debates most relevant to this analysis: Neanderthal behavioural modernity and extinction. Both are pursued further in Chapter 8.

The ethnographic dataset and analysis is discussed in Chapter 3, detailing the overall methodology applied throughout the thesis. Chapter 3 also details the statistical methodology and results obtained from the initial ethnographic analysis on which archaeological interpretations are based; further methodological considerations are also discussed in Chapter 4, 5 and 7 regarding the application of the ethnographic model and its finds to the archaeological record. Chapters 4 and 5 describe the application of the ethnographic model and its associations to the archaeological record of the Upper Palaeolithic, with Chapter 5 sub-divided into two sections to reflect the different behavioural contexts which existed in the Early Upper Palaeolithic (EUP). Chapter 6 provides a summary of the Upper Palaeolithic behavioural associations highlighted by the ethnographic model. The ethnographic model is applied to the Middle Palaeolithic archaeological record in Chapter 7 with subsequent discussion of the overall implications of its finds for Neanderthal and modern human behaviour in Chapter 8. The thesis concludes (Chapter 9) with recommendations for future research and an assessment of the utility of ethnographic based quantitative modelling for studying the Palaeolithic.

2. THE NEANDERTHALS AND OXYGEN ISOTOPE STAGE-3

Neanderthals (*Homo neanderthalensis*) were once the dominant human species of Europe, and due to their extensive archaeological record they are one of the most well known prehistoric hominids, second only to that of *Homo sapiens*. Over 150 years since they were first discovered, our image of Neanderthals has grown from that of primitive, cave dwelling scavengers to apex social predators and new finds and methodological approaches constantly alter our understanding and perception of our closest extinct ancestor.

In an effort to further understand Neanderthal social and symbolic expressions, this thesis has employed an anthropological approach based on ethnographic modelling that allows for the comparison of contemporary human behavioural responses to those inferred from the archaeological record. This should highlight behavioural differences and similarities between the two species and help further our understanding of those non-material behaviours which by their very nature are not typically represented in the Neanderthal archaeological record. To understand the context of this analysis, and why such an approach could potentially provide important insights into Neanderthal social and symbolic behaviour, a brief introduction to Neanderthals is warranted. Presented here is an overview of Neanderthal discovery, the extent of their geographical range and the archaeological assemblages that are associated with them. As this thesis will concentrate predominantly on Neanderthal social behaviour in Europe during Oxygen Isotope Stage-3 (OIS), the overview will focus on Neanderthals of this period (60 – 30 kya) and also provide a synopsis of European environmental conditions. Finally, the overview will address the key social behavioural debates relevant to this thesis.

2.1 DISCOVERY, GEOGRAPHIC RANGE & ORIGINS

2.1.1 Discovery

For a species that occupies such an important place in our understanding of what it means to be human, the initial discovery of Neanderthals was distinctly low-key. The first known Neanderthal specimen, a fragmentary child's skull, was found in 1829/30 at Engis Cave, Belgium (Kennedy, 1975, Stringer et al, 1984). Though the unique morphology of the specimen was immediately recognised it, was several years before it was attributed to that of an archaic human, with assessments of the time attributing it that of a bear (Fraipont, 1936). Although a similar find at Forbes Quarry, Gibraltar in 1848 confirmed the presence of a distinct human species the scientific community paid little attention to them beyond assessing their supposed antiquity (Barton et al, 1999). The discovery, at Kleine Feldhofer Grotte in the Neander Valley, of 15 postcranial and cranial remains ultimately brought the species to the forefront and it is from these finds that the species receives both its type specimen and name[1](Howell, 1957). The discovery of two adult skeletons at Spy, Belgium in 1886 along with a range of tools and animal bones (including large game species such as mammoth and rhinoceros) verified the Neanderthals as fossil humans with their own cultural and material expressions.

The development of archaeology during the early 20th Century saw an increase in the finds of Neanderthal specimens and a broader understanding of the material cultures associated with them. The majority of these finds, such as La Chapelle-aux-Saints (1908), Le Moustier (1914), La Ferrassie (between 1909-1912) and La Quina (1911), were found in France; though significant finds were also found in Eastern Europe at sites such as Krapina (Croatia, 1899-1905) as well as new finds in Gibraltar (Devils Tower, 1926) (Wolpoff, 1979; Brace, 1982; Trinkaus, 1995; Schmitz et al, 2002). These discoveries served to solidify

[1] There are two possible spellings depending on how one approaches the Germanic spelling of 'Valley': TAL or THAL. This thesis has opted to use the latter, more common, spelling.

Neanderthals as a unique species (Stringer et al, 1984) and subsequent archaeological finds since the 1920's have reinforced the material associations between Neanderthals and the Mousterian industry as well as the geographic extent of the Neanderthal occupation of Europe (Table 2.1).

Country	Site	Date of Discovery
Belgium	Scladina Cave (Scalyn)	1993
France	Le Regourdou Cave	1957
	L'Hortus Cave	1960
	Roc de Marsal	1961
	Saint-Cesaire	1979
Germany	Ehringsdorf	1908, 1925
Greece	Apidima Cave A	1979
Gibraltar	Devil's Tower Rockshelter	1926
Hungary	Subalyuk Cave	1932
Italy	Saccopastore	1929, 1935
	Guattari Cave	1939
	Lanakuga Cave, Altamura	1993
Russia	Mezmaiskaya Cave	1993
Spain	Zafarraya Cave	1983, 1992
	El Sidron Cave	1994, 2000
Ukraine	Kiik Koba	1924

Table 2.1. European sites which feature notable Neanderthal fossils discovered since 1920. Site locations are displayed in Figure 2.2. Adapted from Klein (2009). Baryshnikov et al (1996); Klein et al, (1971); Arensburg et al, (1995); Grun and Stringer, (1991); Smith et al, (2007); Stringer (1990); Petit-Maire et al, (1971); de Lumlet (1972) Madre-Dupout (1992)l Bocherens et al (2005); Defleur et al (1999) Lalueza-Fox et al, (2005) and Perez-Perez (1993).

Figures 2.1 and 2.2 highlight the known geographic range of the Neanderthals as well as sites associated with significant Neanderthal occupation events. It is clear from the archaeological record that Europe represents the core Neanderthal range, with significant occupational excursions into the Near East and Siberia. This large geographical area is unlikely to have been occupied continuously, and climatic downturns would have likely seen the northern and southern ranges contract and expand respectively. The greatest fluctuation in Neanderthal geographic ranges occurred during OIS-3 as contact with modern humans brought about a significant contraction of foraging ranges that were restricted to zones of refugia in south-west Europe.

Figure 2.1. Neanderthal Geographic distribution as inferred from fossil and archaeological finds. Darker shaded areas represent the known core range of the Neanderthals, whilst lighter shaded areas represent thee possible extent of this range into Siberia. Adapted from Krause et al (2007).

Figure 2.2. Geographic distribution of Neanderthal archaeological sites throughout Europe mentioned in the text and included in statistical analysis in Chapter 6. Adapted from Klein (2009).

2.1.2 Neanderthal Chronology

The geological age and origin of the Neanderthal lineage is open to debate but consensus is they were a uniquely European hominid species who diverged from *Homo heidelbergensis* sometime between 530 – 200 kya. Morphologically such an origin is supported by the fossil record from Atapuerca Sima de los Huesos (Spain) where specimens display a range of Neanderthal facial characteristics, including the presence of a robust supraorbital torus over the eyes and distinct prognathism along the midface (Trinkaus, 1982, 1983). Other early specimens, including Petralona and Steinheim which both display Neanderthal-like characteristics, as well as other archaic morphologies, suggest that Neanderthals emerged in the European landscape before 400 kya (Stringer et al, 2012). The relative discontinuity of the emergence of Neanderthal features over time suggests either a slow adaptive evolution to European conditions; though it could alternatively represent the effects of genetic drift on the Neanderthal population (Howell, 1958; Weaver et al, 2007). Though the size, amount and nature of the fossil sample make definitive interpretations of Neanderthal emergence debatable, on the basis of morphological evidence it is reasonable to theorise that Neanderthals emerged on to the European landscape between 400 – 200 kya. Analysis of Neanderthal mitochondrial DNA (mtDNA) supports a modern human-Neanderthal divergence sometime between 300 – 750 kya (Serre et al, 2004; Krause et al, 2007). Though mtDNA does not provide a more refined range for the divergence of the two species, the midrange corresponds to the period when many believe Europe was first occupied (Stringer et al, 2012) and broadly supports morphological assessments for the emergence of Neanderthals sometime between 400- 200 kya.

This inherent antiquity ensures that typical methods of dating, specifically radiocarbon (C^{14}), are not applicable to the majority of Neanderthal fossil and occupational sites. The use of absolute dating methods, including Thermoluminescence (TL), Electron Spin Resonance (ESR) and U-series allow for more reliable assessments of the earliest Neanderthal fossils. Ehringsdorf and Biache-saint-Vaast represent the earliest Neanderthal fossils, dating to 190 and 159 kya respectively (Cook et al, 1982; Blackwell and Schwarcz, 1986; Grun and Stringer, 1991; Somme et al, 1986 and Aitken et al, 1986), and suggest a speciation date closer to 200 kya than the morphological affiliations of the Atapuerca fossils whilst the dating of sites such as La Chapelle-aux-Saints and Le Moustier (France) suggest that Neanderthals were a distinct feature of the European landscape between 127 – 71 kya (OIS-5)(Dennell, 1986; Mellars, 1996). The majority of European Neanderthal fossils date to between 71 – 30 kya (OIS-4/3), though this may reflect taphonomic processes rather than any increase in Neanderthal occupations or population density (Pettitt, 2011). The latest Neanderthal fossils occur within the Iberian Peninsula and Gibraltar, and are dated to 27 kya (Finlayson, 2006), which suggests that Neanderthal became extinct sometime between 27 – 25 kya, roughly 20 kya after the initial contact with modern humans.

2.2 MORPHOLOGY

Neanderthals constitute the largest single hominid classification in the fossil record, with the majority of skeletal elements represented. This has shown researchers that Neanderthals were a robust and muscular species, in contrast to modern humans who displayed a more gracile morphology reflective of their African origins. Post-cranially, Neanderthals are defined by their broad chests, short upper and lower limbs, and large joint surfaces (notably at the knee) whilst the Neanderthal cranium tends to be larger and longer than that of modern humans with a notable protrusion of the face (Coon, 1962; Frayer, 1992; Stringer et al, 1984; Trinkaus, 1983, 1984, 1986, 2006). Initial assessments of these physical characteristics led early researchers (eg. Boule, 1920) to conclude that Neanderthals were

were more closely related to apes than to modern humans. Today's researchers, however, know these characteristics to be adaptations to the cold and variable climate of Europe. These defined characteristics, and their consistency throughout the duration of Neanderthal existence have resulted in them being the most recognised hominid species in the archaeological record (Figure 2.3).

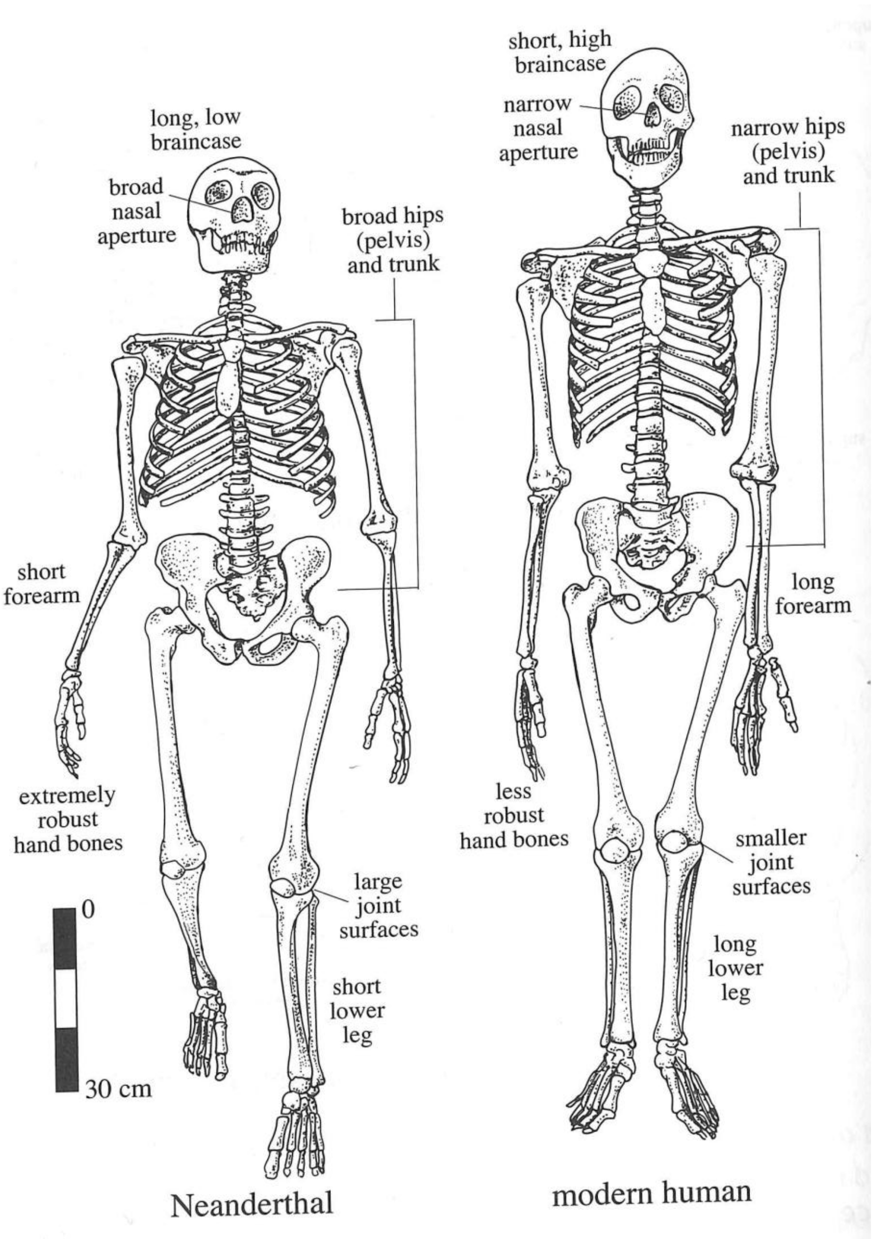

Figure 2.3. Comparison of Neanderthal (Left) and Modern Human (Right) skeletal morphology, with key elements highlighted. Note that on average Neanderthals were smaller than modern humans as well as smaller distal limbs though the Neanderthal thorax was broader. (Adapted from Klein, 2009).

2.2.1 Cranial Morphology

Though postcranial anatomy offers distinct diagnostic markers, the majority of Neanderthals are identified via their cranial morphology, notably through the unique qualities of the Neanderthal cranial vault, face and dentition (Figure 2.4).

Typically long and low, the Neanderthal cranial vault is globular in shape compared to that of modern humans which tends to be high and circular (Trinkaus, 1984). Its general morphology is robust and defined by a continuous supraorbital torus that forms a raised ridge over the eyes as well as strong muscle attachment sites to the rear and lateral sections of the cranium, represented by the occipital bun and mastoid tubercles (Trinkaus, 1983, 1984). This suggests that the musculature in relation to eating and remaining upright was significantly more developed in Neanderthals than modern humans. The most distinct aspect of Neanderthal cranial morphology is its size. Ranging from between 1,245 to 1, 740cc the Neanderthal cranial capacity represents the largest cranial volume of any hominid (Holloway et al, 2004). In comparison, modern human cranial capacities range from between 1,340 to 1, 560cc. Increasing encephalisation is a noticeable feature throughout hominid evolution, and the difference in Neanderthal cranial capacity compared to their contemporaries likely facilitated the successful evolution of the species throughout the variable environmental conditions of Europe.

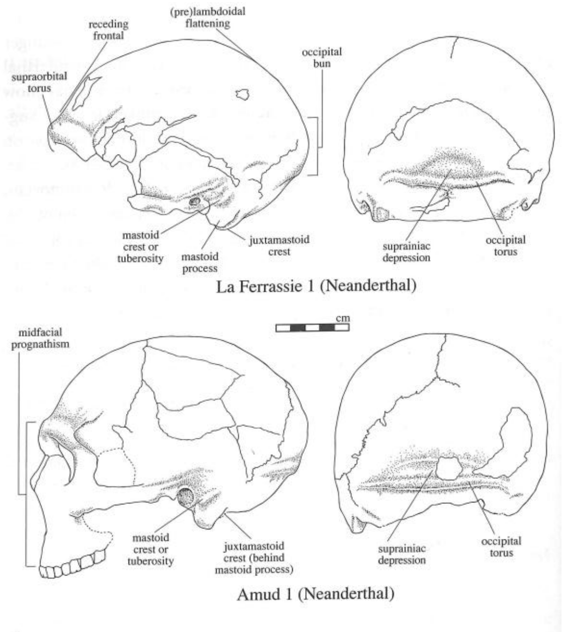

Figure 2.4. Comparison of Neanderthal (Upper) and Modern Human (Lower) craniums with key differences noted. (Adapted from Klein, 2009).

The Neanderthal facial skeleton displays five diagnostic features that can be used to attribute a specimen to the species: the first is the prominent protrusion of the face away from the cranial vault, particularly along the midline. Second, the nasal cavity of the Neanderthal face is larger than that of modern humans, as are the orbits which are both larger and more rounded when compared to those of modern humans. Fourth, the Neanderthal face is offset by zygomatic arches (cheekbones) that recede into the cranial vault rather than project laterally outwards as they do in modern humans, and finally the Neanderthal mandible does not feature a mental eminence (chin) (Trinkaus, 1984, 1986).

As well as lacking a chin, the Neanderthal mandible is generally longer than that of modern humans though it features a shorter ascending ramus, and a space between the third molar and the ramus itself (Frayer, 1992; Franciscus and Trinkaus, 1995). This retromolar notch is a key morphological trait of the Neanderthals and not observed in modern humans, reflecting a morphological response to the size of the mandible in relation to the cranium (O’Connor et al, 2005). Neanderthal teeth can be characterised by their size and composition, with incisors often larger than those found in modern humans and the enamel layer of all teeth thinner in Neanderthals (Bailey and Lynch, 2005). The reduction in enamel results in distinct traces of wear being a common pathology in Neanderthals, notably in the incisors and canines. Finally, Neanderthal molars display unique ridges and contours on the crowns that are not found in any other hominid species (Villa and Giacobini, 1995).

2.2.2 Post-Cranial Morphology

The post-cranial morphology of Neanderthals is remarkably similar to that of modern humans, with the Neanderthal hyoid bone and cervical vertebrae all falling within modern human ranges as do elements of the Neanderthal pelvis (Stewart, 1960). The difference between the two species is again down to the increased musculature of the Neanderthals and the effect this has on the general robusticity of the skeleton.

Large muscle attachment sites can be found on the Neanderthal arms, legs, feet, hand and ribs; the latter being thicker and less curved than modern humans contributing to the broad trunk of the Neanderthals (Trinkaus, 1986). The femoral and tibial epiphyses are also larger than those of modern humans, with the long bones of the upper arms/legs displaying thicker shafts due to the greater amount of muscle mass attached to them (Trinkaus, 1983, 1984, 2006). This increase in muscle mass notably impacts the scapula and pelvis, important in the raising of the arm and walking respectively, which display broader and more flattened morphologies that allow for increased muscle attachment on these skeletal elements.

Finally, though the distal limb elements (tibia/fibula and radius/ulna) are thicker they are also comparatively shorter in Neanderthals than they are in modern humans and as a result Neanderthals are likely to have been shorter than modern humans (Trinkaus, 1983). Stature estimates using these elements suggest that the average Neanderthal was 166cm (5’4”) compared to an average height of 178cm (5’8”) for modern humans (Trinkaus, 1983).

Though the postcranial morphology suggests that Neanderthals were a very robust and muscular species compared to modern humans, muscular scaling in relation to body mass has shown both species were remarkably similar in their overall muscle composition. Scaling reveals that though the Neanderthal upper body is more muscular than that of modern humans the lower bodies of both species are quite similar (Trinkaus et al, 1998).

2.2.3 Implications of Neanderthal Anatomy and Morphology

The majority of the morphological traits, particularly post-cranially, conform to Bergmann and Allen's rules for adaptations to cold environments. The large and broad Neanderthal thorax would have helped retain heat within the Neanderthal body (Holliday, 1997; Pearson, 2000; Trinkaus, 1981; Weaver, 2007), whilst shorter limb lengths and associated reductions in available surface area would have limited the amount of heat lost from these areas of the body (Weaver, 2003). Similar physiological adaptations are also attributed to the Neanderthal cranial morphology, particularly the large nasal aperture which would have helped dispel excess heat after periods of intense activity as well as warming cold air during inhalation (Coon, 1962; Trinkaus, 1987). The major diagnostic features of the Neanderthal skeleton can therefore be viewed as physiological which helped buffer Neanderthals from the extreme effects of the cold. Neanderthal anatomy therefore represents an adaptation to higher latitude environments. Though these morphological traits would have ultimately been beneficial for their survival they would also have imposed distinct physical limitations that would not have been a factor for modern humans, notably in hunting, pregnancy and Neanderthal energetic expenditure.

The region most notably affected would have been the Neanderthal shoulder and upper arm, where the combination of morphology and muscle mass would have restricted the movement and the amount of force which could be applied through the pectoral girdle

(Churchill and Trinkaus, 1990). As a result, Neanderthal individuals are unlikely to have been able raise their arm and throw with sufficient force to the same degree as modern humans. This implies that Neanderthals were incapable of throwing spears and would have had to rely on close quarter thrusting techniques to kill and acquire prey (Churchill and Trinkaus, 1990). Similar physiological restrictions are found in the Neanderthal lower body and mandible. Muscle attachment sites on the Neanderthal calcaneus suggest that the Neanderthal heel and ankle were reinforced by an abundance of muscle mass (Raichlen et al, 2011). Though this would have made Neanderthal walking inherently more stable the overall flexibility of the foot would have been reduced, and the Neanderthal capacity of endurance running would have been severely restricted (Rainchlen et al, 2011). Further, the morphology of the Neanderthal mandible suggests that they were capable of exerting less bite force than modern humans with the majority of the bite force applied onto the rear molars rather than on the anterior incisors. The predominant application of the force to the molars would have allowed the incisors to have been used for other activities such as tool use (Frayer, 1991; Ungar et al, 1997).

With relation to pregnancy, the thinner Neanderthal pubis would have created a larger birth canal than that of modern humans (Rosenberg, 1986; Wolpoff, 1989). This implies that (i) Neanderthal females may have given birth to larger children in comparison to modern humans at the end of their term (Dean et al, 1986), or (ii) Neanderthals required a longer gestation time during pregnancy (Trinkaus, 1983, 1984). When one considers the amount of muscular development a Neanderthal foetus would require to develop the standard Neanderthal morphology, the latter interpretation seems likely but both remain possible.

Finally, though increases in cranial capacity have been an evolutionary precedent throughout the hominid lineage the substantial increase in the Neanderthal cranial capacity likely reflects a greater intellectual aptitude than previous *Homo* species. A larger braincase could also, however, reflect the greater metabolic need required for surviving in higher latitude environments (Holloway, 1985). Other theories have also been posited; most recently that the larger brain capacity of Neanderthals reflects a higher need for optical processing due to reduced light levels in higher latitudes (Pearce et al, In Press). The expansion of the Neanderthal braincase and what it represents will most likely remain an issue for debate for some time. The effect of this expansion in brain size is well known: as the brain accounts for between 20-25% of the total energy expenditure (TEE) of a hominid's energetic budget any expansion of the brain would have resulted in increased energetic requirements (Verpoorte, 2006).

This increase in energetic expenditure would have been a feature of Neanderthal physiology as a whole, as increases in both muscle mass and brain size would have resulted in a higher Neanderthal total energetic expenditure (TEE) compared to that of modern humans. Modern humans usually have a TEE of 2,500 calories per individual per day which accounts for the majority of modern human metabolic processes. Verpoorte (2006) and others (Sorenson and Lenard, 2001; Snodgrass and Leonard, 2009) have inferred from their physiology that Neanderthals are likely to have had a TEE slightly less than double that of modern humans, within the range of 4,000 calories per individual per day. Snodgrass and Lenard (2009) have assessed how activities of varying intensity would have affected Neanderthal energy budgets concluding that high intensity activities, such as winter hunting, may have resulted in a loss of 6,000 calories per individual per day. By comparison, such activities may have only cost modern humans 4,000 calories per individual per day (Snodgrass and Leonard, 2009).

The implication of these higher energy requirements for Neanderthals is clear: they would have had to acquire more food resources to ensure that they obtained sufficient calories to sustain their basic metabolic processes and as a result are likely to have spent more time hunting. It is possible that the higher energetic costs in Neanderthals may have inflicted further constraints on Neanderthal individuals and behaviour, and these are discussed in Chapter 9.

Neanderthal morphology, therefore, represents a range of adaptations to the European environment. Robust morphological and physiological adaptations would have allowed Neanderthals to survive in higher latitudes, though these same adaptations would also have presented them with new problems to solve. In the contexts of their daily lives issues such as increased energy budgets may not have been a consideration for Neanderthal individuals (they were the norm for them after all) but in competition with modern humans such factors may have proved decisive. Overall, these limitations seemingly did not affect the Neanderthal cognitive and physical ability to adapt materials such as flint, wood and other organic materials into a range of material artefacts.

2.3 ARCHAEOLOGY AND MATERIAL CULTURE

What is commonly referred to as the 'Middle Palaeolithic' is essentially a collection of artefact assemblages and industries that are associated with Neanderthals. These industries show distinct variability in their typology and function compared to the Acheulean industries of the Lower Palaeolithic and the succeeding Upper Palaeolithic, typically defined as a reduction in the use of handaxes in favour of scraper and point typologies but lacking the characteristic blades associated with Modern Humans. The 'Middle Palaeolithic' is thus a cultural term and one that implies a progress between its different expressions. Thus the Middle Palaeolithic is more progressive than the Lower Palaeolithic and the Upper Palaeolithic better than the Middle. This serves to support interpretations that Neanderthals were less behaviourally modern than modern humans who employed Upper Palaeolithic artefacts, though the construction of the Middle Palaeolithic assemblages shows this not to be the case.

2.3.1 The Mousterian

The Middle Palaeolithic is essentially a blanket term for the Mousterian industry, named after the site of Le Moustier, France. Though predominantly found in Europe, Mousterian assemblages have also been found in North Africa and the Near East (Olsen, 1987; van Peer, 1998; Wendorf et al, 1993).The Mousterian emerges sometime between 250 – 130 kya, in line with the emergence of Neanderthals, and is associated with Neanderthals until their extinction: in Eastern Europe until 43 – 39 kya, Western Europe between 40 – 37kya, and the latest Mousterian assemblages dated to c.30 kya in southwest Europe (Bouzouggar et al, 2002; Close, 2002; Wendorf and Schild, 1992; Cremaschi et al, 1998; Roebroeks et al, 1993; Bar-Yosef, 1993; Conard and Fisher, 2000; Finlayson et al, 2006).

Neanderthals were expert stone knappers who created tools on the finest resources available, notably flint and chert (Bordes, 1961; Boeda et al, 1990), and employed distinct *châine opératoire* techniques to create blank flakes from cores: prepared core technologies and unprepared core technologies (Kuhn, 1995; Mellars, 1996; Schlanger, 1994). The former, represented by the Levallois technique, involves pre-shaping the initial core in an effort to remove flakes of a predetermined shape or size (Boeda, 1988; Mellars, 1996; Roland and Dibble, 1990). Experimentation has shown that using this method, Neanderthals could produce a variety of flakes and tool typologies in one setting. The latter, highlighted by the La Quina method, refers to the simple removal of blank flakes from a core without any preparation (Mellars, 1996; Turq, 1992). Thus flake sizes are often variable. The adoption of these two flake production methodologies show that Neanderthals had a cognitive understanding of both the mechanics of stone knapping and the properties of the stone materials they used. In terms of flint knapping, this places Neanderthals on parity with Modern Humans.

The archaeological record suggests that the majority of flakes produced were not altered (re-worked) once they were produced; suggesting that the sharp edges of flakes may have been used as simple cutting tools (Bordes, 1961; Turq, 1992). Re-working of flakes occurs, however, and analyses by Bordes (1961) employ these features to typologically define the tools which constitute the Mousterian industry. In all, Bordes recognised 63 discrete types (Figure 2.5), though side-scrapers, points and denticulates dominate throughout (Bordes, 1961). Unlike the preceding Acheulean the numbers of bifaces in Mousterian assemblages are considerably reduced and tend to be smaller than those created in the Lower Palaeolithic (Stiner, 1987). Unlike the Upper Palaeolithic, where tool creation is centred on overall shape, the production of Mousterian typology seems to be centred on the production of a defined edge; which suggests that these tools were geared toward function rather than style (Dibble, 1998; Mellars, 1996).

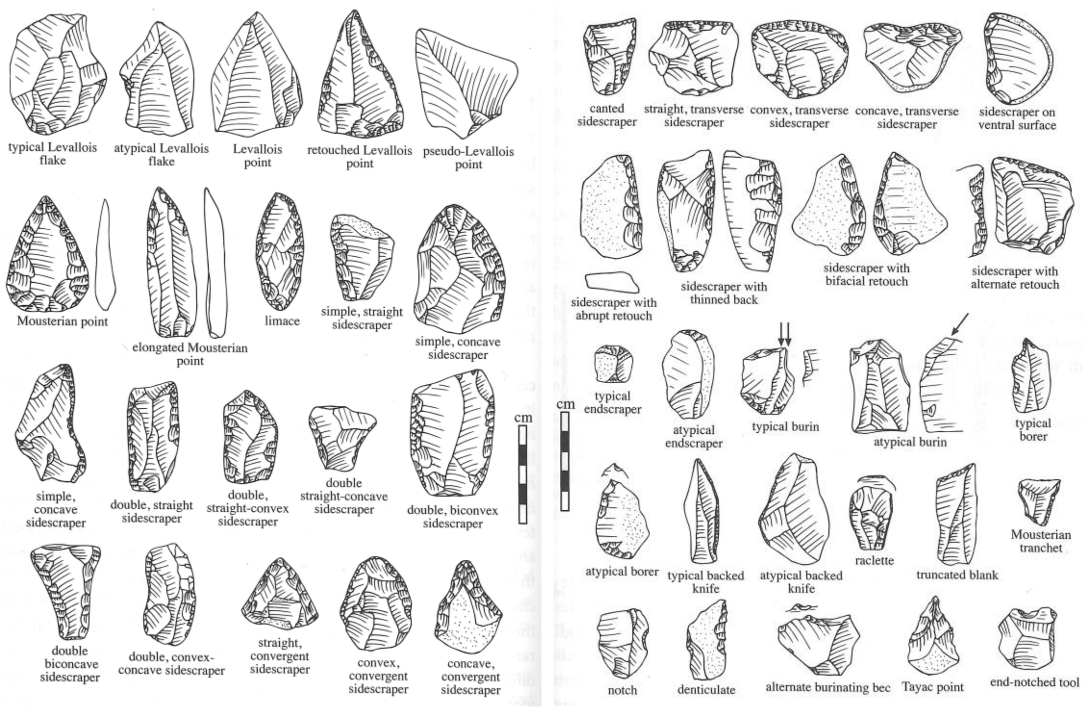

Figure 2.5. Representative examples of the Mousterian industry according the the Bordes (1961) typology. Adapted from Bordes (1961).

Use-wear analysis has shown that Mousterian typologies had two functional uses: micro-wear analysis suggests denticulate typologies were used to work wood, whilst scrapers have been shown to have been used on flesh and wood (Anderson-Gerfaud, 1990; Beryries, 1988; Grace, 1996; Shea, 1992). This would suggest that scrapers had a much more variable function than other typologies. The working and use of wood by Neanderthals is supported by birch-pitch finds from Konigsaue (Germany) which were used to bind stone flakes onto wooden handles (Grunberg, 2002; Koller et al, 2001). The analysis of stone points from sites such as La Cotte de St. Brelade (Jersey) and Starosel'e Cave (Ukraine), which feature fractures consistent with their use as spears, suggests that Neanderthals were adopting various methods of hafting technology (Callow, 1986; Jenson, 1988; Rots, 2005). This is highlighted at Starosel'e Cave which also features evidence of plant fibres used for binding rather than pitch as seen at Kongisaue (Shea, 2006; Williamson, 2004). Not only does this show Neanderthals were capable of working stone and wood, but also suggests that they understood a range of organic material properties and that they successfully incorporated all of these elements into a single tool (Shea, 2006). Overall, however, use-wear analysis suggests that tools were used to process food and work wood, with little evidence of bone working in the archaeological record or via use-wear analysis (d'Errico and Henshilwood, 2007). This is in stark contrast to the Upper Palaeolithic, which displays a range of bone and antler work (Kozlowski, 1990).

Finally, though Mousterian typology is remarkably uniform throughout the Middle Palaeolithic (unless influenced by raw material choice) it does display several variants:

- *Mousterian of Acheulean Tradition (MAT)*. Defined by triangular handaxes as well as the dominant Mousterian typologies of scrapers, denticulates and points. The MAT is typically found in north-west Europe.
- *Typical Mousterian*. Sidescrapers dominate, with fewer denticulates and points. Handaxes are rare/absent. This is the general Mousterian assemblage as described above.
- *Denticulate Mousterian*. Denticulates dominate, and handaxes are rare/absent. Number of sidescrapers reduced.
- *Charentian Mousterian*. This variant is characterised by high numbers of sidescrapers that feature high degrees of retouch.

Bordes (1961) believed these variants to represent different regional groups, a position somewhat supported by recent analyses by Reubens (2009, 2012) who suggests that assemblages which feature 'Mixed typologies' represent the coming together of different Neanderthal communities. Alternatively, these variants could represent different seasonal activities conducted by Neanderthal groups, with the Denticulate Mousterian representing groups focused on wood work whilst the Typical Mousterian likely represents groups geared towards the processing of food resources (Klein, 1998, Mellars, 1996).

It is clear that Neanderthals employed a range of materials in the Mousterian, notably stone and wood (as noted above). The Mousterian use of bone, however, is limited with the majority of bone work interpreted as butchering marks rather than deliberate bone working to create tools (d'Errico and Henshilwood, 2007). The lack of bone or antler work represents the major difference between the Middle and Upper Palaeolithic tool industries.

2.3.2 Neanderthal Symbolic Expression

The nature of Neanderthal symbolic capability is a contentious issue (see below) but the Middle Palaeolithic archaeological record presents some evidence to suggest that the Neanderthal capacity for symbolic expression was not as limited as previously thought. There are three areas where Neanderthals have shown potential symbolic activity: art and ornamentation, the use of pigmentation, and Neanderthal burials.

Table 2.2 lists the archaeological evidence of possible Neanderthal material symbolic expression. The majority of these artefacts feature incisions on either bone or stone, though the perforation of animal teeth also features predominantly (Bednarik, 1992; d'Errico et al, 1998; Enloe et al, 2000; Marshack, 1976). The classification of these artefacts as symbolic is down to the interpretation of the researcher, but the presence of similar artefacts within the Lower Palaeolithic as well as the example of the Berekhat Ram (Israel) figurine reinforces the idea that the Neanderthals were capable of creating symbolic objects (Bahn, 1996). Yet the overall acceptance of them as symbolic is not universal, with researchers highlighting taphonomic considerations which suggest that several of these objects may have emerged from Upper Palaeolithic contexts (Mellars, 1996; White, 1989). The interpretation of these, and similar, artefacts and behaviours are thus a contentious one and further finds and taphonomic work must be done before a firm conclusion can be made.

Site	Object(s)	References
La Quina, France	Perforated reindeer phalanx and fox canine	Marshack, 1976
La Ferrassie, France	Bone fragment with incised parallel lines	Marshack, 1976
La Roche-Cotard, France	Flint nodule with facial characteristics	Marquet and Lorblanchet, 2003
Bocksteinschmeide, Germany	Perforated wolf metapodial and swan vertebra	Marshack, 1991
Repolusthohle, Austria	Perforated wolf canine	Bednarik, 1992
Divje Babe I, Slovenia	Incised bear femur	D'Errico et al, 1998
Tata, Hungary	Polished mammoth molar plate and incised invertebrate fossil	Marshack, 1976

Table 2.2. List of European Middle Palaeolithic artefacts showing proposed symbolic behavioural within Neanderthals. Adapted from Klein (2009)

Within the Upper Palaeolithic, the use of pigment such as ochre has often be used to suggest a wide range of symbolic behaviours (d'Errico, 2001; d'Errico and Soressi, 2002; d'Errico et al, 2003). Thus the presence of large amounts of manganese dioxide, a black pigment, at over a dozen sites, notably at Pech de l'Azé I, suggests that Neanderthals used this pigment in similar contexts as modern humans, i.e. skin colouring, drawing etc. Dioxides such as those found within Pech de l'Azé I, however, have many functional uses which cannot be discounted, notably their use as tanning and hardening agents for hide work (Keeley 1980; Wadley, et al, 2004). Neanderthal pigment use could therefore represent both functional or symbolic behaviours, and the use of black pigments rather than red has led some to interpret that they were used for more functional aspects over symbolic ones (Klein, 1995; Mellars, 1996).

The Neanderthal capacity for burial, however, is more distinct in that they represent the largest collection of fossil hominids in the archaeological record and as such we can infer that they were capable of expressing a range of social and possibly symbolic behaviours relating to the internment of deceased individuals. The lack of defined burial pits and material inclusions similar to that observed in human burials of the Upper Palaeolithic has led some to conclude these burials were not inherently symbolic or spiritual (Gargett, 1989, 1999), whilst some have argued that they represent accidental burials rather than deliberate acts (Solecki, 1989). Pettitt (2011) has conducted an in depth analysis of Neanderthal burial and concludes that Neanderthals preferred to cache their dead rather than bury them. Caching typically involves burial of certain skeletal elements in a secondary context with the removal of these elements and the transportation of them to specific locations suggesting these actions were not accidental or merely purely functional. Rather one can infer that Neanderthal burial was sufficiently different to that of modern humans, with different underlying social/symbolic associations (Pettitt, 2011). Table 2.3 lists the main Neanderthal burials featured within the subsequent analysis in this thesis.

Site	Date	Specimen	References
La Ferrassie	60 – 75, 000 BP	2 adults, 3 children, one foetus and one neonate. Various skeletal elements present.	Capitan and Peyrony, 1921; Peyrony, 1934; Deporte, 1976
La Quina	55 – 66,000 BP	Adult cranium partially complete upper body	Defleur, 1993
La Chapelle-aux-Saints	40 – 60,000 BP	Male adult, near complete skeleton.	Roche, 1976
Le Moustier	40,000 BP	One near complete adolescent and one neonate.	Maureille, 2002
Roc de Marsal	70,000 BP	Partial infant cranium	Turq, 1989
Le Regourdou	55 – 65, 000 BP	Adult	Madelaine et al, 2009
La Roche-a-Pierrot (Saint Cesaire)	36,300	Fragmentary adult skeleton	Vandermeersch, 1993
Spy	34 – 36,000 BP	Partially complete skeleton with other cranio and post-cranial elements	Semal et al, 2008
Neanderthal I	39 – 41,000 BP	Partial cranium and post-cranial skeleton	Schmitz et al, 2002
Shanidar	40 – 50,000 BP	10 individuals representing complete and partially complete skeletons	Trinkaus, 1983

Table 2.3. List of Neanderthal burials corresponding to Europe and OIS-3 and employed within this analysis. Adapted from Pettitt, 2011.

This brief synopsis of symbolism which can be attributed to the Neanderthals highlights that they displayed less symbolic behavioural expressions than modern humans, but also highlights some of the interpretational problems of associating these artefacts to

Neanderthal groups. This represents a core debate within Neanderthal archaeology and is mentioned below.

2.3.3 Neanderthal Life-ways

Though Neanderthals may have experienced a longer gestation period (see above), once born Neanderthal postnatal development is likely to have been similar to that of modern humans (Guatelli-Steinberg et al, 2005, 2007). This would have prolonged Neanderthal childhood, which would have been offset by longer lifecycles compared to previous prehistoric hominids. Neanderthal mortality profiles suggest, however, that few individuals survived beyond the age of 40; much younger than modern humans (Caspari and Lee, 2004). This is likely the result of hunting tactics which would have placed Neanderthal individuals in circumstances that could result in severe injury and even death (Trinkaus, 1995). Inferring that Neanderthal maturity was similar to that of modern humans, it is likely that Neanderthals reached sexual maturity within the mid-teens and are likely to have procreated sometime after this but the increased mortality rate of Neanderthal individuals suggests that they would not have survived long enough to become grandparents. This would imply that Neanderthal foraging groups were comprised of individuals separated by a single generation.

Neanderthals were predominantly limited to mid-latitude environments of Europe, but they are notable in being the first hominid species to occupy regions above 60^{o}N. As with all hominids, Neanderthals survived through the hunting and gathering of resources from the environment, which would have involved significant amounts of migration throughout the year (Grove et al, 2012). It is possible, looking at ethnographic precedent, that the gathering of plant resources formed a significant portion of the Neanderthal diet and though the archaeological record does not preserve these materials, analysis has shown that a range of edible vegetation would have been available for Neanderthal foragers to exploit (Hardy, 2010).

The faunal and isotopic record, however, suggests that meat constituted the major dietary element for Neanderthals (Bordes and Prat, 1965; Richards et al, 2000, 2008; Stiner, 1994; Straus, 2002; Soffer, 1989); with species such as deer, reindeer, bison and horse all being exploited, along with mammoth and woolly rhinoceros (Smith, 2011, Stewart, 2004). By comparison, the faunal record of the Modern Human foragers in the Upper Palaeolithic shows that they too exploited a range of species for their meat sources but isotopic evidence also suggests that they consumed a greater proportion of plants and vegetable material compared to the Neanderthals (Guatelli-Steinber, 2009; Hardy, 2010; Hallin et al, 2011; Hockett, 2012). The successful acquisition of these resources would have required the use of distinct tools, with the archaeological record suggesting that Neanderthal employed heavy thrusting spears to kill their prey (Trinkaus, 1983). The construction of these spears, in conjunction with the physiological constraints of the Neanderthal shoulder, would have meant that Neanderthals would have had to engage in close quarter hunting strategies rather than rely on long distance tactics which may have involved throwing (Snograss and Leonard, 2009). Hunting would have had to have been cooperative, involving several individuals working together, especially during the pursuit of large game species such as mammoth. C^{13} isotope analysis suggests that the majority of meat resources were hunted in open environments, rather than forested landscapes, whilst N^{15} ratios show that Neanderthal consumption of meat placed them as the apex predator of Europe during OIS-3 alongside social carnivores such as wolf and hyena (Beauval et al, 2006; Bocherens et al, 1999, 2001, 2005; Richards et al, 2000, 2008). Though the evidence of Neanderthal exploitation of aquatic and coastal resources is limited, Zilhao et al (2007) have presented convincing evidence that Neanderthals may have exploited shellfish from coastal sites. Thus

Neanderthals exploited a range of environments and resources, likely as a result of their greater calorific need (Hockett, 2012), but strontium analysis has shown that Neanderthals may have restricted their foraging ranges to within a 20km radius (Richards et al, 2008). This suggests that Neanderthals exploited familiar landscapes and that migration may have been hindered by unfamiliar landscapes and their higher energetic constraints.

No practical methods have been developed for determining population sizes from the archaeological record, but energetic constraints and ethnographic modelling suggest that Neanderthals had smaller population densities and group sizes than modern humans (Sorenson, 2011; Grove et al, 2012). As discussed above, Neanderthals required more calories from the environment. Thus, a given foraging range with a finite amount of resource would have been able to support less Neanderthals compared to modern humans. Models by Grove et al (2012) suggest that Neanderthals displayed higher amounts of group fission than modern humans, which would have resulted in small Neanderthal foraging groups overall as a result of environmental and physiological pressures. Neanderthals in higher latitudes are likely to have resided in smaller groups which were distributed infrequently in the landscape.

Neanderthal lifecycles were invariably hard, but the persistence of the species over environmental and physiological constraints suggests that they had adapted to these factors. The lack of Neanderthal material evidence at this time would suggest that they did not participate in overtly symbolic and spiritual expressions; though the nature of cache burials suggests that some symbolic elements had a role in their lifestyle.

2.4 OXYGEN ISOTOPE STAGE-3 (OIS-3)

For the majority of hominid evolution, environmental variability would have been a barrier to human migration and is likely to have inspired human technological and behavioural adaptations that allowed human groups to survive in times of downturn (Potts, 1996). It was only with the emergence of the Holocene, c. 10kya, that environmental conditions stabilised, and during their occupation of Europe Neanderthals would have experienced highly variable environmental conditions that switched between cold and warm periods (Table 2.2) (Taylor et al, 1993; Burroughs, 2005).

The aim of this thesis is not to determine Neanderthal behavioural responses throughout the entirety of their evolution, merely during the latter period of their existence during Oxygen Isotope Stage-3 (OIS-3), roughly between 60 – 30 kya. Oxygen Isotope Stages (OIS) are agreed climatic periods which measure the ratio of O^{16} isotopes to that of O^{18}. As ice sheets expand, representing the onset of colder periods and climatic downturns, they lock a greater amount of O^{16}, resulting in a greater O^{16}/O^{18} ratio, which can be used to identify the onset and duration of these periods (EPICA Community Members, 2004). There are 19 stages which are used to highlight the main glacial (even numbered stages) and interglacial (odd numbered stages) periods from 750kya (Burroughs, 2005). Figure 2.6 highlights the climatic variability experienced by Neanderthals during the last 100 kya, incorporating OIS-5 to OIS-1, and includes the significant warming (Dansgaard-Oeschger Events (DO)) and cooling (Heinrich Events) events of the period (Burroughs, 2005).

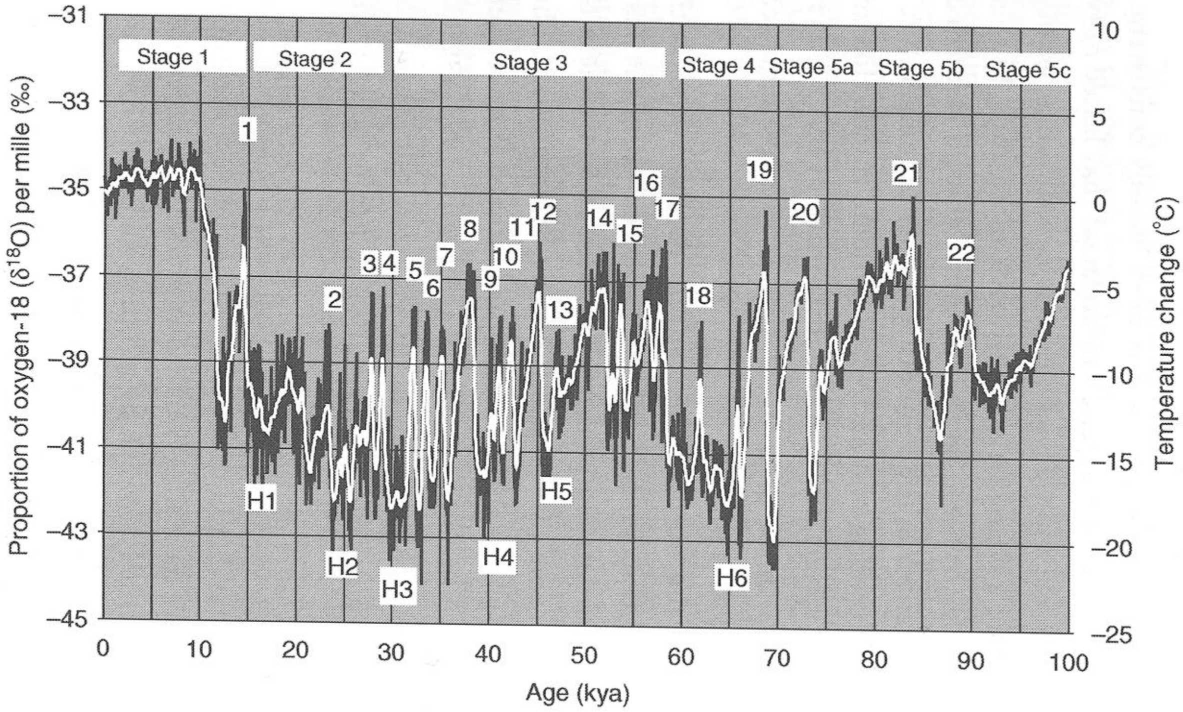

Figure 2.6. Oxygen isotope data for OIS-5 to OIS-1 from the GISP2 ice core. The black line represents data values taken for every 50 years, and the white line represent smoothing this data. Dansgaard/Oeschges events are represented by whole numbers whilst Heinrich Events are represented by (H1 etc). Adapted from Burroughs (2005).

This analysis will focus on the Middle Palaeolithic of OIS-3 (c.60 – 30 kya) for two reasons: (i) there is an abundant Neanderthal archaeological record for this period which is securely dated, and (ii) there is a large body of environmental data available for this period thanks to significant research and statistical modelling conducted by the Stage Three Project (van Andel and Davies, 2003a).

The Stage Three Project database provides a range of maps and projections of climate and biome cover during the period 59 – 29 kya, and has modelled how the climatic variations experienced during the period influenced European faunal and flora distributions as well as providing interpretations on how these variations would have affected human behaviour (Van Andel et al, 2003b; Davies and Gollop, 2003; Davies et al, 2003; Stringer et al, 2003). Though there were disagreements between project participants regarding the best models to use for the variable cold periods of OIS-3, the data collected by the Stage Three Project represent one of the largest collections of climatic and environmental data that is directly relevant to Neanderthal and modern human behaviour and can therefore not be ignored (van Andel and Davies, 2003a). A description of the general environmental conditions Neanderthals experienced during OIS-3 is provided below and expanded on in further chapters (Chapter, 4, 5 and 6).

2.4.1 Environmental Conditions in the Last Interglacial

Though the onset of OIS-3 is recognised to begin at c.59kya, events prior to this time need to be mentioned as they induced wide ranging climatic conditions which would have affected the Neanderthals. The eruption of Mt. Toba c.74 kya was the biggest volcanic eruption for over a million years, and the ejection of over $3000km^3$ of materials into the atmosphere brought about a significant global environmental downturn (Rampino and Seld, 1992). The ejection of large quantities of ash into the atmosphere reduced global temperatures on average by 5^oC, but northern latitudes may possibly have seen a temperature reduction by as much as 15^oC. The accumulation of ash and reduction in temperatures is likely to have impacted growing seasons and may have resulted in a layer of frost being deposited throughout higher latitude landscapes (Rampino and Self, 1992). The eruption of Toba would have impacted both modern humans and Neanderthals, and would likely have seen population numbers of both species decrease significantly (Ambrose, 1998) and though modern human recovered from this bottleneck, many have suggested that the Neanderthals did not (Ambrose, 1998; Stringer et al, 2003). If total Neanderthal population sizes never recovered from the Toba eruption then this may mark the beginning of their extinction (Stringer et al, 2003) which ultimately occurred c. 27 kya.

The effects of Toba are likely to have been short term, with Interstadial 19 (Figure 2.5) showing the emergence of a warm period. By 67 kya, however, a longer and more intense cold period had set in that lasted until the beginning of OIS-3 at 59kya. The onset of OIS-3 shows the beginning of more variable climatic conditions which resulted in the majority of European landscapes becoming more habitable. Overall, environmental conditions closely resemble that of the contemporary Siberian floodplain, with high winds and snow covering the ground for up to six months of the year (van Andel, 2003). Mid-summer temperatures would have been moderate, ranging between 15 – 20^{o}C, not that much colder than modern summer temperatures (Table 2.4)

Region	Interstadial (W)	Interstadial (S)	Modern (W)	Modern (S)
Britain	-4	10	4	15
Southwest France	2	10	8	16
Northern Balkans	-4	20	0	22
Southern Italy	0	18-20	6	24

Table 2.4. Summary of temperature ranges (^{o}C) experienced through OIS-3 winter (W) and summer (S) periods and their modern equivalents. Though winter periods are slightly colder, OIS-3 displays a relative parity with modern values. Adapted from van Andel and Davies (2003) and Burroughs (2005).

These conditions combined to create a largely herbaceous landscape, though one subject to local regional variations (Figure 2.6); reflecting the variable nature of the period, longer lived species such as Birch, Pine and Spruce were infrequent (Huntley and Allen, 2003). Overall the European landscape was very open and would have provided a range of resources for human hunter-gatherer groups to exploit: large game such as mammoth, woolly rhinoceros and bison were frequent, as were more medium and small sized species including reindeer, ibex and hare (Stewart et al, 2003; Musil, 2003) and a range of edible vegetation available from fruits (including various berries) to underground storage organs (USO's) like carrots (Hardy, 2010). Europe during OIS-3 was therefore a productive landscape, though one marked by frequent variations in the distribution of resources as a result of sudden downturns. This variability would have ensured that hunter-gatherers in Europe during OIS-3 would have opted to exploit the most favourable environments for their particular needs, as well requiring communities to be adaptable in times of sudden environmental downturns.

2.5 CURRENT DEBATES CONCERNING THE NEANDERTHALS

Thanks to the abundance of the archaeological and fossil records, we know more about Neanderthals than any other prehistoric hominid. Though new finds and interpretations constantly update our knowledge about our extinct cousins, several debates are currently underway which attempt to address the nature of Neanderthal extinction and behavioural modernity[2].

2.5.1 Neanderthal Extinction

Neanderthal extinction is believed to have occurred sometime between 30 – 25 uncal kya , with the last remaining Neanderthal populations restricted to south-western Europe as modern humans increasingly dominated the landscape throughout the Upper Palaeolithic (Finlayson et al, 2006). Not surprisingly, of the five hypotheses regarding Neanderthal extinction, three centre on the actions of modern humans and the impact they had on incumbent Neanderthal populations.

The first hypothesis, presented by Diamond (1992), is that Neanderthals went extinct due to a mass act of violence, equivalent to genocide, on behalf of modern humans (Diamond, 1992). Diamond attempts to relate his hypothesis in the context of similar genocides observed in the ethnographic record when two human groups/communities meet for the first time, but the fossil record shows that the pathologies obtained by Neanderthals in their lifetimes were more likely caused by hunting accidents rather than inter-hominid

[2] The aim of this chapter is to highlight the current issues regarding Neanderthal social behavioural ecology and provide background on the relevant aspects of Neanderthal physiology and archaeology relevant to these debates. There are many currents issues centring on Neanderthal archaeology and biology which are not relevant here, notably genetics. For a synthesis of current issues relevant to the Neanderthals not related to their social and symbolic behaviour please see Klein (2009: 367).

violence. Though violence between the two species cannot be discounted, the inherent strength of the Neanderthals would have placed modern human aggressors at a distinct disadvantage in close quarter 'combat'. This hypothesis has not received any significant support since its original conception.

The second hypothesis on Neanderthal extinction employs a more epidemiological focus on hominid interactions, suggesting that incoming *Homo sapiens* may have brought unknown foreign pathogens into Europe which the Neanderthals has no prior immunity to. Originally posited by Bar-Yosef and Belfer-Cohen as a possible constraint of human migration into new environments (Bar-Yosef and Belfer-Cohen, 2000) this hypothesis has recently re-emerged as a valid interpretation for Neanderthal extinction thanks to the work by Snodgrass (2011) who employed modelling techniques to show that factors other than demography, reproduction and resource competition could not have accounted for the relatively rapid rate of Neanderthal extinction (Sorenson, 2011). Though an interested concept, this thesis lacks distinct archaeological markers for disease spread (even assuming that they would leave any at all) and current models rely on several assumptions that could over- or underestimate the impact of each of the variables noted that could also influence rates of Neanderthal extinction (Sorenson, 2011). Further work, notably on the genetic analysis of Neanderthal bones which could yield evidence of bacterial, fungal, or viral DNA that would support a pathogen extinction hypothesis, needs to be conducted before this hypothesis can be considered further.

The third hypothesis centres on the premise of extinction via competition; specifically that modern humans out competed Neanderthals for valuable food resources. The theory was first proposed by Boule in 1912 and Banks et al (2008) have subsequently noted that a slight competitive advantage on behalf of modern humans would have brought about Neanderthal extinction within the range of 10 – 20 kya; a similar time span of extinction inferred from the archaeological record. The higher energetic needs of Neanderthals compared to modern humans may have been such an advantage, as they could have exploited resources faster and more efficiently than their Neanderthal counterparts, undermining the latter's food base significantly (Banks et al, 2008). An inferred lack of divisional labour (Kuhn and Stiner, 2006) suggests that any loss of meat resources is unlikely to have been compensated by other resources. Without a sufficiently reliable calorific intake, Neanderthals are likely to have migrated away from incoming modern human groups to find new resources but the advance of modern humans would have meant this would have only been a delaying tactic.

Fourth, an alternative to competitive exclusion, is the theory that Neanderthals and modern humans interbred. This hypothesis was originally a feature of the 'Multiregional Origin Hypothesis' proposed by Wolpoff (1988) which suggests that both human species were capable of interbreeding and that Neanderthals were absorbed into the modern human clade. The dominance of the Recent African Origin hypothesis throughout the 1990's resulted in this theory being neglected, but more recent archaeological interpretations as well as genetic studies have brought this hypothesis back to the fore. Fossils such as that of the Lagar Velho child (Soficaru et al, 2006), which displays both Neanderthal and modern human morphologies, suggest admixture between the two species, whilst recent genetic analyses show that Neanderthals and Denisovans may share a significant portion of their genome with modern humans (Reich et al, 2010). The implications of this hypothesis is that either (i) Neanderthals were eventually incorporated into the modern human clade or (ii) that interbreeding between the two species resulted in sterile offspring, preventing the further spread of Neanderthal genetic material leading to their extinction; though the latter would leave no genetic signature in instances were it occurred and would subsequently prove difficult to substantiate.

The final hypothesis centres on the role of climate change. Though Neanderthals would have experienced notable climatic downturns during their occupation of Europe the eruption of Mount Toba c. 74 kya and subsequent volcanic eruptions of around 40 kya would have affected the distribution of food resources between Italy and the Caucasus Mountains (Gilligan, 2007). Increased metabolic requirements coupled with the downturn in resources would likely have significantly reduced Neanderthal population numbers and would have represented a significant bottle neck which they may never have been able to recover from.

It is unlikely that any one factor would have caused Neanderthal extinction; rather a combination of climatic constraints and modern human competition may have started the process that ultimately ended with Neanderthal extinction. Neanderthals are known to have adapted to previous climatic downturns, but the inclusion of modern human competition relating to valuable resources may have proved too much for our closest ancestor.

2.5.2 Behavioural Modernity

Since the 1980's, the concept of the Upper Palaeolithic Revolution has dominated interpretations of modern human-Neanderthal interactions. It states that at c.40 kya, modern humans entered Europe with the full suite of behavioural adaptations, including symbolic and ritual expressions that allowed them to survive in the variable European landscape (Barham, 2010; Shea, 2011). The implication of this interpretation is that Neanderthal extinction was the result of the behavioural dominance of modern humans over the more behaviourally archaic Neanderthals (Klein, 1995; Mellars, 1989; 1996). Since the 1980's this has been the predominant implication of the so-called 'modern human behaviour'.

Recently, this concept has been challenged with the recognition that symbolic behaviours developed gradually within modern humans and that even in the Early Upper Palaeolithic (EUP) such behavioural expressions were inconsistent in modern human groups

(McBrearty and Brooks, 2000). In this context, the limited archaeological record for Neanderthal symbolism can be viewed as a gradualist development of symbolic behaviour (McBrearty and Brooks, 2000; McBrearty, 2007). Archaeological finds relating to the Neanderthal creation of shellfish beads and the exploitation of various terrestrial and coastal environments suggest that Neanderthal behavioural expressions were more 'modern' than previously believed.

Though the new evidence regarding Neanderthal food resource exploitation has been generally accepted, the association of symbolic material artefacts has not; this is particularly notable with regard to the Neanderthal creation of Châtelperronian and Uluzzian industries. Both industries display Upper Palaeolithic characteristics which emerged from previous Mousterian traditions, with the association of Neanderthal fossil remains with the former (Zilhao et al, 2006) suggest that Neanderthals were the creators of this industry. This interpretation has not been widely accepted and the Châtelperronian currently represents the key behavioural argument of Neanderthal modernity. Mellars (1989, 2005) has presented arguments about the impossibility that Neanderthals and modern humans developed similar tool industries simultaneously, and uses this to argue that Neanderthals merely copied industries from modern humans rather than develop them independently (Mellars, 1989, 1999, 2005). This interpretation by Mellars would imply that Neanderthals were not cognitively advanced enough to develop their own Upper Palaeolithic typologies, and ultimately that they were not behaviourally or cognitively modern (though this still suggests that Neanderthals were cognitively capable of successfully recognising a need to copy these tools and creating them in their own style). Zilhao et al (2006, 2008) argue the opposite and suggest that the Châtelperronian represents the Neanderthal creation of distinct Upper Palaeolithic typologies stemming from the Mousterian industry and therefore represent cognitive modernity in the species. Taphonomic arguments are now being employed to support both arguments (Mellars, 1996; White, 1982) but it is unlikely that the debate will be resolved in the near future. It is arguments of this nature which have come to define Neanderthal archaeology, and though new finds and advances in dating techniques and taphonomic assessments increase our knowledge of modern human-Neanderthal interactions, they only serve to polarise the debate.

When it comes to addressing behavioural modernity Neanderthals are often neglected, though new archaeological evidence increasingly suggests a Neanderthal-modern human parity in behavioural expressions (Barham, 2010; Shea, 2011). This thesis aims to expand on these behavioural arguments through the use of ethnographic modelling and will hopefully provide insights into Neanderthal non-material social behaviours that which often overlooked in traditional interpretations of the Middle Palaeolithic archaeological record.

2.6 SUMMARY

This chapter serves to highlight the core behavioural, physiological and material aspects of Neanderthal existence in Europe during OIS-3. Clearly, the Neanderthal material record lacks the variation of that of modern humans during the Upper Palaeolithic with regard to symbolic artefacts and behaviours; but both hominid species display similarities in their development, aspects of their physiology and tool creating ability. This chapter also serves to outline the key debates that are currently centred on Neanderthal extinction and behavioural modernity which are relevant to the goals of this thesis. The information described in this chapter will be developed in further chapters during more in depth discussions of modern human and Neanderthal behavioural responses to environmental productivity. Ultimately, though the Neanderthals went extinct, they represent a hominid adapted to survival in high-latitude environments and who thrived in these variable environments for more then 250 kya. Though OIS-3 represents the final chapter of Neanderthal existence, the continuing debate on their behaviour and interactions with modern humans ensures that our closest extinct ancestors are very much alive today.

3. AN ANTHROPOLOGICAL AND ARCHAEOLOGICAL APPROACH

3.1 INTRODUCTION

The primary goal of this research project is to identify the ecological constraints that human populations were subjected to within Oxygen Isotope Stage 3 (OIS-3), and determine how this environment would have affected the full range of behavioural, symbolic, and material output of Neanderthal populations of the Middle Palaeolithic, particularly on the expression of symbolic behaviours which would not be preserved within the archaeological record.

In essence, the aims of this research calls for the testing of an adaptation of Binford's '*routed foraging hypothesis'*(Binford, 1984), which stipulates that site locations were not chosen by hominid groups as places to which they would transport materials, but rather that location choices were a response to limiting resources, around which cultural materials would accumulate (Binford, 1984). Binford's definition of 'limiting resources' include environmental features such as watering holes, lithic outcrops as raw material sources, and locations which act as natural shelters or provide natural defences; in short Binford, is measuring levels of environmental productivity but from the narrow focus point of its impact upon hominid/H-G site selection. The predictive model described here aims to take the theoretical basis of the '*routed foraging hypothesis'*, limited resources influence site choice, and expand it to focus on the effects environmental productivity[3] has on the expression on all behavioural variables; both material and non-material.

[3] By environmental productivity, read: resource availability.

3.2 ETHNOGRAPHIC BASED BEHAVIOURAL MODELLING

A predictive model will allow us to determine the relationship of environmental variation and risk, measured by using the proxy of latitude, on the output of social, symbolic, and material expressions within human populations. Basing such predictions on current archaeological evidence presents an issue which is at conflict with the primary research goal of this project, however: archaeological artefacts typically represent the physical activities which occurred at a site and, at best, yield little information on those non-material actions and behaviours which may also have occurred. The research goal is to determine the effect of environmental and ecological variation on all behaviours and artefacts, both material and non-material. As a result of this understandable flaw, there is no justification in using the existing archaeological sites and their interpretations as a basis for a predictive model within this analysis, as they would not yield relationships on the full spectrum of behavioural activities.

As the archaeological record does not provide the required behavioural information for Middle Palaeolithic Neanderthal populations, and as similar interpretative constraints occur for the Upper Palaeolithic modern human record, the development of a full spectrum behavioural predictive model needs to be based on records which record the all the behaviours an analysis of this type requires, i.e. the ethnographic record of contemporary hunter-gatherer (H-G) societies. The contemporary ethnographic record allows for the observation of environmental productivity on all material and non-material behavioural expressions of one species that inhabits a variety of ecological settings which cannot be found within the archaeological records of either the Middle or Upper Palaeolithic.

The creation of a behavioural predicative model based on modern H-G sources for use in the prediction of prehistoric Neanderthal behaviours presents two obvious issues of contention: the first, and most obvious, being that modern populations are not Neanderthals;

and the second, that contemporary populations by their very definition are not prehistoric populations. The latter concern centres upon the issue of cognition, in that prehistoric *Homo sapiens* H-G populations of the Upper Palaeolithic may not display the same level of cognitive ability as their contemporary analogues, and as such may have responded to stresses in environmental productivity in different manners than H-G's of today. Though the contemporary H-G populations have been used as an analogue for prehistoric H-G populations for decades (Binford, 2001; Finlayson, 2006, Panter-Brick et al, 2001 and references therein), the issue needs to be addressed. The solution is straightforward: once developed, test the model on Upper Palaeolithic populations, comparing the archaeological record and its associated behavioural interpretations to those made by the predictive model. Sufficient environmental data (GRIP, GISP, the Stage 3 Project) have been gathered, and numerous sites excavated, to make this essentially a comparison of two environmental timeframes: Modern vs Upper Palaeolithic, with the modern environment able to produce a suitable analogue for the Upper Palaeolithic environment on which to base human behavioural predictions. If the archaeological and predictive interpretations match, then one can deduce that no distinctive cognitive change has occurred between Upper Palaeolithic and contemporary *Homo sapiens* populations, and that the model can be employed to predict the material and non-material expressions of prehistoric modern humans which were subjected to varying levels of environmental productivity and risk.

Though testing the model on Upper Palaeolithic populations addresses the prehistoric vs modern issue, it does not address the former concern that *Homo sapiens* are not Neanderthals; and that different species have different mechanisms for dealing with risk and stress. In order to apply the predictive model to Neanderthal populations of the Middle Palaeolithic, one needs to make the assumption that behavioural responses to environmental stress and risk would be the same given that everything was equal. There are obvious inequalities between Neanderthals and modern humans which can be used to discredit the previous comment, and discredit the use of the predictive model: physiological differences in body shape and expenditure, neurological differences in brain size and organisation, a lack of symbolic material culture, the occupation of different environmental niches, and the active exploitation of large game are at odds with the behaviours of modern humans who displayed similar, though uniquely expressed, behaviours. Yet in spite of these differences Neanderthals still produced a tool technology that suited their environment and needs perfectly; they adapted to changing environments by migrating to more suitable climes; they were the first hominids to actively bury their dead; and though they hunted different and more niche orientated game, they did so in groups. Modern humans adopted similar behavioural mechanisms, but in a different way. Though their behavioural methodologies differ, each species accomplished the same essential goals to ensure their survival, and one could use these similarities to argue that Neanderthal-Modern cognitive differences were not grossly different. Indeed, work by Finlayson et al (2006) has shown that Neanderthals responded to environmental changes in similar ways to modern humans. As a result, a model based on predicting human behavioural responses to environmental change should, in theory, be applicable to Neanderthals. As prehistoric foragers lived in different environmental contexts as those in the current ethnographic dataset however a brief test of the model will be applied to the archaeological record of the Gravettian Upper Palaeolithic. This brief test will serve to highlight whether a model based on contemporary data and its behavioural associations can be applied to prehistoric foragers, both modern human and Neanderthal, who lived in variable environmental contexts over 30,000 years ago and serve to highlight whether H-G behavioural responses have remained consistent over this period. Ultimately, the Upper Palaeolithic test will used to show the suitability of applying behavioural predictions gained from contemporary analyses to prehistoric forager populations.

A predictive model based upon the observed material and non-material behaviours of contemporary H-G's is the ideal analytical method to determine the full extent of environmental influence upon Neanderthal behavioural expression: this model will allow for the firm prediction of non-material symbolic behaviours which would not otherwise have been evident within the archaeological record; whilst testing this model on Upper Palaeolithic modern human populations will ensure that the model will be applicable to prehistoric populations.

3.2.1 Ethnographic Datasets

The construction of behavioural models is dependent upon a reliable source of ethnographic information which can be adapted for statistical analysis to determine behavioural relationships with regard to environmental context. Ethno-archaeologists do have available to them a range of resources, both statistical and ethnological, with which to compile ethnographic datasets; ranging from unbiased ethnographic monographs, which detail the lifestyles and behaviours of individual hunter-gatherer societies; to collected statistical volumes, which provide detailed information on the environmental context of contemporary hunter-gatherer societies.

The Human Relations Area Files (HRAF), compiled by Yale University, is an example of the former. Collated within the HRAF cultural database are hundreds of ethnographic accounts which detail the yearly life and social cycles of individual hunter-gatherer societies. Monographs within the HRAF database range from general summaries which detail the defining information about a particular hunter-gatherer society, to detailed ethnographic accounts, which describe the key facets of a society's lifestyle. The majority of the ethnographic accounts within HRAF fall within the range of the ending of 'colonial' ethnography and the beginning of the modern period of 'preservation' ethnographies, and are thus relatively free of cultural bias. One must always be aware when employing individual ethnographic monographs that an inherent research bias may exist (see below).

The cultural range of societies which feature in the HRAF dataset is quite extensive, covering a large geographical range and including high latitude societies such as the Inuit sub-populations, to equatorial groups which vary from rainforest and savannah environments; providing the range of environments and cultural detail which ethno-archaeologists require in the construction and analysis of behavioural datasets. HRAF does, however, have limitations within its collated dataset: there is a lack of information with regard to hunter-gatherers of the South-East Pacific; in particular New Guinea, which has become the focus of ethno-archaeologists in recent years (Roscoe, 2002, 2004), whilst the level of detail given with regard to environmental variables is often presented in descriptive, rather than statistical, form. This latter point can make the analysis of those variables which are typically measured on a scale (i.e. the amount of time spent performing a task or the total distances populations migrate within a given season) difficult to measure and this creates issues with interpretation depending upon the analytical focus of the models in question, especially when these models require discrete environmental data for their application.

The primary statistical datasets which ethno-archaeologists rely upon for detailed information on variables such as environmental factors, migratory distances, food resource acquisition percentages, and kinship relations can be found in Binford (2001) and Murdoch (1979).

The dataset compiled by Binford (2001) is one of the most extensive statistical datasets compiled within the literature; containing statistical information on over 300 hunter-gatherer societies which span North and South America, Asia, and Oceania. It presents in detail those variables which are used to measure the levels of environmental productivity that hunter-gatherer societies are subjected to, given as an average compiled from an annual record. Such variables include recordings of biomass, effective temperature (ET), and latitudinal location amongst others. Further, Binford (2001) provides concise information on the food acquisition and migratory behaviours of all the hunter-gatherer societies which are included within the dataset. It is this latter information that is arguably the defining aspect of the Binford (2001) dataset: the quantification of behavioural responses which allow for statistical analysis.

Mirroring Binford (2001), Murdoch's (1979) *Ethnographic Atlas* details similar behavioural responses. The interesting aspect of the Murdoch dataset is its focus on kinship and social behavioural variables within its inclusive H-G societies. This allows ethno-archaeologists to broadly measure and interpret non-material behavioural responses within H-G societies throughout a range of latitudinal locations and their subsequent environments. Within this research study, Murdoch has been employed as a secondary dataset; with the majority of the environmental data extracted from Binford (2001) and social behavioural variables taken from Murdoch (1979).

3.2.2 Current Applications

Ethno-archaeologists have increasingly employed these datasets, as well as their own, in conjunction with ethnographic monographs to predict and infer the behavioural responses of prehistoric H-G societies to variations in environmental productivity. Though such analysis was prevalent within the late-1970's and 1980's, within the past decade researchers have begun to reinterpret and adapt past behavioural models to gain a better understanding of the social responses H-G societies implement in response to changes in environmental variation.

Oswalt (1976) was one of the first to statistically employ ethnographic data in the analysis of human responses to environmental variation, using latitude as a proxy measurements for environmental productivity. Employing a dataset which featured twenty one (21) H-G societies from various latitudinal locations, Oswalt (1976) noted that those societies who resided in higher latitudinal environments constructed tools which had a higher degree of complexity compared to lower latitudinal societies. Oswalt (1976) referred to this increasing level of complexity in the terms of techno-units (Tu), with those societies subjected to lower levels of environmental productivity employing technologies with a higher Tu score than those in areas which display higher levels of environmental productivity. Oswalt (1976) attributes this correlation between environmental productivity and H-G tool technologies as a behavioural response to risk; specifically that those societies who inhabit environments which are not environmentally productive need to invest in complex tool technologies to reduce the risk of failure attributed to food resource acquisition. Expanding on the Oswalt dataset, Torrence (2001) analysed the diversity of tool technologies employed within each of the societies included within the original dataset. Along similar lines as Oswalt (1976), Torrence concluded that decreasing levels of environmental productivity results in H-G employing not only an increasingly complex tool kit but also one that is more diverse in the structure and materials used to create the tools, the design of tools, and an increase use in the employment of storage tools to preserve food resources (Torrence, 2001). As with Oswalt, Torrence noted a correlation between the diversity of the tool technologies and latitudinal location (Torrence, 2001: 81); and also concluded that this increasing diversity reflects H-G responses to variations in environmental productivity to reduce the amount of risk in the acquisition of food.

Oswalt (1976) and Torrence (2001) highlight how technological complexity increases with regard to latitude, arguing that more complex and multi-faceted tool forms are a response by H-G's to reduce risk of failure by actively exploiting a variety of food resources. This is corroborated by latitudinal research carried out by Hayden (1982), and more recently by Rosoce (2004, 2006), who highlight the relationships between latitude and H-G food acquisition behaviours. Both Hayden (1982) and Roscoe (2004, 2006) highlight that higher latitudinal societies increasingly adopt fishing as their primary method for food resource acquisition, whilst lower latitudinal societies primarily rely on plant and gathered food resources. Interestingly, Roscoe (2004, 2006) draws attention to the dominance of hunting as a method for food resource acquisition. One may expect that hunting becomes the dominant form of food acquisition as H-G latitudinal residency increases and edible plant resources become scarcer. Roscoe (2004: Figure 1) notes that the reliance on hunting within a society peaks at around the 30^{o} – 39^{o} latitudinal range, at which the reliance on hunting plateaus at around 40% of the total food resources acquired by a H-G society. Further, Roscoe notes that hunting is never the primary acquisition behaviour for food resources, with gathering being the dominant form through the 0^{o} – 39^{o} latitudinal range, whereby fishing equals and then dominates over hunting (Roscoe, 2004: 5). Thus, as the latitudinal location of H-G residency increases societies adapt their acquisition behaviours to a lack of food resource availability in the form of plant and fruit materials by focusing upon fish and other aquatic resources, supported by terrestrial hunting. This distinct behavioural change around the 40^{o}N latitudinal mark from dominate gathering to dominate fishing, requires a distinct change within the tool kits employed by H-G societies; resulting in the complex tool forms and material diversity observed by Oswalt (1976) and Torrence (2001) in higher latitude H-G societies. The continued reliance upon terrestrial hunting by all H-G societies creates a ‘base-line’ level of technological complexity which bridges the technological gap from those societies who primarily gather their food resources, and those that primarily fish giving the appearance of continued technological complexity throughout the latitudinal range.

Following on from the recognition of the impact environmental variation has upon the material output and food resource acquisition behaviours, Binford expanded on the concept by examining how H-G societies responded to such variations in selected site locations (Binford, 1984, 2001). Binford's analysis was not concerned with measuring H-G site choice in relation to environmental variations, but in determining how material resources affect H-G migration and settlement choices (Binford, 1984). The '*routed foraging hypothesis*' described above is the result of Binford's analysis, which stipulates that the locational choices of sites were a response to resource availability at which material artefacts would naturally occur due to human occupation, rather than sites being randomly chosen and aspects of a societies material culture being brought to the site (Binford, 1984). Such resources, according to Binford, are quite varied; including those used for sustenance, such as water sources and animal trails; and those which can be employed to create tools, such as lithic outcrops.

The recognition that resource availability has a significant influence upon H-G behavioural choices has prompted ethno-archaeologists to determine exactly how H-G societies respond when environmental resources become strained, either due to natural climate variations or increasing demographic pressures exerted on the local environment. Grove (2009, 2010), adapting the work of Binford (1982), has determined that local resource availability in the form of available food resources is a key predictor in determining the amount of times, and the total distance, H-G groups migrate throughout the year. Grove (2009), employing a model which mirrors those who posit optimal foraging theory (Winterhalder and Smith, 1981; and Smith, 1983; Surovell, 2000; Kuhn, 2004, Morgan, 2008), determines that it is the depletion within the initial foraging zone of a H-G's range which prompts a group to migrate; with such migrations consisting of distance which is equal to twice the radius of the initial foraging zone to ensure the group moves into an environment which has resources to offer (Grove, 2009: 223). The analysis supports Binford's (1984, 2001) conclusions, highlighting that limited resources are a cause for a response in H-G behavioural expression, in this instance migration; and though the analysis by Grove (2009) focuses upon the depletion of resources within the initial foraging zone, one does not have to measure just behaviours in relation to food: the !Kung Bushmen, for example, migrate between watering holes to maintain social ties (Minnis, 1985). Migratory responses to local food resource stress are a constant behavioural response within H-G groups: the more limited the initial foraging zone, the more frequently a society migrates. In higher latitude H-G societies where such a foraging zone may be limited to a few metres beyond the residential site; migration event are much more numerous and longer (Table 3.2).

By ‘resources’ one simply does not mean those which are related to the acquirement of food, or the production of tools. The term ‘resource’ can also apply to the amount of individuals within H-G familial units, bands, or populations. Individuals can be considered resources as some will provide food, construct the best tools, or have specific knowledge on issues such as hunting, migration routes, and ceremonies due to experience. In theory, the larger the H-G group the more resourceful it can be. In practice, this cannot be realised as local environments can only support a finite number of individuals. This results in larger rates of fisson within larger populations (Coward, pers comm) so that resources can be distributed evenly instead of between groups. Coward argues, however, that in instances such as these material culture increases in importance as it links fragmentary kin groups together through common material bonds. This increase in material expression which is relevant to a specific kin group or population will ensure that the resources, in terms of an individual innovative skill or acquired knowledge, are not lost and can be continuously employed by other kin members during instances of population fusion. Examples of such behaviours can be found within the large seasonal gatherings of sub-arctic and arctic H-G populations, who trade information based on kinship networks which are recognised through a combination of memory and material culture, and work together during the harshest times to hunt and fish for food resources (Fitzhugh, 2001).

Behavioural modelling has thus become an important tool for ethno-archaeologists; providing a bridge between contemporary and prehistoric H-G societies, on whose framework interpretations can grow as to possible behavioural responses of prehistoric H-G's based upon analogy with their contemporary cousins. The summary of past and current uses of such analogous models, however, highlights the one drawback ethno-archaeologists face during the application of such behavioural models: typically researchers are constrained to analysing the behavioural responses which leave physical traces. Tool complexity; migration distance; material culture all leave material traces which ethno-archaeologists rely upon to test the predictions of their models, but material traces can only inform us of so much about prehistoric populations. Ethno-archaeologists are thus ignoring a large behavioural area of research with regard to H-G responses and environmental variations in productivity. This is by no means the fault of researchers such as Binford (1982, 1984, 2001), Oswalt (1976) and others, it is just a natural constraint of archaeology and its predisposition towards material artefacts.

3.2.3 Outline of the Behavioural Model

The behavioural model described and employed within this research project aims to address the imbalance in how such models are used to predict those behaviours which leave material traces and often ignore those behavioural responses which are inherently non-material.

As described above, the behavioural model presented here is an adaptation of Binford's (1984) *Routed Foraging Hypothesis*. Employing latitudinal location as a proxy for the measure of how environmentally productive an area is, this model will analyse a variety of behaviours which yield material and non-material traces. Behavioural outputs from H-G societies throughout the world have been compiled from a variety of sources (see below), and quantitative data were gained from supporting materials such as Murdoch (1976) and Binford (2001).

The model will specifically highlight those social behavioural outputs H-G societies make in response to decreasing levels of environmental productivity, and incorporate these responses in the analysis of prehistoric behaviours. This behavioural model will continue the research goal of ethno-archaeologists who have been inspired by the work of Binford (1982, 1984, 2001), analysing the behavioural responses of contemporary and prehistoric H-G groups, and expand its focus to include non-material social behaviours in an effort to understand the specific social changes and adaptations that occur within H-G when they adapt to varying levels of environmental productivity in their local environments.

3.3 ETHNOGRAPHIC AND STATISTICAL ANALYSIS

Predictions of Neanderthal material and non-material behaviours from a model based upon contemporary H-G analogy yields three prominent points which need to be addressed before the model can be constructed: the first issue is that the selection of modern H-G societies need to be comparable with Middle and Upper Palaeolithic populations; the second issue centres upon the exact resources one should use in gathering the required behavioural data which will eventually become the analytical variables that will be subjected to statistical analysis; and following from this, the third issue is how behavioural variables should be classified for statistical analysis.

3.3.1 Hunter-Gatherer Acquisition Criteria

As the overall research aim of this analysis is to create a predictive model to determine hominid responses to varying levels of environmental productivity, the selection of contemporary H-G populations, and their behavioural variables which are to form the analytical basis of the model, must inhabit the full environmental range that prehistoric hominid populations (i.e. Neanderthals and *Homo sapiens*) were subjected to, and still maintain a somewhat traditional H-G lifestyle. To fully identify the behavioural responses of contemporary H-G's to changing levels of environmental productivity; all contemporary environments must be represented within the model. This ensures that human responses to environmental changes are noted throughout all possible environmental ranges, and not just specifically niche ranges which would only be applicable to certain populations (both contemporary and prehistoric) who occupy these niche regions.

This study therefore incorporates contemporary societies from all climatic ranges, broadly speaking tropical, temperate, sub-arctic and arctic which ensures that all material and non-material behavioural changes between these broad environmental zones can be noted within separate populations who reside in different latitudinal ranges. Latitudinal location is the proxy variable being used to measure the level of environmental productivity within these analyses. Such a decision rests on the assumption that higher latitudes display considerably less environmental productive compared to more equatorial latitudes which are typically more environmentally productive. As a secondary indicator of environmental productivity, longitude has also been included to give the exact location of a particular H-G society. Using these two variables, the level of environmental productivity can be measured using the Köppen-Geiger Climate Classification System. The benefit of including all contemporary environmental regions is that environments which are analogous to Neanderthal and Upper Palaeolithic modern human populations are included as a matter of course. For the Middle Palaeolithic Neanderthal populations, this will include the analogous environments of arctic and sub-arctic tundra and taiga environments, as well as more temperate environments which current research suggests Neanderthals inhabited (Finlayson et al, 2006; Jimenez-Espejo et al, 2007; Hardy, 2011; Slimak, 2011) and for the Upper Palaeolithic modern human populations this will include sub-arctic taiga and temperate grassland environments (van Andel and Davies, 2003).

Though a representative sample of H-G populations from varying latitudes successfully addresses the issue of ensuring analogous environments between modern human and prehistoric hominid populations, the environmental location of a contemporary H-G society is only one issue that needs to be addressed for the successful development of the predictive model. A second issue concerns itself with the specific lifestyle of H-G societies which are to be included within the model. Neanderthal and modern human populations of the Middle and Upper Palaeolithic respectively led an active lifestyle in the pursuit of game, actively migrating from one location to another. Typically, such migrations are necessary for the continued pursuit of prey. The increasing influence of industrialisation has compromised the lifestyles of H-G populations in some manner; some, like the Maasai of Northern Tanzania/Southern Kenya have adopted a more pastoral lifestyle, whilst others have simply opened up exchange/trade links with industrialised villages and towns. A criterion for H-G inclusion into the development of the predictive model is therefore that the society in question must not be unduly influenced by industrialisation and its various processes. Such influences are potentially wide ranging, but the criteria selected for this model centres upon how an H-G society acquires its food resources. For inclusion within the model, contemporary societies must display a change in their behavioural responses when their primary food source becomes scarce and as such need to display adaptive strategies in their food resource acquisition. Such a criterion ensures that those populations who rely only on one food resource behaviour are excluded from this predictive model. As a result of this, the Maasai and similar pastoral H-G populations are not included within this predictive model as they rely on one principal methodology of food resource acquisition; whilst societies such as the Plains Cree and Copper Inuit who rely on a mixture of acquisition strategies, are included within the predictive model[4].

The final criterion for H-G inclusion within the predictive model centres upon the availability of ethnographic data for any eligible H-G society who conform to the previous criteria. The development of a predictive model which aims to discover the relationships between the levels of environmental productivity and material and non-material behaviours requires a high level of detailed data on eligible societies. As such, full ethnographic monographs will be the primary sources of information. Such ethnographies are typically compiled by researchers who spend several years in the field with individual societies, and they therefore include the full range of a society's behavioural repertoire in the face of seasonal changes to resource availability, a record of social and ceremonial activities, and descriptions of material artefacts and decorations used by individuals. Each H-G society which has been included within the predictive model has an in-depth ethnographic monograph which focuses upon their individual society. Such ethnographies will be supported by secondary sources such as cultural summaries, which yield brief descriptions of key aspects of a society's lifecycle, and cultural datasets, which present statistical information on each society. The former is represented by the Human Relations Area Files (HRAF) of Yale University; whilst the latter is represented by datasets compiled by Binford (2001) and Murdoch (1979) described above. These primary and supporting materials will allow for a

[4] The aspect of behavioural change we are focusing on here is the development of different food resource strategies employed by H-G populations which ensure their survival. In the examples above, both the Cree and Copper Inuit change their strategies in response to seasonal changes, and adapt by migrating to regions which support new game. Migration is not a stipulation of this criterion, as behavioural changes within food resource acquisition can be employed by sedentary H-G populations such as the Kukukuku and Asmat of New Guinea. These societies respond to the differing growth seasons of tubers by exploiting different species at different times, and supplementing their diets with wild hog when tuber numbers dwindle due to over exploitation (Blackwell, 1971; Roscoe, 2002). Thus, we see a change in behavioural responses in a sedentary society. The Maasai on the other hand have become increasingly pastoral, and rely on their goat herds to provide them with milk and meat. In times of stress, with a few exceptions, Maasai acquire extra food and grain from local villages and towns (Lee and Daly, 2001).

complete understanding of the environmental conditions selected populations experienced, and provide the behavioural and material variables which will be used for statistical analysis.

There arises one particular issue with using ethnographic data as the primary source of behavioural information. Recent ethnological reports focus upon expressing the need to preserve H-G lifestyles in the face of increasing industrial influence, yet they do not focus upon the intricate social details which the creation of a model of this type and scope requires. Though not employed as a primary source of data, such 'preservation ethnographies' have been used as a secondary source to confirm specific behavioural patterns within certain H-G societies. The earliest ethnographies[5] suffer from a similar lack of scientific focus. These accounts, though exceedingly descriptive, have a biased viewpoint in the same manner as more recent ethnographies. The authors of such reports invariably viewed these cultures as primitive in comparison to industrialised societies, and such bias is evident within their general writings. The presence of this bias clouds the impartiality of ethnographic research of this time; and as a result those H-G societies which are the focus of these earliest reports are not fully understood, and the context of their existence and behaviours are ignored. Like more modern ethnographies, these earliest works are treated as secondary sources due to their descriptive wealth.

Following these criteria, the majority of the behavioural data about H-G societies employed within this study were gathered between the years 1850 and 1970, which corresponds to the development of the structured field of ethnography. This range still leaves discrepancies within those H-G societies who conform to all the above selection criteria: notably, intense industrialisation during this period no doubt affected traditional H-G lifestyles.

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[5] Early ethnographies in this instance refer to ethnographic research conducted prior to 1850, when the field of ethnographic research was developing. Correspondingly, the number of 'preservation ethnographies' increases post-1970.

3.3.2 Hunter-Gatherer Selection

Following these criteria, fifty-five H-G societies have been included in the construction of the predictive model (Table 3.1), who reside in one of four broad climate zones: tropical, temperate, sub-arctic, and arctic[6]. Of these fifty-five societies, eight fall within the arctic region; twelve fall within the sub-arctic; twenty two within the temperate region; and thirteen within the tropics. The geographical ranges of these populations span North America, Central Eurasia, South America, Africa, Australasia-Oceania and the Far East, residing within specific eco-niches that include inland taiga, polar tundra, and equatorial monsoon environments.

Of the fifty-five societies used to construct the model, twenty-nine are to be found within North America; a bias which has been previously noted by anthropologists who have used the contemporary H-G record as comparative analogies (Binford, 2001, Murdoch, 1979; Roscoe, 2004). The *Ethnographic Atlas* collated by Murdoch (1976), for example, has a 59% sample bias towards North American H-G sources, whilst the model used within this study has a 52% bias towards North American H-G populations.

[6] Tropical zones are equatorial, ranging from the equator to 23°N; Temperate zones from 23°N to 50°N; Sub-Arctic zones range from 50°N to 65°N, and the Arctic zone ranges above 65°N. Such ranges also extend into southern latitudes.

Society Name	Country	Latitude	Longitude	Mean Temperature (°C)	Mean Coldest Month (°C)	Mean Warmest Month (°C)	ET
Copper Inuit	Canada-Northwest Territories	68.58 N	106.61 W	-13.6	-32.98	8.61	9.78
Aleut	USA-Alaska	55.00 N	162.85 W	3.16	-2.11	10.72	10.28
Netsilik Inuit	Canada-Northwest Territories	71.46 N	94.93 W	-16.24	-34.33	4.61	9.08
Innu (Labrador)	Canada-Newfoundland	57.97 N	62.02 W	-3.58	-20.47	11.39	10.28
Mistassini Cree	Canada-Quebec	51.75 N	72.66 W	0.53	-17.96	16.46	11.22
Dogrib Indians	Canada-Northwest Territories	63.85 N	115.61 W	-6.25	-27.76	14.54	10.72
Cheyenne	USA-Colorado	38.83 N	102.35 W	10.52	-1.83	23.83	13.29
Plains Cree	Canada-Saskatchewan	51.86 N	102.67 W	1.44	-18	18.54	11.53
Ona	Argentina	53.90 S	68.62 W	5.23	1.11	9.5	9.76
Koryak	Russia-Siberia	65.96 N	170.08 E	-6.91	-20.47	6.64	9.23
Chukchee	Russia-Siberia	65.96 N	170.08 E	-6.91	-20.47	6.64	9.23
!Kung	Botswana	20.00 S	21.18 E	20.6	14.78	24.22	16.52
Hadza	Tanzania	3.82 S	35.32 E	19.6	16.5	26.5	23.5
Kukukuku	New Guinea	7.50 S	146.52 E	29.14	24.69	33.58	12.56
Yuki (Coastal)	USA-California	39.64 N	123.74 W	12.96	7.81	18.03	13.53
Evenk	Mongolia	51.91 N	122.50 E	-2.46	-20.46	19.22	11.37
Ainu	Japan	44.01 N	144.17 E	6.26	-7.43	20.3	12.31
Mbuti	Congo	1.54 N	28.61 E	22.01	21.11	23.11	20.49
Aka	Congo	2.00 N	17.00 E	25.56	24.72	26.5	23.5
Aranda	Australia-Northern Territory	23.70 S	144.17 E	20.84	11.73	28.62	15.98
Semang	Malaysia	5.86 N	101.00 E	24.58	24.02	25.18	23.39
Wikmunkan	Australia-Queensland	13.47 S	142.00 E	25.89	23.02	28.22	21.04
Tasmanians	Tasmania	42.62 S	147.49 E	11.35	6.72	15.89	12.74
Patwin	USA-California	39.08 N	122.05 W	16.33	7.46	25.59	14.77
Wintu	USA-California	40.90 N	122.35 W	15.23	5.69	25.72	14.49
Miwok (Coastal)	USA-California	38.24 N	122.88 W	14.08	8.28	18.89	13.82
Miwok (Lake)	USA-California	38.79 N	122.48 W	13.99	8.09	18.83	13.77
Yuki (Proper)	USA-	39.70 N	123.15 w	12.89	4.83	21.69	13.76

	California						
Panamint Shoshoni	USA-California	36.37 N	117.33 W	19.17	7.63	30.78	15.34
Hukunduka Shoshoni	USA-Utah	41.55 N	112.22 W	9.92	-4.06	24	13.11
Salmon-Eater Shoshoni	USA-Idaho	42.94 N	115.30 W	10.98	-1.78	24.14	13.44
Comanche	USA-Texas	36.83 N	100.50 W	17.81	6.78	28.17	14.95
Plains Ojibwa	USA-North Dakota	47.60 N	97.25 W	3.99	-15.03	20.75	11.96
Blackfoot	Canada-Alberta	51.01 N	110.76 W	2.64	-14.94	18.5	11.64
Tlingit	USA-Alaska	57.00 N	133.59 W	6.24	-0.96	13.5	11.25
Eyak	USA-Alaska	60.48 N	144.00 W	0.91	-12.58	12.92	10.7
Alutiiq	USA-Alaska	61.21 N	147.61 W	1.13	-9.09	11.69	10.47
Kitchibuan Ojibwa	USA-Michigan	45.21 N	85.10 W	6.17	-7.63	19.35	12.14
Albany Ojibwa	Canada-Ontario	51.22 N	83.10 W	-0.76	-20.28	16.56	11.17
Nunamiut Inuit	USA-Alaska	68.18 N	151.71 W	-9.36	-25.3	9.31	9.87
Ingulik Inuit	Canada-Northwest Territories	69.44 N	81.51 W	-12.48	-30.83	7.22	3.52
Polar Inuit	Greenland	77.49 N	69.50 W	-10.6	-23.33	4	8.64
G/Wi	South Africa	22.46 S	23.39 E	19.35	12.93	23.52	15.82
Nganasan	Russia-Central	73.83 N	90.00 E	-11.62	-28.06	8.39	9.71
Asmat [R]	New Guinea	6.10 S	138.57 E	26.25	25.00	27.50	12.56
Lower Arafundi [E]	New Guinea	4.91 S	144.50 E	27.44	26.92	27.96	12.52
Yahgan[H]	Argentina	60.00 S	68.66 W	5.57	1.78	9.22	9.60
Guayaki (Ache)[H]	Paraguay	25.70 S	55.38 W	21.86	16.83	26.06	17.46
Chichimec	Mexico	25.00 N	111.54 W	22.19	14.00	30.50	16.69
Ute-timanogas	USA-Utah	40.22 N	111.81 W	10.79	-1.72	24.14	13.34
Sandbeach	Australia	15.92 S	130.87 E	24.85	21.89	20.23	20.23
Wiil and Minong	Australia	34.95 S	117.81 E	10.59	12.00	14.83	14.83
Pitjantjatjara	Australia	26.00 S	130.00 E	21.57	12.59	16.33	16.33
Kunai	Australia	37.59 S	147.42 E	12.79	7.03	13.51	13.51
Ngarinyin	Australia	15.32 S	124.72 E	25.27	20.94	19.41	19.41

Table 3.1. Geographical and Climate Data for 55 Hunter-Gatherer Societies, ranging from Arctic to Tropic Environments (Binford, 2001).[R] Data retrieved from Roscoe (2004, 2006).[H] Information obtained from the Handbook of South American Indians (1946).

Table 3.1 lists those H-G societies which have been included within the development of this behavioural predictive model, along with information regarding a society's location and the average temperatures each society is subjected to within their own environment. Further information, focusing on the hunting and migration patterns of each H-G society, has been compiled within Table 3.2, whilst Table 3.3 contains information on some of the measurable environmental variables populations are subjected to. This information has been compiled so that each society can be categorised according to their demography, hunting preferences and migratory styles along with the environmental conditions they experience.

3.3.3 Demographic Variables

Tables 3.1 and 3.2 contain demographic variables which have been obtained from the extensive cultural dataset compiled by Binford (2001) in his seminal work, *Constructing Frames of Reference*. Some demographic variables have been inferred from the cultural data compiled by Blackwood (1978), Roscoe (2002, 2004, 2006), and *The Handbook of South American Indians* (1946) and references therein. A brief explanation of the demographic variables employed within this model, and how such variables were arrived at, is presented here. For a more detailed review of the variables refer to Binford (2001):

- ***Population Density*** is measured by using the calculation [Population Size/Total Area of Occupation]. The Total Area of Occupation is measured in kilometres (km^2), and population density is measured in km;
- ***Food Resource Acquisition*** behaviours are given in percentages depending upon the amount of food acquired by hunting, the acquisition of protein from terrestrial sources; fishing, the acquisition of protein sources obtained from aquatic sources; or gathering, the acquisition of food resources through terrestrial plant, vegetable and fruit resources;

- The ***Primary Resource*** refers to the dominant food source of an H-G population, inferred from the acquisition percentages described above. The largest resource percentage will be used as the proxy in assigning the Primary Resource to a H-G population;
- ***Migration*** is measured by three variables: Migration Style, which notes whether a population is nomadic or central, with the central variable representing populations who migrate from central hubs; Number of Migrations refers the amount of times a population actively moves from one location to another; and finally, the Migration Distance is the average distance H-G populations tend to relocate during each movement. Such distances are measured in miles.
- The final demographic variables centre upon ***Population Numbers*** H-G nomadic and aggregated populations. Such demographics are averages taken from various groups within the population over several aggregated and nomadic events.

3.3.4 Environmental Variables

Tables 3.1 and 3.3 contain environmental variables which have also been compiled using the Binford (2001) dataset, and information relating to individual H-G societies has been taken from Blackwood (1978), Roscoe (2002, 2004, 2006), and *The Handbook of South American Indians* (1946) and references therein. A brief explanation of the environment variables employed within this model is presented here. For a more detailed review of the variables refer to Binford (2001):

- ***Temperature*** has been recorded via three variables in an effort to understand the variable temperature ranges. The Mean Temperature variable is the average recorded temperature experienced by H-G populations throughout the year. Whilst the Mean Coldest Month and Mean Warmest Month variables record the coldest and warmest temperatures a population experiences. All temperature variables are measured in degrees Celsius;

- The ***Effective Temperature*** (ET) is the amount of effective light hours a population has available to them, and can be used as a proxy to the level of environmental productivity an individual population has available to them. Those populations which occupy areas with higher ET values have, in theory, a greater amount of productivity available to them compared with those populations who have lower ET values;
- ***Potential Evapo-transpiration*** (PET) is a further proxy value that can be used to determine the environmental productivity of a given environment H-G populations reside within. PET is a measure of the evaporation of water from vegetation into the atmosphere, and is a reflection of the energy available within an environment to evaporate water. The energy referred to is usually light and heat, and as such PET reflects the amount of energy an environment receives: higher levels of PET reflect higher amounts of energy, and as such a higher level of productivity available within the environment. A second variable, *Actual Evapo-transpiration* (AE), has also been included which records a more conservative evapo-transpiration value;
- ***Net Above Ground Productivity*** (NAGP) is a reflection of how environmentally productive a given area is. NAGP is the accumulation of biomass in the above ground parts of plants (trunks, leaves, fruits), and higher NAGP values reflect higher levels of primary productivity. NAGP can be employed as a proxy in determining levels of secondary (i.e. terrestrial animal) productivity, on the assumption that a greater amount of above ground plant materials will attract larger numbers of herbivorous animals;
- ***Water Deficit in Soil*** (WATD) refers to the available amount of water within a plant's active rooting depth that is removed by the plant itself. WATD values decrease when

rates of precipitation (rainfall) increase, and values increase as the plant requires more water (evapo-transpiration). There are several values H-G populations who reside in environments which display a WATD value of 0.00; these are arctic dwelling populations which has a lack of plant growth. WATD values are expressed in centimetres (cm).

- ***Snow Accumulation*** (SNOWAC) refers to the amount of snow, in centimetres an area receives on average over an annual period. Typically, environments which have high accumulations of snow are environmentally unproductive.

The inclusion of these variables within the predictive model ensures that H-G material and non-material behaviours which are included within the model are analysed against variables which have links to environmental productivity to determine if any relationships exist between the two factors.

Society	Total Population	Area (km^2)	Density	% Gathering	% Hunting	% Fishing	Primary Resource	Migration Style	Nomadic Population	Aggregate Population	No. Migrations	Distance (Mi)
Copper Inuit	2,000	4,620	0.43	0.01	25	74.99	Aquatic	Nomadic	18	105	14	444
Aleut	13,500	247	54.65	1	5	94	Aquatic	Central	0	55	0.1	0
Netsilik Inuit	500	1,970	0.25	0.01	25	74.99	Aquatic	Nomadic	22	85	11	307
Innu (Labrador)	1,460	525	2.78	0.01	29	70.99	Aquatic	Nomadic	11	35	4	135
Mistassini Cree	450	779	0.58	0.9	74	25.1	Terrestrial	Nomadic	6	37	16	450
Dogrib Indians	1,590	1,809	0.88	3	66	31	Terrestrial	Nomadic	22	60	13	450
Cheyenne	2,750	570	4.82	15	80	5	Terrestrial	Nomadic	45	275	18	390
Plains Cree	4,650	1,700	2.73	10	75	15	Terrestrial	Nomadic	40	75	0	0
Ona	3,497	481	7.27	5	75	20	Terrestrial	Nomadic	20	45	24	320
Koryak	1,292	274.9	4.7	1	30	69	Aquatic	Nomadic	15	35	3	90
Chukchee	1,292	274.9	4.7	1	30	69	Aquatic	Nomadic	15	35	3	90
!Kung	726	110	606	67	33	0	Plant	Nomadic	10.4	24.3	5.5	75
Hadza	600	25	24	60	40	0	Plant	Nomadic	16.5	42	7	80
Kukukuku	-	289.68	-	~55	~22.5	~22.5	Plant	Central	0	30	2	≥75
Yuki (Coastal)	750	11.2	66.96	25	15	60	Aquatic	Nomadic	4	85	3	25
Evenk	3,200	744	4.3	10	65	25	Terrestrial	Nomadic	20	60	15	350
Ainu	122	3.5	34.8	10	15	75	Aquatic	Central	6	30.3	1.5	8
Mbuti	1,496	34	44	90	9	1	Plant	Nomadic	30.2	104	13	64
Aka	1,088	120	9.06	79.5	20	0.04	Plant	Nomadic	18	36	6	75
Aranda	2,045	767	2.66	55	45	0	Plant	Nomadic	9.6	30	14	285
Semang	366	20.8	17.57	50	40	10	Plant	Nomadic	34	71	36	147
Wikmunkan	1,602	83	19.31	50	30	20	Plant	Nomadic	8	45	14	238
Tasmanians	700	85.7	8.17	25	35	40	Aquatic	Nomadic	7.5	35	12	165
Patwin	1,517	18.5	82	50	30	20	Plant	Central	20	50	6	139
Wintu	4,000	68	58.82	35	25	40	Aquatic	Central	20	50	6	139
Miwok (Coastal)	1,500	28	53.57	40	10	50	Aquatic	Central	0	26	0	0
Miwok (Lake)	227	3.5	65	60	10	30	Plant	Central	0	90	0	0
Yuki (Proper)	4,000	30.4	131.6	50	15	35	Plant	Central	0	25	0	0
Panamint Shoshoni	500	236	2.12	65	35	0	Plant	Nomadic	7.5	22.5	11	220
Hukunduka Shoshoni	1,000	337.6	2.96	45	35	20	Plant	Nomadic	0	24	12	250
Salmon-Eater Shoshoni	400	57.9	6.9	30	50	20	Terrestrial	Nomadic	11.2	34	12	210
Comanche	3,500	1500	2.33	20	80	0	Terrestrial	Nomadic	60	269	0	0
Plains Ojibwa	2,000	716.8	2.79	10	75	15	Terrestrial	Nomadic	40	250	0	0
Blackfoot	2,425	700	3.46	20	75	5	Terrestrial	Nomadic	70	346	30	540
Tlingit	12,000	1,050	11.42	1	15	84	Aquatic	Central	0	197	3	30
Eyak	156	26.6	5.86	0.01	10	89.99	Aquatic	Central	0	57	2	25
Alutiiq	3,170	262	12.1	0.01	10	89.99	Aquatic	Central	0	53.5	2	40
Kitchibuan Ojibwa	3000	600	5	15	40	45	Aquatic	Nomadic	15	65	14	225
Albany Ojibwa	225	157.4	1.43	5	60	35	Terrestrial	Nomadic	0	50	14	2.75
Nunamiut Inuit	240	249	0.96	0.1	89	10.9	Terrestrial	Nomadic	18.5	25.1	11	501
Ingulik Inuit	1,193	2,210	0.54	0.01	15	84.99	Aquatic	Nomadic	20	60	12	385
Polar Inuit	300	731	0.41	0.01	30	69.99	Aquatic	Nomadic	11.5	35	11	350

G/Wi	528	180	2.63	55	45	0	Plant	Nomadic	5.6	36	11.5	270
Nganasan	876	1,904.3	0.46	1	55	44	Terrestrial	Nomadic	14	29	12	375
Asmat [R]	13,000	4,305	3.0	30	10	60	Aquatic	Central	0	505	0	0
Lower Arafundi [R]	454	240	2.0	60	10	30	Plant	Central	0	120	0	0
Yahgan[H]	2,500	88	28.42	5	25	70	Aquatic	Nomadic	13	24	7	90
Guayaki (Ache)[H]	100	28.7	3.48	30	62	8	Terrestrial	Nomadic	26.7	60	58	290
Chichimec	3,000	333	9	65	20	15	Plant	Nomadic	0	0	0	0
Ute-Timanogas	480	138.8	3.47	40	30	30	Plant	Nomadic	17.5	50	0	0
Sandbeach	650	-	-	35	10	55	Aquatic	Nomadic	14.30	0	-	-
Wiil and Minong	889	-	-	40	30	30	Plant	Nomadic	9	50	-	-
Pitjantjatjara	358	-	-	65	35	0	Plant	Nomadic	10	23	-	-
Kunai	700	-	-	25	35	40	Aquatic	Nomadic	7.5	35	-	-
Ngarinyin	1114	-	-	60	30	10	Plant	Nomadic	18	35	-	-

*Data inferred from Roscoe (2002), Blackwood (1978) and current climate data. [R] data obtained from Roscoe (2004, 2006). [H] Information obtained from the Handbook of South American Indians (1946).

Table 3.2. Population Data for 55 Hunter-Gatherer Societies, ranging from Arctic to Tropic Environments (Binford, 2001).

Society	Country	PET	AE	BIO 5	NAGP	WATD	SNOWAC
Copper Inuit	Canada-Northwest Territories	223.71	95.44	250.4341	42.30	128.27	7.78
Aleut	USA-Alaska	388.73	388.73	8646.98	435.32	0.00	224.91
Netsilik Inuit	Canada-Northwest Territories	118.49	104.89	27.4751	49.48	13.61	4.77
Innu (Labrador)	Canada-Newfoundland	342.46	287.11	2542.70	263.25	55.35	53.86
Mistassini Cree	Canada-Quebec	475.15	444.71	11943..50	544.26	30.45	73.04
Dogrib Indians	Canada-Northwest Territories	423.14	150.48	1387.74	90.08	272.66	11.20
Cheyenne	USA-Colorado	681.55	395.81	6532.32	448.56	285.74	30.35
Plains Cree	Canada-Saskatchewan	535.17	351.02	5240.62	367.50	184.14	3.94
Ona	Argentina	485.00	392.84	8600.41	443.00	92.16	0.00
Koryak	Russia-Siberia	223.66	189.93	1235.29	132.57	33.73	124.51
Chukchee	Russia-Siberia	465.09	358.30	8724.06	380.24	106.79	190.84
!Kung	Botswana	998.50	457.32	2081.68	540.12	541.18	0.00
Hadza	Tanzania	899.93	732.73	11372.16	1246.84	167.20	0.00
Kukukuku	New Guinea	-	-	-	-	-	-
Yuki (Coastal)	USA-California	700.29	464.55	36077.82	585.15	235.75	00.00
Evenk	Mongolia	-	-	-	-	-	-
Ainu	Japan	565.29	550.42	21509.67	775.45	14.88	106.14
Mbuti	Congo	1048.96	1043.32	33168.24	2241.67	5.64	0.00
Aka	Congo	1472.02	1443.27	25461.31	3841.66	28.75	0.00
Aranda	Australia-Northern Territory	1094.03	277.63	862.00	248.97	816.40	0.00
Semang	Malaysia	1320.69	1320.69	50350.34	3315.37	0.00	0.00
Wikmunkan	Australia-Queensland	1513.15	983.44	16648.36	2032.18	529.71	0.00
Tasmanians	Tasmania	658.31	575.94	12091.62	836.05	82.36	0.00
Patwin	USA-California	864.97	265.15	4702.85	230.68	599.81	0.00
Wintu	USA-California	831.02	367.28	13717.91	396.18	463.74	0.00
Miwok (Coastal)	USA-California	731.93	377.74	11200.64	415.09	354.19	0.00

Miwok (Lake)	USA-California	731.30	365.07	9873.17	392.24	366.22	0.00
Yuki (Proper)	USA-California	722.32	372.37	19987.89	405.34	349.95	0.00
Panamint Shoshoni	USA-California	1066.02	96.84	379.35	43.34	969.18	0.00
Hukunduka Shoshoni	USA-Utah	677.65	257.16	5240.48	219.25	420.49	89.13
Salmon-Eater Shoshoni	USA-Idaho	710.18	156.92	2051.78	96.57	553.26	29.80
Comanche	USA-Texas	989.59	515.77	4101.51	696.11	473.56	0.00
Plains Ojibwa	USA-North Dakota	585.12	468.07	10336.32	592.53	117.05	74.85
Blackfoot	Canada-Alberta	540.22	333.93	3918.71	338.28	206.28	4.22
Tlingit	USA-Alaska	542.21	542.21	29593.31	435.32	0.00	224.91
Eyak	USA-Alaska	459.19	459.14	17420.94	573.90	0.00	481.01
Alutiiq	USA-Alaska	388.73	388.73	8646.98	435.32	0.00	224.91
Kitchibuan Ojibwa	USA-Michigan	571.29	465.09	18090.10	586.28	106.20	169.98
Albany Ojibwa	Canada-Ontario	460.68	395.51	8177.04	448.00	65.17	39.32
Nunamiut Inuit	USA-Alaska	284.45	178.63	1115.98	119.74	105.82	92.13
Ingulik Inuit	Canada-Northwest Territories	197.93	91.58	212.7756	39.50	106.35	20.46
Polar Inuit	Greenland	133.09	88.18	31.33	37.10	44.91	71.91
G/Wi	South Africa	934.94	333.84	1521.00	338.12	601.09	0.00
Nganasan	Russia-Central	250.51	171.06	1219.11	111.44	79.44	109.28
Asmat [R]	New Guinea	-	-	-	-	-	-
Lower Arafundi [E]	New Guinea	-	-	-	-	-	-
Yahgan[H]	Argentina	508.63	414.50	10603.66	484.28	94.13	0.00
Guayaki (Ache)[H]	Paraguay	1108.86	1108.86	31611.53	2480.26	0.00	0.00
Chichimec	Mexico	973.32	653.53	3788.91	1031.20	319.79	0.00
Ute-timanogas	USA-Utah	692.44	336.91	5959.34	343.30	355.53	118.99
Sandbeach	Australia	1435.67	1097.66	21477.13	2438.82	338.01	0
Wiil and Minong	Australia	759.21	550.68	17590.48	776.07	280.52	0
Pitjantjatjara	Australia	1192.01	284.49	12888.24	1683.40	139.27	0
Kunai	Australia	696.90	568.81	12535.66	836.05	82.36	0
Ngarinyin	Australia	1544.83	909.11	9543.11	1783.62	635.72	0

Table 3.3. Measurable environmental variables experienced by H-G population in their resident environments.

3.3.5 Behavioural Variables

As the aim of the predictive model is to determine the relationships between material and non-material behaviours in relation to varying levels of environmental productivity, a full range of behaviours from the contemporary H-G ethnographic record needs to be included within the predictive model. The full list of the behavioural variables, and their descriptions, employed within this analysis can be found within Appendix One. These behavioural variables are used to create the behavioural components noted below and mentioned in the results (Section 3.4).

Individual behavioural variables will be placed within one of five behavioural categories: Artefacts, which includes the physical produce of a society ranging from tool technologies to symbolic material output; Social Cohesion, which features those non-material behaviours that create and maintain social bonds; Spiritualism, which includes those behaviours, both material and non-material, that reflect the beliefs of spirits and the concept of an afterlife; Spatial Use, featuring the physical layout of H-G activity sites and the placement and use of specific areas, both local and regional; and Resource Acquisition, which features the behaviours used to acquire food resources. These categories cover the broad behavioural spectrum which this model aims to address. Appendix 1 describes the one hundred and forty-four behavioural and material variables that have been selected to determine the relationships between levels of environmental productivity and behavioural expression.

The selected list of behavioural variables, placed within their associated categories, covers the typical behaviours one normally associates as symbolic behaviour: notably the employment of colour pigments (Hovers et al. 2003); spatial arrangements (Gamble, 1998); and the design of tool technologies, both in the materials they employ (Oswalt, 1978) and in the cognitive imagining required to construct them (Barham, 2010). These variables have been included in the development of the predictive model as they are regarded as key indicators of behavioural modernity, and they are well represented in varying degrees throughout H-G societies in the four climatic ranges described above. The behavioural list also includes variables which are specific to regional environments so that regional identification can be attempted once statistical analysis has been conducted.

3.3.6 Assigning Importance to Behaviour

As the intention of the model is to determine the relationships between these behavioural variables and environmental productivity through statistical analysis, numerical associations need to be assigned which reflect the level of expression of a particular variable within a society. Numerical assignments need to be on a scale which reflects the increasing expression of the behaviour as the scale also increases; as a result a numerical ordinal scale has been employed in the statistical description of behavioural expressions within H-G societies, rather than employing a nominal scale which will simply divide behaviours into categories without assigning a level of expression which can be measured statistically.

Behavioural variables were assigned a numerical value dependant upon the level of expression within a population. A value of zero (0) indicates that the behaviour is not represented within a population, or that ethnographic data are too sparse to assign the level of behavioural expression of the variable within a population. A value of one (1) indicates that a behaviour is present within a society, but is only expressed sparsely and has limited social importance; a value of two (2) shows that a behaviour is expressed within a population much more consistently throughout the annual calendar of events of a H-G population; finally, a value of three (3) is indicative that such a behaviour is ubiquitously expressed within a population, and as such is important in the social structure of individual H-G societies.

Once each behavioural variable has been assigned an ordinal value dependent upon its expression, the compiled dataset will be placed through a statistical programme to determine if any associations exist between levels of environmental productivity and behavioural expression. Full behavioural classifications can be found within the Supplementary Disc of this thesis whilst full behavioural descriptions of each variable can be found within Appendix #1.

3.3.7 Statistical Methodology

Statistical analysis began by referring to the initial dataset. If links exist between H-G symbolic and social complexity and levels of environmental productivity as shown by Collard and Foley (2002), then assigned numerical values need to be compared to accurate environmental variables which represent different levels of productivity within the landscape. Latitude can be employed as such a proxy for environmental productivity, with increasing latitudinal locations corresponding broadly with decreasing levels of environmental productivity. As the aim of the model is to determine which behaviours vary with environmental influence, traits which display conformity in their numerical values (i.e. traits with low variance) have been removed from further statistical analysis.

Those variables which deal with the influence of time on H-G populations have been subjected to further statistical testing to ensure that importance can be given to the specific length of time each society spends completing certain tasks, such as hunting budgets. These standardised values have been placed through an equation so that values represent a distinct weighting representative of the amount of time a society spends on certain behavioural aspects. The equation **(TV1*1,TV2*2)/(TV1:TV2)** will allow for the temporal weighting of variables. Where TV1 represents Time Variable 0-4hrs and TV2 represents Time Variable 4-8hrs. In instances were more than three Time Variables were employed in the weighting of the variable for analysis the following equation was employed: **(TV1*1, TV2*2,TV3*3)/(TV1:TV3)**, where TV3 represents Time Variable 8-12hrs and the other variables. These new, temporally weighted, cases will give a better understanding of the time, and thus importance, of particular time consuming behaviours to specific H-G societies. Each weighted value still ranges from zero (0) to three (3) similar to the standard cases noted previously, but also includes decimal values within these ranges. As such, a weighted value of three (3) indicates that a society spends more than twelve hours conducting a certain task, whilst a value of a lower range, say 1.5, indicates that a society spends less time (around 4-hours) conducting a specific task. Essentially these values represent a more in depth and continuous ordinal scale valuation.

Once the dataset was amended, and all variables were seen to display a variable nature (see above), the data was inputted into a statistical programme for analysis. In this instance the statistical programme used was SPSS v.16. v.17 and v.18. Four methods of analysis were conducted: Principal Component Analysis, Correlation, Stepwise Linear Regression, and General Linear Modelling.

3.3.8 Behavioural Themes

The overall goal of statistical analysis is to determine the effect varying levels of environmental productivity have on the expression of symbolic behaviour on H-G populations, with the goal being to employ the resulting model upon prehistoric populations. To facilitate the statistical analysis, eight analytical goals have been constructed to determine environmental influence on H-G populations (Table 3.4); each analytical goal employs specific variable selection used within each analysis. Variable selection for each hypothesis was based upon how the variables best represented the behaviour which was the subject for analysis. Each goal thus asked a specific question regarding a behavioural link to levels of environmental production through the proxy of latitudinal location, via variables which are believed could provide answers to the analytical goals. For example, analytical goal #2 (below) was aimed at determining the relationship between material artefact culture and environmental productivity. As a result, those behaviours which were expressed as physical artefacts were initially included in the analysis.

The aim of these goals is to identify a core set of behaviours which can be linked to the overall aim of the analysis, with shared behavioural associations between inclusive variables, and which would have been preserved within the archaeological record and would thus help in future comparisons and predictions within prehistoric H-G societies.

3.3.9 Principal Component Analysis (PCA)

The first round of statistical analysis focused upon reducing the hard data (behavioural variables and their numerical associations) into workable components. PCA acts as minor correlation analyses, identifying variables which are closely associated with each other.

Variable associations range from -.999, which represents strong negative associations; .999, which represent strong positive associations; and .000, which represents a neutral association (Hair et al, 1998). Component analysis will present a variety of ranges for each identified component in the analysis, not all of which will be within the acceptable range. Values of .500 and above, and -.500 and below, will be accepted as values representing significant association between individual variables and components. This cut-off value ensures that values represent significant associations between each other in developing the component. Due to the amount of variable data being inputted into the component matrix, it is expected that multiple components will be identified in each analysis. To compensate, VARIMAX Rotation has been employed so that variables are loaded more economically within identified components; ensuring that stronger relationships between variables and variables and variables and components will be identified (Field, 2005). Those variables not conforming to the .500 cut-off will be dismissed.

Variables which were included within factor analysis (optimal factors) all shared a behavioural association with each other as determined by the overall goal of the analysis (see above). In the course of determining the optimal factors, several initial principal component analyses had to be run for each analytical theme. These early factor runs determined which variables shared behavioural links between each other. Behavioural variables which scored highly, but showed no behavioural links with other variables, were removed from the analysis as these would inhibit the results from those variables which did show behavioural links. Any removal of a variable from analysis was conducted in reference to the VARIMAX Rotated component analysis, which yielded a more concise interpretation of how variables interacted with other. If, in such instances, a variable stood alone from other variables, it was removed from the analytical goal.

Principal component analysis yields three statistical results which will be employed within this model, the first are the association variables which have already been mentioned above, and linked with these are the KMO-Bartlett Scores, the second statistical variable used within this Principal component analysis.

The KMO-Bartlett scores represent the ratio of the squared correlation between variables to the squared partial correlation between analytical variables (Fields, 2005). In essence, it determines the level of appropriateness that principal component analysis will have on the included data. KMO scores range from 0 to 1, with scores of 1 representing compact patterns of correlations which yield distinct factor scores; whereas scores of 0 represent more diffuse correlations where principal component analysis would be inappropriate. Typically, values between 0.5-0.7 are considered adequate, 0.7-0.8 values are good, 0.8-0.9 great, and values above 0.9 are considered superb (Hutcheson and Sofroniou, 1999).

The final statistical variable will be the Factor-Regression Scores which will be employed in future statistical analyses, specifically with Regression and General Linear Modelling, to determine if the behavioural components recognised by principal component analysis can be used as predictive markers for other behaviours. The use of Factor-Regression Scores links the categorisation of behavioural components to later analytical analyses and the development of behavioural models.

Though the loading of variables into components can be attributed to the presence of relationships existing between variables by quantitative analysis, the labelling of components rests on the interpretation of the author. Interpreting what behavioural components represent is therefore subject to possible personal bias which may skew the overall behavioural analysis.

To overcome the possibility of bias in assigning behaviours to components a framework of interpretation has been devised which intends to remove as much potential observer bias as possible. Component labelling is based on two factors: the variable with the highest score and the overall range of variables which make up the rest of the component. The variable with the largest factor score highlights the strongest behavioural factor in the assembled component in relation to other loaded variables. This variable therefore has a leading influence in the observed relationship recognised by Principal Component Analysis (PCA). Constructing an interpretative label on the strongest variable will therefore ensure that an appropriate context is indentified to base interpretations on. Secondly, the range of other variables loaded in the component should broaden this base further and in conjunction with the dominant variable should provide enough information to provide a behavioural label for the components. As with the dominant variable, factor scores are taken into consideration when developing an overall interpretation of a component.

Though the framework employed in interpreting and identifying behavioural components is intended to remove aspects of personal bias, it cannot be guaranteed and one should be aware that arguments for other labels/interpretations of components may be possible. All recognised components have been interpreted in this manner and a brief description of the reasoning behind each component interpretation is included in the relevant statistical section.

3.3.10 Correlation

Those variable components identified within principal component analysis shall be used in a bivariate correlation analysis which employs a Pearson coefficient measuring the association between the independent (latitudinal coordinates) and dependent (component) variables without making a distinction between them.

The aim of the Pearson correlation is to determine if component variables are related to others in some manner and if they are, to determine the strength and direction of this relationship. Correlations can be negative, indicating that as the independent variable increases the dependent variable decreases; or positive, which indicates that as the independent variable increase so too does the dependent variable. Correlations will be measured to two-tails of significance, at both the .005 and .001 levels.

3.3.11 Stepwise Linear Regression

Using the identified behavioural components from Principal Component Analysis which represent broad behaviour links between selected variables, regression analysis will be employed to determine if the latitudinal location (our independent variable) can be used as a predictor for the expression of the behavioural components (our dependent variables) identified through Principal Component Analysis.

A stepwise linear regression model has been employed in this analysis to ensure that the model is developed from dependent variables which are significantly influenced by the model's independent variable. The stepwise procedure employed here is a backwards elimination method, whereby all selected dependent variables are tested one-by-one for their significance to the independent variable; those dependent variables which do not display a significant relationship are deleted from the model.

Variable selections for model testing were based on the overall analytical goal, and as such all inclusive variables are linked together in some form. Several models were run, each including a different set of variables for analysis for each analytical goal. Each model analysis provides an Akaike's Information Criterion (AIC), which is a measure of the goodness of fit of a statistical model. The AIC is not a test of the model in regards of hypothesis testing, but rather it is a test between models and is typically employed as a tool for model selection (Fields, 2005). Though the AIC penalises models that contain more parameters, the models employed within the anthropological and archaeological analyses of this thesis rarely contain more than ten variables per model, and along with their comparison to existing behavioural models to determine their accuracy (see above: section 3.2.2), the AIC variable is sufficient in this context to be used as a guide for model selection (Fields, 2005). As several models have been run for each analytical goal, each competing model can be compared via their AIC's to determine which model is best representative of the relationships between the independent and dependent variables, i.e. the relationships between environmental productivity and behavioural expression. The lowest AIC value represents the model which has the best goodness of fit between independent and dependent variables within the analytical model.

The two stages of regression modelling will be employed within this analysis. The first, as described throughout this section, concerns itself with determining the relationship between behaviours and latitudinal location, where latitude acts as a proxy of environmental productivity. The second stage focuses upon the influence of behavioural expression on other behavioural expressions. A similar methodology as described above has been employed within this second set of regression analyses: multiple stepwise regression modelling, with AIC values determining which model is best to use.

The AIC values from both stages of analysis (latitudinal and behavioural) will be compared to determine which variables have the best relationships between each other. By comparing the AIC values, one will be able to determine: whether environmental productivity or behavioural expressions were the primary factors in symbolic expressions, or a combination of the two, within contemporary H-G societies.

3.4 RESULTS

3.4.1 Food Resource Acquisition

The aim of this analysis was to determine which environmental variables influence the expression of food resource acquisition behaviours (Hunting, Gathering, and Fishing) within hunter-gatherer societies. Principal Component Analysis (PCA) identified three components, which have been determined to represent the three different forms of food resource acquisition behaviours employed by H-G societies. Table 3.4 notes variables associated with each of these components, as noted each behavioural variables and its ordinal classification can be found in Appendix #1 and the Supplementary Disc respectively for each analysis.

The KMO score of .862 for the hunting component indicates that this component represented a ‘great’ distribution between the individual variables within the hunting component; a KMO score of .669 for the gathering component indicates that individual variables within this component share an 'adequate' distribution between each other; the fishing component displays an 'acceptable' KMO score of .500 and as such has been placed within this analytical component.

Component Lane	Inclusive Variables	% Variance Explained	Factor Scores	KMO Score
Hunting	Individual Hunting	62.985	.661	.862
	Terrestrial Hunting		.587	
	Aquatic: Small		.730	
	Aquatic: Medium		.897	
	Aquatic: Large		.916	
	Food Distribution		.655	
	Butchering Rules		.779	
	Time: Hunting		.843	
	Time: Tool Creation		.820	
	Time: Maintenance		.960	
Gathering	Veg: Root	73.744	.901	.669
	Veg: Flowering		.772	
	Fruit		.897	
Fishing	Fish	64.566	.804	.500
	Shellfish		.804	

Table 3.4 Identified components and associated variables linked with Resource Acquisition Behaviours.

Three analyses were run in an effort to determine the effect environmental variation has upon a hunter-gatherer society's resource acquisition behaviour. The models centre upon the recognised food resource behaviours which have been described *ad infinitum* within anthropological literature: gathering of plant and fruit resources, hunting animal meat-protein resources, and fishing for meat-protein resources.

The first analysis centres upon the assumption that active hunting is employed as the primary method of obtaining food. No environmental variables were selected within this model, indicating that hunting is adopted regardless of environmental variation. The behavioural variables highlighted within the model were gathering (T: -14.26; P: <.001 [Table 3.5: All associated T-Scores can be found in their associated tables in the text]) and fishing (T: -16.871; P: <.001). The analysis indicated that as fishing and gathering decrease, the adoption of hunting will be employed.

The second analysis centres upon the assumption that active gathering is employed as the primary method of obtaining food. The analysis identifies two environmental variables which exert an influence upon gathering behaviour: Latitude (T: -14.498; P: <.001) and AE (T: -4.809; P: <.001); with increases in these variables resulting in corresponding decreases in the employment of gathering as the primary method of food resource acquisition by a factor of -1.200 and -.398 respectively. Increases in latitude are associated with a corresponding reduction within the available primary biomass a hunter-gatherer society can rely upon as potential food resource. As a result, higher latitude societies would not be dependent on primary biomass food resources unlike those societies who reside in lower latitudes. The model also states that increases in AE will reduce the amount of gathering a society will employ within its resource acquisition activities. AE has influential factors which contribute to its total rate of occurrence, wind, overall temperature, the number and variety of plant species within a region, and the levels of humidity an area experiences. Typically, one would expect AE to increase in areas of high temperature, but tropical environments have high humidity levels which prevents the evaporation and transpiration of water into the atmosphere. Thus, AE within these environments can be low; correspondingly, AE levels within arctic environments will vary according to wind intensity and the variety of plant life within these environments; as humidity levels are low in such environments, AE levels could potentially be higher within these regions than in some tropical environs. Overall, rates of AE should be greatest within temperate environments which combine all the factors which influence the rate of AE. Therefore, according to the predictions of the model, populations within temperate regions will not resort to gathering as the primary means for food resource acquisition. This models shows that environmental variables other than latitude can be employed to highlight associations in behavioural expressions related to environmental variability. This association will no doubt aid future analyses of forager behavioural expressions, though a latitudinal proxy will still be employed as 1) the majority of forager behavioural models rely on this proxy and therefore provide an aspect of comparability with the results this anthropological model, and 2) the recognition of defined environmental variables within prehistory are still in their early stages and thus may not be reliable for an analysis such as that described here (though see the Stage Three Project [van Andel et al, 2003] for notable progress in this area) whilst latitudinal scales remain constant and therefore provide a readily accessible proxy.

Taking both variables and their associated predictions into account, gathering would not be employed within high latitude environments where primary biomass resources would be naturally limited, and would be greatly expressed within tropical environments over temperate environments. In such temperate conditions, gathering would most likely have been employed as a secondary means of resource acquisition by H-G societies. This confirms the analysis and findings of previous researchers such as Hayden (1981) and Roscoe (2002, 2004).

Model	Factors	d.f.	Std. Coefficient	T	P	Adj. R^2	Excluded Variables
Hunting	Fishing	43	-1.352	-16.871	<.001	.866	Latitude, PET, AE, SNOWAC, Average Temp, Daylight.
	Gathering		-1.146	-14.265	<.001		
Gathering	Latitude	43	-.14.498	-16.871	<.001	.869	PET, SNOWAC, Average Temp, Daylight.
	AE		-4.809	-14.265	<.001		
Fishing	Gathering	43	-.593	-5.288	<.001	.575	Latitude, PET, AE, Average Temp, Daylight
	AE		.278	2.479	.017		

Table 3.5. Models and Associated variables predicting Food Resource Acquisition Behaviours within hunter-gatherer societies.

Analysis suggests that hunting will be employed as the primary method of resource acquisition when both fishing and gathering are not primarily employed. Models have established that gathering will be chiefly employed within tropical environments, whilst fishing may be the dominant form of resource acquisition within higher latitude, more arctic, environments. Gathering and fishing within temperate environments would be employed as secondary methods of resource acquisition; thus hunting would be employed as the primary of food acquisition within these temperate areas, and a potential secondary method of food resource acquisition within arctic environs.

The analyses highlight that environmental variability influences the expression of the acquisition of food resource by gathering; which in turn influences the acquisition of food resources by fishing and hunting within hunter-gatherer societies. In sum, the above analyses collectively highlight that as hunter-gatherer societies increasingly reside in higher latitudinal environments which display greater variations in the levels of their environmental productivity, they will adapt their methods of food resource exploitation from methods dominated by terrestrial resources by adopting methods which exploit marine environments, supporting Roscoe (2004).

3.4.2 Tool Complexity

The theme of this analysis was to determine which variables influence the choice of materials in the creation of hunter-gatherer tool kits. Five variables were included within the PCA, which highlighted one underlying component shared between all inclusive variables (Table 3.6). One variable, Stone: Tools, was removed from analysis as the behavioural factor score did not exceed the .500 inclusion point.

The KMO Score of .769 highlights that the data has a 'good' distribution, providing a reliable component on which to base further analytical interpretations.

Component Label	Inclusive Variables	% Variance Explained	Factor Scores	KMO Score
Tool Complexity	Stone: Storage	61.415	.710	.769
	Wood: Tools		-.900	
	Bone: Tools		.918	
	Stone: Tools		<.500	
	Bone: Processing		.891	
	Wood: Household		-.772	

Table 3.6 Identified component and associated variables linked with hunter-gatherer Tool Complexity.

One model was identified in determining the influence of environmental and food resource variation upon the expression of tool kit complexity within hunter-gatherer societies, with two behavioural variables highlighted as particularly influential (Table 3.7): Hunting (T: 7.16; P: <.001) and Gathering (T: -4.346; P: <.001). The model states that as a society increasingly employs hunting as the primary method of food resource acquisition there will be a corresponding increase in the level of complexity displayed within that society's tool kits; whilst within societies whose principal form of food resource acquisition is gathering, the level of tool kit complexity will decrease: supporting the interpretations of Oswalt (1976) and Torrence (2001).

Model	Factors	d.f.	Std. Coefficient	T	P	Adj. R^2	Excluded Variables
Tool Complexity	Hunting	43	.615	7.126	<.001	.829	Latitude, Avergae Temp, Daylight, PET, AE, BIO-5, SNOWAC, Fishing
	Gathering		-.375	-4.346	<.001		

Table 3.7 Models and Associated components predicting the influence of food resource acquisition behaviours upon hunter-gatherer tool kit complexity.

The model states that as hunting becomes more predominant within a society, its tool kit will correspondingly increase; a reflection of the increased variability in the selection of food resources, and the increased need to have tool forms which can be adapted to the greatest number of potential prey targets. As hunter-gatherer societies increase their home ranges into higher latitudes, with the loss of primary biomass resources, they will invariably increase the frequency of their hunting and fishing behaviours which will require new and intricate tool forms to ensure the successful acquisition of prey. Societies located in such environments, therefore, should employ a varied and much complex tool kit than lower latitude societies.

3.4.3 Non-Material Social Expressions

The aim of this set of analyses is to determine the effect foraging behaviour, and environmental variation, has upon the expression of non-material symbolism, i.e. the establishment of intra-societal communication between individuals.

Table 3.8 highlights the identified components obtained from PCA, with associated variables. All the identified components attained reliable KMO scores, to which we can employ these components within further statistical analysis.

Component Label	Inclusive Variables	% Variance Explained	Factor Scores	KMO Score
Migration	Settled	62.393	-.702	.595
	Aggregation: Seasonal		.938	
	Dispersal: Seasonal		.908	
	Prey Influenced		.771	
	Return: Same Sites		-.706	
	Return: Same Areas		-.674	
Kinship Networks	Patrilineal	74.513	-.863	.500
	Matrilineal		.863	
Social Controls	Social Hierarchy Indicators	48.166	.559	.724
	Social Taboos		.717	
	Tension Relief Ceremonies		.821	
	Code of Honour		.601	
	Ritual Violence		.740	
Population Controls	Infanticide	87.837	.937	.500
	Disassociation of Elderly		.937	
Influence: Elderly	Political Centre: Elders	40.334	.785	.598
	Influence: Attained		.712	
	Influence: Chosen		.672	

Table 3.8 Identified components and associated variables linked with the expression of immaterial symbolic expression.

The five components were analysed individually, providing a unique model for each component (Table 3.9).

The first model, focusing upon migration, highlights that as AE increases the total amount of migration within a society decreases. As rates of AE are typically higher within temperate and tropical environments, societies within these broad climatic areas should be predisposed to migrate more frequently.

The second model, focusing upon the expression of kinship networks, notes that as food resource acquisition behaviours increase, i.e. the adoption of a variety of resource acquisition methods is employed within a H-G society, the expression of kinship becomes stronger; whilst increasing frequencies of migration will result in the decreasing strength of established kinship bonds between individuals.

The hunting/gathering/fishing for food resources would bring groups of individuals together which would necessitate team work to ensure a successful excursion; this reliance on other individuals would create bonds of trust within a hunting party/unit due to the mutual trust each would have in the other. Increasing instances of migration by a society, or band, means that the time spent in anyone place in limited. Thus there would not be enough time at any one location to ensure that any bonds of trust established between bands would survive after a particular band has migrated to another region.

Model	Factors	d.f.	Std. Coefficients	T	P	Adj. R^2	Excluded Variables
Migration	AE	44	-.568	-4.573	<.001	.307	Latitude, PET, SNOWAC, Average Temp, Daylight, Hunting, Fishing, Gathering
Kinship Networks	Gathering	41	1.598	5.5151	<.001	.721	Latitude, PET, AE, SNOWAC, Average Temp, Daylight
	Hunting		.972	4.286	<.001		
	Fishing		1.080	3.313	.002		
	Migration		-.212	-2.483	.017		
Social Control	Latitude	44	.590	4.850	<.001	.334	PET, AW, SNOWAC, Average Temp, Daylight, Hunting, Fishing, Gathering.
Population Control	Average Temp	44	-.578	-4.695	<.001	.319	Latitude, PET, AE, SNOWAC, Daylight, Hunting, Fishing, Gathering.
Elderly Influence	SNOWAC	44	.322	2.256	.029	.083	Latitude PET, AE, SNOWAC, Daylight, Hunting, Fishing, Gathering.

Table 3.9 Models and associated components predicting the influence of foraging behaviour and environmental variability on the expression of immaterial symbolic behaviours.

The third model, focusing upon social control behaviours, notes that as latitude increases, societies will also increase their expression of social control behaviours. Due to decreases in available food resources in higher latitude environments, the increasing employment of social controls will restrict the actions of freeloaders in these environments; thus ensuring that the few food resources available within the environment are equally distributed throughout the entire society.

The fourth model, focusing upon population control behaviours, notes that as average temperatures increase the use of such control behaviours will decrease. Similar to social control behaviours, population control behaviours are an attempt by a society to ensure food resource availability is sufficient for the entire population by ensuring that the total numbers of a population never exceed what the natural resources a given area can provide. Thus, when food resources become scarce such behaviours will actively limit the amount the individuals within a society. In tropical environments, where food is available year round in the form of plants and fruits as well and animals, there will be no real need to employ such behaviours; whilst in regions where temperatures are low (read: arctic) and were food resources are not available year round, such behaviours will ensure that a society does not exceed the food requirements that the environment can provide.

The final model focuses upon the influence of elderly individuals within hunter-gatherer societies, note that as the amount of snow accumulation increases within an environment, there will be a corresponding increase in the influence attributed to the elderly members of a population. The SNOWAC variable is a proxy for arctic environments, where regions will be covered in snow and ever changing due to snow drifts etc. Elderly members of a society will have greater knowledge of the local environment, such as optimum hunting and fishing grounds, and in times of environmental hardship such knowledge will prove invaluable to the survivability of a population. Essentially where resources are variable (i.e.

the arctic), knowledge is revered as resources can only be located in specific regions; compared to tropical regions which have bountiful resources during all seasons.

3.4.4 Spiritual Expression

The aim of this analysis was to determine if the expression of social control behaviours would influence the expression of spiritual worship within hunter-gatherer societies. Dunbar (2007) notes that religious systems were developed due to the need to control populations more efficiently by providing a threat of punishment from a spiritual level; this hypothesis is partially aimed at determining if such a process is possible, and to determine the whether environmental variability has any influence upon spiritual expression.

Model	Inclusive Variables	% Variance Explained	Factor Scores	KMO Score
Spiritualism: Animism	Spiritualism: Animism	47.154	.606	.758
	Spiritualism: Animal Representation		-.699	
	Spiritual Ceremonies		.522	
Spiritualism: Animal Representation	Spiritualism: Animal Representation	47.154	.869	.758
	Grace Offerings		.579	
	Spiritual Reincarnation		.694	
	Shamanism		.768	
Influence: Shamans	Political Centre: Shamans	40.334	.918	.598
	Influence: Attained		<.500	
	Influence: Chosen		<.500	

Table 3.10 Identified components and associated variables linked to the expression of spiritual behaviours within Hunter-Gatherer societies.

Table 3.10 presents the components identified by PCA, with associated variables. All identified components display more reliable KMO scores with which to base further statistical analysis upon.

These components yielded three models which can be used to infer influential variables upon the expression of spiritual behaviours (Table 3.11).

The first model, focusing upon the expression of animism, highlights three behaviours which exert an influence upon this form of spiritual expression. Specifically, the model suggests that as social control behaviours increase there will be a corresponding increase in the expression of spiritual animism; which goes some way in supporting the argument presented by Dunbar (2007). The model also notes that as migration and hunting behaviours increase, the expression of spiritual animism will decrease. As spiritual animism focuses upon the spirits of non-living things, it stands to reason that as a society focuses upon living things to maintain itself the spiritual focus will move from non-living to living ones.

The second model, focusing upon animal representative spiritualism, identifies three variables which influence the expression of this form of spiritualism. Interestingly, increases in social control expression bring about increases in animal representative spiritualism; further confirming Dunbar (2007). Also, the model stipulates that as migration increases within a society there will be a corresponding increase in animal representative spiritualism. As migration is typically brought about due to the migration of game, increasing frequencies of migration may represent a focus on a particular species of game. Ultimately, migration is focused upon animals; so if this focus increases then there will be a corresponding increase in the form of spiritualism which focuses upon animals as its centre of worship. Finally, as population control behaviours increase this form of spiritual worship will decrease. This highlights that this form of spiritual behaviour may not be employed to actively maintain the physical number of individuals within a society, but is used to control the behaviour of individuals within a society.

The final model, focusing upon the influence of shamans within hunter-gatherer societies, predicts that shamanic influence is employed as a form of social control within animal representative forms of spiritualism; with increases in social control behaviours, hunting, and animal representative spiritualism yielding corresponding increases within the overall influence of shamans within a population. The focus of shamanic influence is distinctly animal based, suggesting that shamans themselves are a personified social control to help ensure that animal resources are not overly exploited by hunters.

Model	Factors	d.f.	Std. Coefficients	T	P	Adj. R^2	Excluded Variables
Animism: Spiritualism	Migration	46	-.439	-3.809	<.001	.422	Latitude, Fishing, Gathering, Kinship Networks, Population Control
	Social Control		.437	3.791	<.001		
	Hunting		-.314	-2.792	.008		
Spiritualism: Animal Representation	Migration	46	.638	6.015	<.001	.572	Latitude, Hunting, Fishing, Gathering, Kinship Networks.
	Social Control		.586	4.808	<.001		
	Population Control		-.311	-2.319	.025		
Influence: Shamans	Social Control	45	.557	3.454	.001	.375	Latitude, Fishing, Gathering, Migration, Kinship Networks, Spiritualism: Animism.
	Population Control		-.408	-2.788	.008		
	Hunting		.316	2.786	.008		
	Spiritualism: Animal Representation		.276	2.064	.045		

Table 3.11 Models and Associated variables predicting the influence of social behaviours upon hunter-gatherer spiritual expression.

3.4.5 Material Symbolic Expression

The aim of this set of analyses is to determine if the non-material social and symbolic behaviours of hunter-gatherer societies can be used as predictors for the expression of material forms of symbolic expression that may be preserved within the archaeological record. In essence, this hypothesis could potentially form the initial basis of an analogy between contemporary and prehistoric hunter-gatherer societies.

Table 3.12 highlights the components identified within PCA, and the associated variables linked with these components. All component KMO scores are reliable, so that recognised components can be used within further statistical analysis.

Component Label	Inclusive Variables	% Variance Explained	Factor Scores	KMO Score
Material Culture	Sculpture: Wood	61.225	.658	.781
	Sculpture: Ivory/Bone		.904	
	Ornamental Decoration		.889	
	Bone Ornaments		.879	
	Tool Engravings		.724	
	Spiritual Engravings		.578	
Social Ceremonies	Dance Ceremonies	59.362	.844	.474
	Song Ceremonies		.920	
	Storytelling		<.500	
Funeral Rites	Burial	59.408	-.716	.586
	Surface Burial		.858	
	Rites: Other		.731	
Social Rites	Ceremonial Artefacts	57.353	.696	.729
	Ceremonial Clothing		.818	
	Embroidery Patterns		.755	
	Rites: First Hunt		.812	
	Rites: First Menstruation		.695	

Table 3.12 Recognition of underlying components and their associated variables identified by Principal Component Analysis (PCA).

Analysis identified four models which can be employed to predict the expression of material symbolic behaviours (Table 3.13).

Model	Factors	d.f.	Std. Coefficients	T	P	Adj. R^2	Excluded Variables
Material Culture	Population Control	44	.399	4.904	<.001	.861	Latitude, Hunting, Gathering, Migration, Social Control, Influence: Elders, Influence: Shamans
	Fishing		.162	2.084	0.43		
	Kinship Networks		-.364	-3.847	<.001		
	Spiritualism: Animal Representation		.190	3.133	.003		
	Spiritualism: Animism		.157	2.640	.011		
Social Ceremonial Expression	Spiritualism: Animism	46	.295	2.364	.022	.358	Hunting, Fishing, Gathering, Migration, Kinship Networks, Population Control, Spiritualism: Animal Representation, Influence: Elders, Influence: Shamans, Material Culture.
	Latitude		-.532	-3.767	<.001		
	Social Control		.470	3.123	.003		
Funeral Rites	Kinship Networks	45	-.571	-4.309	<.001	.559	Latitude, Hunting, Fishing, Migration, Social Control, Spiritualism: Animal Representation, Spiritualism: Animism, Influence: Shamans, Material Culture
	Social Ceremonies		.424	3.994	<.001		
	Influence: Elders		-.369	-3.493	.001		
	Gathering		-.286	-2.083	.043		
Social Rites	Gathering	47	-.447	-3.599	.001	.476	Latitude, Hunting, Fishing, Migration, Kinship Networks, Population Control, Spiritualism: Animal Representation, Spiritualism: Animism; Influence: Elders, Influence: Elders, Material Culture, Social Ceremonies, Funeral Rites.
	Social Control		.352	2.838	.007		

Table 3.13 Models and associated variables used to predict the expression of hunter-gatherer material culture.

The first model, focusing upon the material cultural expression within hunter-gatherer societies, states that as spiritual expression and population control behaviours increase there will be a corresponding increase in the material output of a society. Increasing emphasis on fishing resources also brings about an increase in material expression. Material output decreases with increasing kinship expression. This model suggests that material expressions are linked to spiritual worship, and variable environments, which result in populations resorting to fishing as the primary method of food resource acquisition. Thus, as hunter-gatherer populations move into more variable, higher latitude environments, the presence and intensity of a population's material culture should increase.

The second model, focusing upon the expression of social ceremonies, predicts that as social controls and spiritual animism expressions increase there will be a corresponding increase in the expression of social ceremonies. The model further predicts that populations residing in higher latitudes will display less ceremonial behaviours than those populations in lower latitudes. The employment of social ceremonies thus seems to be a form of social control linked to spiritual expression, but one not employed within higher latitudinal environments. It is possible that in environments where seasonality is more marked, such ceremonies would have a greater significance.

The third model, focusing upon the expression of funeral rites, predicts that these behaviours are linked to social ceremonies; indicating that funerals involve significant proportions of the population are paying their respects to a deceased individual.

The final model, focusing upon social rites, predicts that they are linked to social control behaviours. This indicates that such rites emphasis specific roles within societies which individuals must conform to if they are to be considered valuable to the society as a whole. The model further predicts that if gathering is the primary method of food resource acquisition, such rites will be less emphasised. As gathering is primarily used within tropical environments where changes in seasonality do not affect the abundance of food resources, individuals will not be required to have specifically active roles which would ensure the overall survival of the society. However, where seasonality is marked, and food resources are less abundant, such rites will be employed as a form of control to ensure that individuals and properly trained, and above all know their place, within a society that resides in a variable environment.

3.4.6 Phylogenetic Considerations

This thesis is attempting to identify how variations in environmental productivity affect hunter-gatherer behavioural expressions in Neanderthal societies via ethnographic analogy. Though analysis of 55 contemporary hunter-gatherer societies have provided a range of information that suggests environmental productivity influences a range of human social behavioural expressions, one needs to take into account biological and cultural relatedness as these could also influence the expression of social behaviours (possibly more so than environmental factors).

As a complete phylogenetic tree for all the 55 hunter-gatherer societies used in this thesis does not exist in the literature, one had to be created. A complication in the creation of this tree is that genetic data for the majority of the hunter-gatherer societies are not available. As a result, the creation of the phylogenetic tree (Appendix 5) has employed the framework employed by Boncok et al (1994) and Reich (2012) who infer genetic affinities from geographic ranges between populations, the underlying assumption being that the further the distance between societies the less likely they are to share genetic relationships. This analysis has employed latitudinal and longitudinal values, which relate to the core occupational areas of each societies foraging range, to infer distances between populations. These distances have been optimised so that they can be included into statistical analyses that mirror those described above, namely General Linear Modelling. Phylogenetic analysis, including the creation of the tree, was conducted using the R-Statistics using phylogenetic programmes including *APE* and *CAPER* to create the initial phylogenetic tree and finally *GEIGER* which ran initial phylogenetic simulation based on the parameters of the diverse ethnographic dataset i.e. latitudinal and longitudinal distances. Branch lengths were calculated using Grafen's Method so that ethnographic data were considered statistically independent. Results of this phylogenetic analysis are described in Table 3.14 and broadly mirror those in previous analyses (with one exception) suggesting that hunter-gatherer behaviours in this context are not significantly influenced by phylogeny. Table 3.14 includes the Lambda (λ) values for all conducted analyses to provide an indication of the strength of the relationships between independent and dependent variables and ranges from 0.0 to 1.0. A Lambda value of 0.0 indicates that there is nothing to gain from the association and that the independent variable does not predict the dependent variable. Alternatively, a Lambda value of 1.0 suggests that there is a strong association present, and that the independent variable can be used to predict the presence of the dependent variable.

It has to be noted that this addendum analysis incorporates both environmental and phylogenetic factors. Ideally, phylogenetic analysis would be conducted separate from environmental factors so as to determine which variable influences social expression more. However, as the assumed phylogenetic relations have been inferred rather than securely associated a combined analysis was preferred to determine if the inclusion of phylogenetic factors would unduly influence the results already obtained. Due to the lack of significant phylogenetic influence highlighted by this analysis, discussion and interpretation of results will focus on the environmental results discussed above.

The only behavioural variable to show a significant influence by phylogeny is 'Social Control', which loaded on the previous environmental analysis but failed to do so here. It is possible that phylogeny influences the expression of this variable more so than environmental productivity but more research and development of analytical methodologies is required before definitive conclusions can be made. It has to be noted however, that social control behaviours are often culturally dictated and so it is not surprising that phylogeny would influence these types of behaviours over others.

Model	Factors	DF	λ	Std. Coeff	T	P	Adj R^2
Hunting	Fishing Gathering	47	0.909	-0.042 -0.060	-20.815 -14.823	<.001	0.903
Gathering	Latitude AE	47	0.000	-1.369 -8.565	-15.955 -5.601	<.001	0.879
Fishing	Gathering Hunting	47	0.921	-0.059 -0049	-17.039 -20.920	<.001	0.924
Tools	Gathering*	48	0.910	-0.366	-3.811	<.001	0.216
Migration	AE	48	0.837	-0.003	-3.859	<.001	0.221
Social Cohesion	Latitude Social Control	47	0.934	-0.007 -0.153	-3.706 2.871	<.001	0.198
Spiritualism	Migration Social Control	47	0.688	-0.095 -0.1111	3.109 3.939	.001	0.3874
Material Culture	Kinship Fishing Spiritual Expression Population Control	45	0.000	-0.0785 -0.1804 -0.073 -0.070	-2.172 3.874 2.146 7.702	0.05	0.83

Table 3.14. Summary of Behavioural models incorporating phylogenetic variables using geographic distance as a marker to infer genetic relatedness. Note that all results mirror the results obtained in the previous analysis, suggesting that phylogeny in this instance has no significant influence on this expression over environmental productivity. The exception being 'Social Control Behaviours' which did not load, suggesting a stronger phylogenetic influence on these behavioural traits.

Three important aspects of this phylogenetic methodology need to be addressed: first, though geographic ranges are employed to infer phylogenetic relationships, the use of these geographic distance places hunter-gatherer societies into regional clades based on their geography. As a result, the analysis may be highlighting regional environmental factors as well as phylogenetic ones which may account for the similarity between the environmental and phylogenetic results. Second, the broad conformity of these analyses can be attributed to the inherent nature of methodology of this analysis, in that it has employed a macro behavioural focus rather than a micro approach, i.e. the focus is on the general *context* of the behavioural expression rather than its specific *form*. If one were to conduct a micro-scale approach to hunter-gatherer social expressions then one may find a greater influence of phylogeny on the individual forms of behaviours used. Until a better phylogenetic understanding is determined between these societies, however, such an approach is one of the only tools available for social anthropologists who wish to determine phylogenetic influence on hunter-gatherer behavioural expressions. Finally, the negative Lamdba scores for gathering and material culture suggest that phylogeny may have an influence on these particular behaviours. This is understandable as all hunter-gatherer societies gather in some manner and *what* they gather may be dictated by their culture as well as by their environment; whilst the expressions of material culture are likely to be grossly influenced by the societal relations. Thus when it comes to inferring about the presence of material culture in ethnographic, or indeed archaeological, hunter-gatherer populations the influence of cultural relatedness needs to be kept in mind as factors such as demography, distance between groups, kinship relations, and the presence of social networks could all have a stronger influence up a hunter-gatherers material expression than environmental variables.

3.5 DISCUSSION

The results presented here highlight the intricate effects variations within environmental productivity in the landscape have on H-G societies and their behavioural expression. Several of the behavioural responses and adaptations highlighted within these analyses confirm the interpretations of previous researchers (Oswalt, 1976; Binford, 1984; Torrence, 2001; Roscoe, 2002, 2004) with relation to material and foraging expressions which reinforces the validity of the social relationships identified in the analysis. This analytical foundation suggests that, as with the previous behavioural models (Oswalt, 1976; et al), the findings and relationships identified in this series of analysis can be transposed onto prehistoric H-G societies to determine if there are any similarities and differences to contemporary responses.

Overall the analysis highlights a series of behavioural responses H-G societies are likely to adopt as they move into/reside in landscapes that experience variations in environmental productivity. As productivity decreases we would expect H-G's to adopt increasingly varied methods in their food resource acquisition behaviours, notably the exploitation of marine environments and fishing. The analysis broadly highlights that the increasing adoption of varied food resource acquisition coupled with decreasing environmental variability, bring about a series of behavioural responses centred on social and population control behaviours, as well as the adoption of spiritual belief systems which reflect the key resources H-G's rely upon as their primary food resource. The adoption and reliance on these social behaviours by H-G societies will be reflected within the material cultures of said societies through the creation of symbolic artefacts, ritual violence, rites of passage and the presence of intricate sharing protocols for food.

The adoption of these social behaviours can be seen as a response to decreasing levels of productivity in the environment as the analysis shows that expressions of social control should be more prevalent in higher latitude societies (T: -4.695; P: <0.001). This social response reflects a need to maintain resources at an acceptable level of exploitation to ensure that there are enough food resources available for all. Control behaviours in higher latitude societies are therefore more prevalent as the acts of freeloaders in arctic societies would be of greater detriment than similar acts in tropical or temperate societies due to the limited availability of resources in higher latitudes. The act of a single freeloader in higher latitude societies could result in the failure to attain food and possibly starvation, and so resulting control mechanisms need to reflect the severity of these actions. Social control behaviours, like Population control behaviours, are therefore methods which ensure there are enough food resources available for all. The adoption of social cohesive behaviours such as Kinship Networks and the Influence of Elderly individuals (Table 3.9) would ensure that H-G societies in higher latitudes had a social network to fall back on in times of hardship that would create a sense of community and promote cooperative behaviour; acting as the ‘carrot’ to social controls ‘stick’. The result of these different social behavioural expressions is that H-G kinship and social behaviour is reflected through the material artefacts they produce: tools, beads, symbolic artefacts, body pigment, carvings etc have social associations as well as utilitarian functions. The recognition of this is important if non-material social behaviour is to be interpreted from the archaeological record of either modern human or Neanderthal societies.

Indeed, if this analysis holds firm the overall motivation of H-G social behaviour, and material expression, is to help acquire food or maintain acceptable levels of food availability. The behavioural focus on food resource acquisition is supported by examples from the ethnographic record: migration and cooperative behaviours ensures a greater degree of success when hunting (Heffley, 1981; Minnis, 1985; Hawkes, 1992), the exploitation of a range of high- and low-yield game (Jenike, 2001; Winterhalder, 2001), altruistic reciprocity in food sharing by a hunter ensures that they will receive food from other individuals during failed hunts (Smith, 1991), exchanges of material artefacts ensure that networks exist between neighbouring kin and/or groups which promote the sharing of resources during times of regional stress (Wiessner, 2002), the influence of elderly individuals allows for the transmission of regional knowledge relating to animal movements (Woodburn, 1968; Barnard, 2011) and the use of social and population control behaviours ensures that food resources in a given region are never over exploited by a single population (Minnis, 1985). Several of these behaviours conform to the predications of optimal foraging theory (i.e. migration etc) and this analysis shows that not only do contemporary H-G’s conform to this theory but have adopted a range of social behaviours to help them thrive in their particular lifestyle. This *Optimal Social Foraging Theory*, as it were, has been highlighted by others (Winterhalder, 1981; Binford, 1986) but this analysis suggests a complex interplay exists between environmental variability, food resource acquisition and social behavioural expression which ensures human populations can survive in the harshest of environments. These social adaptations act as a buffer between the group and the environment: the more variable the environment, the more complex and ingrained the behavioural buffer. This conclusion is reinforced when one looks at the changes currently occurring in contemporary H-G societies regarding the increasing presence of industrialisation encroaching on their habitat and way of life. Westernisation has fundamentally altered the H-G way of life by providing access to guns, boats, cars, trade, housing, farming, alcohol and disease but surprisingly similar social responses to this changing environment are still evidenced, particularly in higher latitude Inuit societies who still use elements of social control behaviour and still share resources within a community (Balikici, 1968; Boone, 1992). Compare this to tropical examples where several H-G societies have adopted pastoralism and given up hunting. If social expressions are indeed a buffer between a group and the environment then those societies with more complex social expressions may be better equipped to cope with Westernisation than others. This is not to say that higher latitude H-G societies are more robust than tropical societies, far from it, merely that groups which experience consistent environmental and resource variability and have adapted complex social responses to counter this variability may find it easier to maintain their way of life in the face of encroaching westernisation (e.g. Inuit and the Ju/'hoansi).

Finally, the recognition of associations between social behaviours and material artefacts is important for another reason: these associations provide a range of material artefacts that can be used as material proxies for non-material behaviours when the analysis is transposed on to the archaeological record of both the Upper and Middle Palaeolithic. Using the ethnographic record we can identify materials and artefacts that can be used as substitutes to reflect certain social behaviours possibly employed by prehistoric H-G populations. Further, as behavioural associations are applied on to a variety of materials we can employ the full range of archaeological evidence when inferring social behavioural expressions, i.e. tools, faunal evidence, environment, symbolic artefacts etc. This potential range of material proxies for non-material behaviours will be of great importance in transposing the model to the archaeological record of both modern human and Neanderthal foragers.

3.6 SUMMARY

The framework employed in this analysis conforms to previous behavioural models which focus on difference aspects of material culture, reinforcing the conclusion that the results gained in this analysis reflect the social behavioural affiliations of contemporary foragers. Analysis has shown that modelling social behavioural expression on environmental productivity is possible, and that the relationship between the two variables is intricate and complex with social expressions acting as a buffer between groups and the environment. The level of this social buffer is dictated by the amount of variability a group is subject to in food resource availability; those societies which experience more variability therefore develop more complex and flexible social systems which allow them to deal with a variety of social and environmental issues.

Finally, the conformity of the analysis to previous anthropological models supports both the use of latitude as a proxy for environmental productivity and the application of the model's findings to the archaeological record on the condition that suitable material proxies for social expressions are employed.

4. APPLYING THE MODEL TO THE UPPER PALEOLITHIC

4.1 INTRODUCTION

Statistical analysis of the anthropological record of contemporary hunter-gatherer societies (Chapter 3) highlights that certain artefacts are directly related to social behaviours which support survival in environments with fluctuating food resource availability. Analysis of these behaviours has shown that as levels of environmental productivity fall there are associated increases in the expression of particular social behaviours. This correlation between specific adaptive behaviours and highly variable environmental productivity lends support to both Dunbar's 'Social Brain Hypothesis' (1993, 2007) and Whiten et al's (1999; 2003) 'Machiavellian Intelligence Hypothesis', particularly those aspects relating to the application of social control and spiritual behaviours to restrict the activities and impact of freeloaders by implementing a series of physical and supernatural punishments that would deter individuals from going against the overall best interests of a specific forager society (Dunbar, 2007: 95). In this context 'freeloaders' refer to individuals who fail to contribute to a society's overall resources but still benefit from the advantages of communal living such as group safety and food sharing to name but two. By reducing the influence of these individuals through a series of punishments imposed by the group onto a freeloading individual, or the threat of supernatural punishment in the afterlife, ensures that valuable food resources are equally distributed throughout a society as a whole (Whiten et al, 1999; 2003: 93-95). The increase of the expression of these behaviours as environmental variability increases, i.e. as latitude increases, supports the conclusions of Dunbar (2007) and Whiten et al (1999) that the development of social complexity is related to environmental productivity and the need by hunter-gatherers to maintain resources at acceptable levels.

The anthropological record provides invaluable data for inferring the process of social evolution in small scale human groups, suggesting that changing climates and limitations in food resource availability are important variables to consider when interpreting the management of past group behaviour. However, the presence of such social control measures within the contemporary ethnographic record is not an *a priori* reason to assume they existed in prehistoric human groups.

Such assumptions on the continuity of social adaptation need to be tested to determine if relationships between environmental productivity and social adaptation did indeed exist in prehistoric H-G's, and how they may have been employed. That testing can be done using the archaeological record. For the purpose of this study, archaeological testing will be restricted to the European record of Oxygen Isotope Stage-3 (OIS-3) that spans the later Neanderthal occupation of Europe and much of the Upper Palaeolithic generally attributed to anatomically modern humans (AMH). The Upper Palaeolithic record provides a suitable testing ground to determine if the behavioural associations of the anthropological model can be transposed onto prehistoric human societies due to three important factors: the environment, which is broadly analogous to contemporary high latitude environmental zones; the quality and abundance of the archaeological record itself, which can be found throughout Europe and yields sufficiently variable artefacts on which to base an anthropological analysis; and, finally, modern humans within this period are overwhelmingly understood to have displayed so-called modern human behaviour. Upper Palaeolithic modern human populations, principally those represented by Aurignacian and Gravettian typologies are thus the best prehistoric analogy for comparing behavioural responses to contemporary hunter-gatherers. Deviations from the anthropological model with regard to predicted behavioural expressions among Upper Palaeolithic populations will provide a measure of how representative the anthropological associations are when transposed onto prehistoric human societies.

4.2 STATISTICAL ANALYSIS

As the aim of this analysis is to determine whether the behavioural associations highlighted within the previously described ethnographic model can be attributed to modern human societies of the Upper Palaeolithic, the statistical methodology employed broadly mirrors that used within the previous ethnographic analysis, with minor changes which shall be detailed below that relate to the observational differences which are in effect when one looks at the archaeological record (primarily material) compared to the ethnographic record (which is both material and non-material).

By mirroring the analysis conducted within previous modelling (i.e PCA, Correlation, Linear Regression) the primary and tertiary goals of this Upper Palaeolithic testing will be addressed: mirroring the previous models methodology will ensure that latitude will remain as an environmental proxy and will determine whether it can be employed in an archaeological context in the same manner as it was employed in an ethnographic one; whilst employing a similar methodology also ensures that the intricate social relationships highlighted within the ethnographic model may (assuming correct interpretation of social behaviours through the archaeological record) be observed within the archaeological one. In both cases, adopting broadly similar methodologies ensures that the two models (both ethnographic and Upper Palaeolithic archaeological) and their results can be directly compared.

4.2.1 Adaptations to the Anthropological Methodology

As with the ethnographic analysis, variables were categorised into several broad categories: food resource acquisition, tools, material symbolism, social control, social cohesion, spiritualism, spatial use and time use. Behavioural variables were assigned to each of the archaeological categories they were judged to be best related to and were then classified according to the strength of their presence (or inferred presence in the case of non-material social behaviours) using an ordinal scale. The ordinal scale employed in the analysis follows a similar scaling as that used within the ethnographic model, with variables scored between (0) and (3) depending upon the intensity of expression inferred from the archaeological record (Table 4.1). As with the ordinal scale used in the ethnographic analysis, increasing values within the scale represent a distinct increase in the expression of behaviours: a score of zero (0) indicates that the archaeological record does not support the presence of a particular behaviour/artefact. Such an ordinal assignment occurs due a lack of archaeological evidence at the site, i.e. the complete absence of bone tools, or the absence of manufactured beads at a site will result in a score of zero (0) for those particular variables. An ordinal score of one (1) represents the limited presence of behaviours as identified through artefacts within the archaeological record, in that the behaviour itself is interpreted to be present but the material evidence the interpretation is based upon is not particularly strong or numerous (e.g. the presence of a cached burial is not in itself strong evidence of ritualistic or social acts but does lend some limited support to the presence of these behaviours (Pettitt, 2011:92). An ordinal score of two (2), archaeologically, represents the same context as an ordinal score of one (1) in that the archaeological evidence supports the presence of a behaviour in a limited fashion. Within this ordinal categorisation, however, ethnographic data have been directly incorporated, resulting in a stronger inference of the presence of behaviours; i.e. the limited presence in the archaeological record of symbolic artefacts would suggest that other, more complex, social situations may have occurred at the site and using ethnographic analogy of these artefacts we can infer a stronger social presence than simply relying upon the archaeological evidence. In essence, each ordinal scale relies upon the presence of ethnographic analogy to infer the presence of behaviours at a site from the archaeological assemblage, but in the instance of ordinal scale two (2) this inference has been stretched to infer the presence of transient behaviours more directly. Finally, an ordinal score of three (3) is indicative that the archaeological assemblage firmly supports the presence of a behaviour, in that the archaeological assemblage is both varied and numerous enough to convincingly conclude a behaviour was conducted at a site.

Due to the different research focus within the fields of archaeology and ethnography, an amendment has been made to the ordinal scale which was employed within the ethnographic model which takes into account those non-material variables that cannot be directly observed within the archaeological record but merely inferred from a combination of ethnographic and archaeological data.

Ordinal classification of the behavioural variables primarily relies upon the identification of artefacts within the archaeological record that act as material proxies for the presence of certain behavioural traits, and the ordinal scale described above reflects the decisions made about the presence/absence of behaviours (see above). For those social behaviours which do not leave material proxies, ethnographic data (specifically the observation of which types of artefacts are used within social occasions) will be used to infer their presence. For example, social cohesive behaviours such as dancing can be very tentatively inferred from the presence of pigments and intricate symbolic artefacts such as beads and figurines as these archaeological artefacts have ethnographic correlations which provide indirect evidence that such materials are used within communal ceremonies which often include dancing (Barnard, 2011: 79; Donald, 2011). Social behaviours which are inferred from both the archaeological and ethnographic record are classified as (2) as mentioned in the descriptions of the ordinal scale above.

The ordinal classification employed within this aspect of the archaeological analysis is therefore broadly analogous in both classification and application to the ordinal scale employed within the ethnographic analysis (see Table 4.1 below).

Ordinal Scale	Description
0	Behaviour is not identifiable within the archaeological record and is considered not present
1	Behaviour is identifiable due to a limited presence of archaeological artefacts supporting its presence
2	Behaviour is identifiable, and the chain of inference from the ethnographic record is stretched to infer the presence of transient behaviours more directly
3	Behaviour is identifiable through the presence of distinct archaeological artefacts and is considered present

Table 4.1. Description of the ordinal scale on the classification of behavioural variables employed within the Upper Palaeolithic dataset.

4.2.2 Upper Palaeolithic Statistical Analysis

Ordinally scaled archaeological variables have been subjected to the same series of statistical analysis as was conducted within the ethnographic model: Principal Component Analysis, Correlation, and Linear Regression.

Principal Component Analysis (PCA) allowed the ‘hard data’ of ordinally scored variables to be reduced into workable components with each interpreted to represent a broad behavioural theme dependent upon the variables included. Efforts have been made to ensure that there were no overlapping variables within different components, to ensure that no one variable was employed in more than one component. This working practice could not be maintained, however, for several of the social variables, notably social control and social cohesion. These two social behaviours are intricately linked to each other, ensuring that they cannot be separated into independent variables; further, the separation of these behaviours from other variables is especially difficult as many social behaviours (both material and non-material) act as forms of control and/or cohesion at the same time. As with the ethnographic analysis, components were accepted if they scored above the .500 threshold KMO score and components were rotated following the Pearson Rotation when two components were identified within a given set of behavioural variables. Identified components follow.

A simple correlation analysis was conducted to determine if there were any underlying relationships between the identified components once the PCA was complete. Correlation would thus help to focus the initial Linear Regression analysis on those behaviours which displayed significant relationships within the correlation matrix.

As with the ethnographic analysis, regression analysis was employed to determine if one component could be employed to predict the appearance of another to help identify the broad relationships which may have existed between different material expressions of behaviours. Following on from the methodology employed within the ethnographic model, a two-tiered Stepwise Linear Regression analysis was performed. Initially, a regression analysis examined the influence of latitudinal location and other proxy markers of environmental productivity (e.g. longitude) to determine if this factor influenced the expression of certain behaviours, in particular those relating to food resource acquisition and social cohesion. Secondly, a regression analysis was conducted between each of the identified component variables to determine the relationships, if any, which may exist between them. This two-tiered round of regression analyses ensures that relationships between environmental productivity-behavioural expression and behavioural expression-behavioural expression were identified. AIC values were employed to determine which models to accept, with AIC scores below .500 not being accepted for further analysis.

The methodology outlined above reflects the changes made in addressing the analysis of social behaviours from the archaeological record whilst maintaining comparability with the methodology used in the development of the ethnographic model. This ensures that artefacts from secure and well excavated archaeological assemblages can be used as interpretative proxies when used in conjunction with ethnographic observations. Finally, as this methodology is broadly the same as that applied to the ethnographic data we can test the viability of applying the modern ethnographic record to that of past hunter-gatherers, in this case those of the Upper Palaeolithic.

4.2.3 Archaeological Considerations

A total of 21 archaeological sites and their assemblages were included within the Gravettian archaeological analysis, and 72 within the Aurignacian analysis. Sites span the known geographical and chronological range of each cultural typology, and represent a variety of occupational events including long-term regional occupations, short-term hunting endeavours and in some instances single visit spiritual ceremonies.

Each site was assessed for its stratigraphic integrity to ensure the association of artefacts with the assemblage, focusing on aspects of the excavation such as length[7], spit levels, sieve quality and size, artefact types and the post-excavation condition of artefacts and dating methodologies employed to determine site age (Trinkaus et al, 2000; Trinkaus et al, 2010; Wojtal, 2005)(Table 4.2). Such assessments are necessary if one is to understand the frequency/representative sample which form the interpretational basis of the behavioural model were recovered in: excavation length will allow for contrast between older and newer projects which employ widely different excavation techniques that will differ in the reliability and efficiency of artefact collection and recording; spit levels, sieve quality and size will yield some indication as to the quality of artefacts which were recovered during the excavation as well as provide details on the length of occupation of each site. Interpretation of the length and type of occupation at each archaeological site has been inferred from the amount and type of artefacts found within each level of the site. The presence of artefacts,

[7] Length is measured in the total number of years/seasons a site was subject to active excavation. Several sites included in the sample were excavated over several periods separated by periods of inactivity. Such periods of activity have not been included when compiling the estimated excavation length of an archaeological site.

especially of different morphologies, within different spit levels would support a conclusion of recurrent occupation; especially if occupation levels are interrupted by levels containing no traces of human occupation. Similarly, if multiple levels contain traces of human occupation without gaps in the record this would suggest that either the site was occupied for a long duration or that there was a high frequency of short term occupations. To distinguish between these two types of occupation events, the interpretation of the human and faunal record (if applicable) will be required to infer what types of activity may have occurred rather than simply rely upon the presence of stone tools and their morphology.

By taking note of these, and other, taphonomic variables one can begin to understand the overall context of the artefacts which form the foundation for subsequent behavioural interpretations. Tables 4.3 list the sites and criteria used to determine if they were suitable for all Upper Palaeolithic analyses. Due to the importance of the information contained within these tables which pertain to the reliability of each site for the subsequent analysis a discussion of the data contained within it is warranted here.

Twelve variables are recorded which collectively can be employed to determine the reliability of the excavation conducted at each site and thus the reliability of the archaeological assemble on which behavioural inferences are based upon. The final column of each table grades the reliability of each site included within this analysis, with higher graded sites being more reliable as a basis for behavioural inference than those which give a lower grade. ‘A’ graded sites are considered reliable for behavioural interpretation based on their archaeological excavation history and methodologies; ‘B’ sites, are suitable for behavioural interpretation but have minor inconsistencies in their excavation history and methods; whilst ‘C’ sites are adequate for behavioural interpretation but have several issues in the quality of their assemblages due to excavation methods and history. It has to be noted that this scale, though broadly ordinal in nature, relies upon the interpretations of the author based upon the taphonomic data of each site and this grading scale is not intended to be a definitive marker of reliability but merely a tool employed to note that some sites employed within this analysis display greater assemblage quality than others.

Taphonomic variables which have been taken into consideration include total excavation period (measured in years), which provides indirect information on the overall quality of the methods employed at the site and where gaps between seasons occur may suggest that the site has been subject to various excavations that could have differed in quality; the number and depth of levels which were actively excavated at each site as well as the total area of excavation that will yield information on spatial controls, with large excavations areas/level depths/sieves providing less resolution than smaller counterparts (Klima 1955, 1969; 1976a, 1976b; Zotz et al, 1955; Bosinski, 1968; Klein, 1973; Riek, 1973; Kozlowski, 1974, 1986; Muller-Beck, 1974; Albrecht et al, 1976; Hahn, 1977, 1978, 2000; Hahn et al, 1977; Otte, 1981; David, 1985; Soffer et al, 1993; Svoboda, 1993; Aldhouse-Green, 2000; Bosinski, 2000; Bowen et al, 2000; Djindjian, 2000; Lowe, 2000; Oliva, 2000a; Oliva, 2000b; Mussi, 2001; Pettitt, 2011).

Further information can be gained by noting the type of excavation which was undertaken at each site, and what the overall focus of each excavation was. By noting the focus of each excavation one determine further insights into the spatial controls employed at each site and also note which areas were given priority during the excavation process itself. Four categories have been used within this analysis: Grid, whereby the entire excavation area followed the standard grid referencing system with each grid reference being systematically excavated; Structure, where the excavation centred upon hearth and/or stone structures with excavations of surrounding areas employing a limited grid reference system in relation to the primary structure; Burial, like structure though centred upon interred human remains rather than hearths; the final category is Accidental and refers to sites which were discovered by accident and excavated over a short period of time. Of these four categories, the grid reference system is most likely to provide a higher degree of spatial resolution and higher quality artefacts than accidental sites whose quality of data will limited. Structural and burial sites will fall between these two categories, with those employing a supported grid reference system of higher quality than those sites which do not. Finally, each site has been assessed as to whether it can provide reliable environmental/faunal/archaeological and dating information for its occupational layers on which to base behavioural interpretations upon. The quality of this archaeological information relies directly upon the quality of the excavations conducted at each site, and compiling these taphonomic variables one can determine how suitable sites are with regard to behavioural interpretation analysis.

4.3 THE GRAVETTIAN

4.3.1 Chronology and Geographic Ranges

The Gravettian is an Upper Palaeolithic culture broadly spanning the period from 30,000 and 20,000 BP (Table 4.1) covering the majority of Eurasia from the western fringes of Iberia, the northern domains of England and Belgium, southern regions of Italy and the Asian interior in Siberia to the East (Davies et al, 2003: 192). Within this expanse there are regions with diverse and well preserved archaeological assemblages that contain numerous artefacts that provide relatively well-dated and excavated behavioural records of the period. There are also those northern ice-covered regions which are devoid of any archaeological evidence of occupation (all of Scandinavia) (Larsson, 2000). The following analysis will focus on those sequences with the highest quality data to ensure a representative sample of Gravettian material culture is incorporated into the test analysis.

Gravettian Stage	Date	Characteristics
Earliest Gravettian	30 – 27 kya	Dominated by burins, backed implements and endscrapers
Evolved Gravettian	27 – 25 kya	Elaborate marginal retouch; increase in microlith production
Upper Gravettian	24 – 20 kya	Leaf points and shouldered points of the Kostenki type dominate
Epigravettian	18 kya	A combination of Gravettian and proto-Magdalenian tool forms

Table 4.2. Technological stages of the Gravettian techno-complex observable via the lithic record (Roebroeks et al, 2000 and references therein).

4.3.2 Archaeological Record – Site Selection Criteria

The Gravettian represents the florescence of cultural elaboration during the Upper Palaeolithic, for it is within this period that we see evidence of cultural unity in forms of hunting technology, faunal exploitation, and the domestic arrangement of sites in comparison to the preceding Aurignacian which saw incoming modern human populations tentatively begin a European colonisation. There is also an increase in symbolic artefact expression not only in the *amount* of artefacts recovered but also in the *representative variation* found in such artefacts. This was the period which saw the first indisputable domestic habitations, more elaborate burials, and networks of raw material transfer which spanned a whole continent (Mussi et al, 2000). Thus the Gravettian has been described as the ‘Golden Age of Hunters’ (Roebroeks et al., 2000; and references therein). Not only is the record bountiful, it is widespread across habitats (Kolstrup, 1995; Follieri et al, 1998; Pettitt, 2000; Svoboda, 2000) which makes it of potential value for assessing behavioural responses to habitat variability through the latitudinal and longitudinal locations of selected Gravettian archaeological sites. The Gravettian represents a sustained cultural expansion which saw *Homo sapiens* become the dominant hominid species within Europe as the last remaining Neanderthal populations were pushed further south-west due to incoming modern human populations (Mellars, 1999; Pettitt, 1999; Davies et al, 2003; d'Errico et al, 2003; O'Connell, 2006; Banks et al, 2008; Fabre et al, 2011; Sorensen, 2011).

A range of inorganic and organic materials were exploited by modern humans during this period. Chert, flint, quartzite and obsidian are the dominant stone materials used to create tool types such as burins, endscrapers and microliths (Klima, 1963; Absolon and Klima, 1977; Svoboda, 1996; Soffer, 2000) in both backed and standard typologies. The type tool for the Gravettian is the Gravette point, also known as the Font Robert point, a backed geometric implement like many found within Gravettian assemblages and most likely employed as a spear point or the tip of a projectile weapon (Kozlowski, 1997). It is not within the scope of this study to review the possible uses of these stone tools, but it seems feasible that with the dual evidence of worked wood from sites such as Dolni Vestonice II and Pavlov I (Klima, 1955; 1990; 1995), and plant fibres employed in the manufacture of cordage as well as basketry and netting (Adovasio et al. 1999; Soffer et al, 2000), Gravettian hunter-gatherers employed a diverse tool kit comprising standard spears as well as more intricate bow and arrow technology (Roebroeks et al, 2000). Though stone was the material of choice for creating tools, it was also employed for non-utilitarian purposes, such as the examples of haematite at the site of Petřkovice which had been worked into the shape of a female figurine (Klima, 1955).

Complementing the stone tool assemblage are a range of organic materials notably ivory, antler, bone and wood employed in various contexts. The role of wood has already been alluded to, but the uses of other organic materials that had far more malleable qualities, including ivory and antler, were ideal for use in multi-component tools which we can observe within the archaeological record. Klima (1963, 1987, 1994) has provided extensive lists of organic materials and their uses, ranging from personal adornments such as pendants to utilitarian objects such as awls, hammers and handles. Though organic components would no doubt have been employed as hunting implements, Klima (1994) has noted that a majority of ivory and bone tools are consistent with them being used for hide and textile work. These latter tools suggest a greater degree of textile work, most likely in the creation of more intricate clothing and basketry, than can be observed in the preceding Aurignacian.

The innovations in food procurement technologies are dwarfed by the innovations in symbolic culture, which indicates an increased amount of social interaction within and between modern human groups of the period (Wobst, 1977; Kuhn at al, 2001; Henshilwwod and Marean, 2003; Houston, 2004; d'Erricco and Vanhaeren, 2007; Kuhn and Stiner, 2007). The archaeological record shows an increased use of iron oxides, particularly in the mixture of certain pigments to create new colours and pigment compounds (Absolon and Klima, 1977). An extensive assessment of the pigments from the settlement of Pavlov I has been conducted by Vandiver (1997) who shows that red iron oxides, often mixed with local loess, and yellow clay based pigments used within these Moravian sites. The use of pigments is not a definitive indicator of symbolic use, as researchers have highlighted other uses for iron oxide pigments ranging from medicinal uses (Cole, 1954, Velo, 1984, 1986), hide working (Mellars, 1996) and other uses not related to symbolic expression (Chase and Dibble, 1987, 1992) . The archaeological record supports the inference, though, that pigment use was increasingly employed for symbolic purposes; whether decorating personal artefacts (Otte, 2003) the human body, or drawing images upon cave walls (Mezzena and Palma di Cesnola, 1976; Mussi, 2001). Further support for this symbolic inference is found in the use of pigments as decoration within Gravettian burials, notably in the large open air Moravian sites such as Dolni Vestonice and Pavlov I (Pettitt, 2011).

The archaeological record also shows numerous artefacts made from fossil shells, marine shells, and animal teeth (Svoboda, 1994, 1997; Soffer, 2000). These artefacts are typically perforated and indicate that they were worn as pendants or necklaces whilst d'Errico and Vanhaeren (2007) highlight the regional differences in the context of beaded objects and their use within communication networks as exchange media and agents of individual expression and group identity. The dominant symbolic image of the Gravettian, however, are the ‘Venus’ figurines. Found throughout Europe, these figurines have been discovered in several forms but all follow a distinct morphological pattern: typically female, enlarged hips and breasts, lack of definition on the hands and feet, and a small head in relation to the overall size of the body (Soffer, 2000). Such conformity in the creation of these symbolic objects suggests a level of social interaction which stretched throughout Europe and linked human groups together through a common theme; either one of fertility, spirituality, or simply stylistic trade of precious items (Gamble, 1982). An alternative approach to explain this conformity has been presented by McDermott (1996), who approaches the creation of artefacts from the perspective of the artist by suggesting that figurines were created by women, with the common stylistic features explained as representing a ‘point of view of self, rather than others’ (McDermott, 1996:231). This interpretation has been heavily critiqued, most notably by Bahn (1986; Bahn and Vertut, 1988), who argues that Palaeolithic figures were most likely carved by both sexes as pregnant women would have been a feature within most kin groups and thus have acted as ‘models’ for anyone so inclined to create an artefact rather than for pregnant women to stand and observe themselves (Bahn, in McDermott 1996).

Though McDermott (1996) provides an interesting take on the creation of such figurines, he approaches the issue from an artist’s perspective and overlooks other more valid reasons as to why such figurines, and their associated stylistic conformity, would have been created and used. Taken together, the archaeological record of modern human groups throughout the Gravettian Upper Palaeolithic shows that they were bound together in an intricate network of symbolic and technological communication.

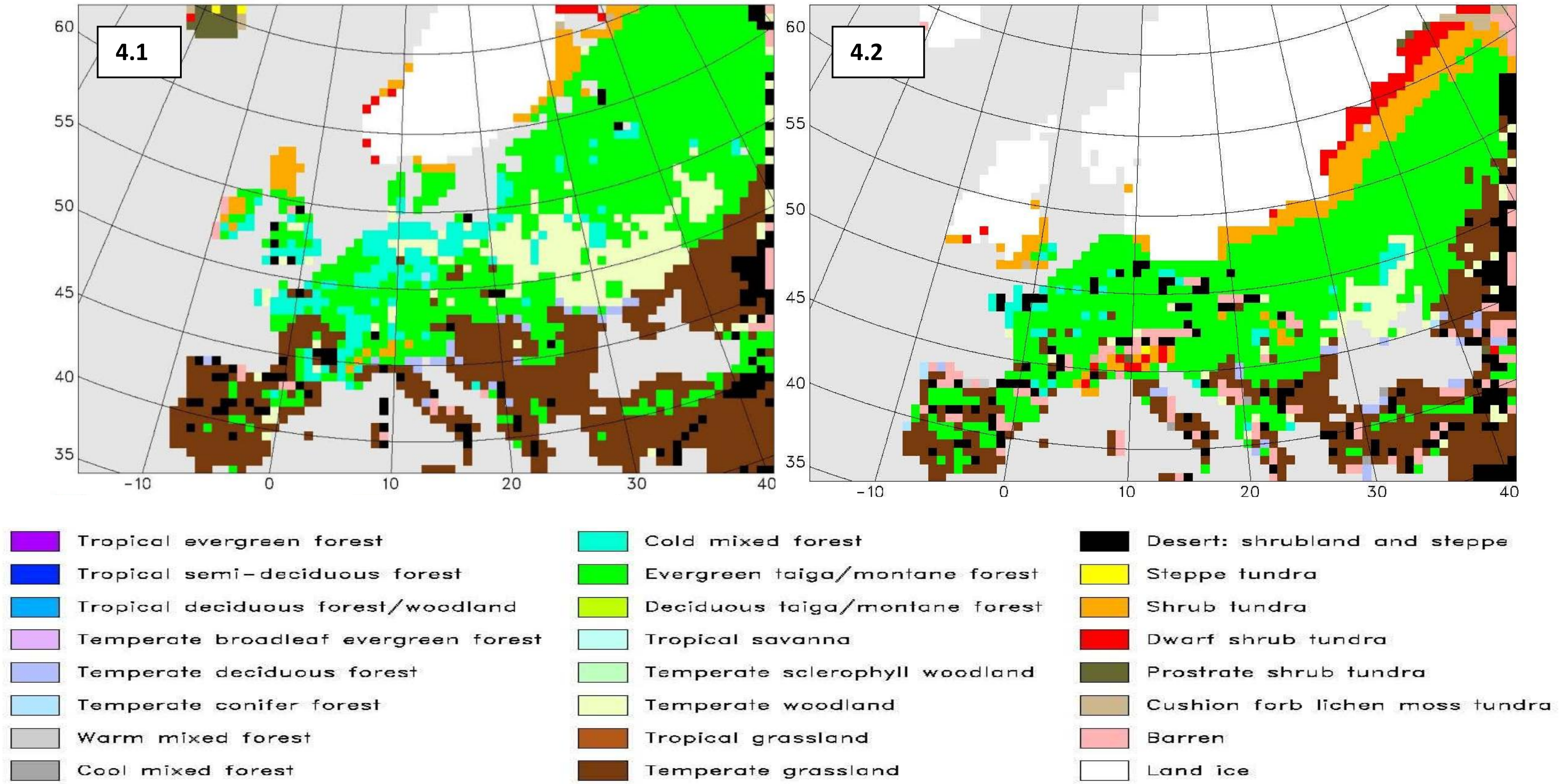

Figure 4.1 (c. 29kya) and 4.2 (c. 21kya). Estimated distribution of habitats/biomes during the Gravettian period c. 29 kya (from van Andel et al, 2003). Though regional changes would have occurred in the thousands of years between these two models, this can be viewed as the broadly available environment experiences by modern human populations during this period.

4.3.3 Environment and Climate during the Gravettian

Van Andel et al. (2003), through their work in the Stage-3 Project, have employed a combination of pollen, faunal, and ice core date to provide reconstructions of the different habitats that modern human groups would have habituated within the Gravettian period. Figures 4.1 and 4.2 highlight the broad environmental conditions which are believed to have been present in Europe during the Gravettian. The predominant biome throughout the Gravettian was the montane forest, which in different regions displays variations in its composition: central regions hosted a cold, mixed forest environment whilst the eastern plain featured areas of temperate woodland (van Andel et al. 2003). Total tree cover was restricted to those mountainous regions (the Alp and Pyrenees in South-Central Europe and the Carpathians in Eastern Europe) of the landscape. As Guthrie and van Kolfschoten (2000) note, the areas directly north of these environments did not display the typically steppic conditions one would associate with climatic downturns of the period. Interspersed within the montane forest are areas which van Andel et al (2003) have classified as barren or featuring shrub tundra. Such areas are geographically located around the Italian Alps. Finally, southern Europe is broadly dominated by temperate grasslands which feature pocketed steppe environments inland; whilst the main feature of northern Europe are the glacial sheets which cover the majority of Scandinavia, the regions preceding the glaciers have been categorised as showing a combination of shrub/dwarf-shrub tundra (van Andel, 2003). Temperatures are believed to have ranged from the mid- to high-teens during the summer months, and considerably colder during the winter downturn (Guthrie and van Kolfschoten, 2000).

Details of Gravettian environmental conditions gained from the various marine and ice core data (GRIP, 1993; Kotilainen and Shackleton, 1995; Chen et al. 1997; van Andel et al, 2003; Davies et al, 2003) show that there were fluctuations in climatic and environmental conditions which would have impacted upon mammalian migrations and as a consequence human behavioural adaptations. Indeed, though there was a marked disparity between the total amount of animal numbers between the northern and southern regions of Europe (with an estimated 10 mammal species within northern regions compared to 33 in southern ones (Markova et al. 1995)), human populations were able to actively forage and hunt in these regions successfully (Torke, 1981; Soffer, 1993; Musil, 1994, 1997, 2003; Djindjian, 2000; Svoboda et al, 2001). These northern regions were milder compared to previous climatic oscillations due a lack of glacial accumulation in the region caused by the Gulf Stream which brought moisture and heat towards the Iberian peninsula rather than Northern Europe, whilst increases in glacial ice mass in both the North Atlantic and Scandinavia reduced overall temperatures, moisture and cloud cover in the Northern and Central European regions (Soffer and Gamble, 1990; Porter and An, 1995). An overall reduction in moisture levels does not fully account for the mild conditions observed within the archaeological record, with Guthrie and von Kolfschoten (2000) and others (Barron et al. 2003) proposing that a series of short and rapid climatic oscillations occurred during this period bringing about rapid ecological downturns followed by rapid upturns (though see Muller et al (2011) on the role precipitation played in hindering the spread of certain habitats into the European interior from the Mediterranean coast). According to Guthrie and von Kolfschoten (2000) such oscillations occurred so frequently that no one habitat dominated the European landscape during the Gravettian Upper Palaeolithic, instead the Montane Forest ecosystem represents those plant species which could survive during the early cold phase of Oxygen Isotope Stage-3 (OIS-3) (Stuiver and Grootes, 2000). The early cold phase of OIS-3 covers the entire Gravettian range (37-27kya)(van Andel et al, 2003) and marks a distinct downturn in environmental conditions compared to the prior transitional phase which gave a greater degree of regional and seasonal variability that human groups would have had to adapt to: with south-western Europe experiencing snowfall for up to 7 months of the year (November to May) in high altitude regions, and temperatures ranging from 7 – 18^{o}C during warm seasons and just below freezing during winter; whilst north-central Europe would have experienced less snowfall compared to higher altitude regions of south-western France, it would have experienced significant decreases in seasonal temperatures with winter lows of -8^{o}C and summer highs of 11^{o}C. Finally, Eastern Europe had summer temperatures comparable to central European regions of 11^{o}C, but with the loss of the warm Atlantic current winter temperatures fell to -12^{o}C[8] with frost persisting until April (Davies et al, 2003).

The climate experienced by Gravettian modern humans was quite variable, experiencing both seasonal and decadal changes, but environmentally quite stable as the rapid onset of climatic oscillations meant the only habitat to thrive was one which could withstand both cold and mild phases.

Though the climatic oscillations observed in the Gravettian resulted in the regional dispersal of various plant and animal species throughout Europe, several species dominated throughout the Gravettian that ensured hunter-gatherer populations had a somewhat consistent backdrop of food resources to fall back on in times of scarcity.

Pollen data sampled from Gravettian layers throughout Europe record four types of plant dominating throughout the continent: (1) caryophyllaceae, representing seasonally available herbaceous plants; (2) poaceae, and inclusive true grass types; (3) cyperacaeae, commonly referred to as sedge; and (4) arboreal pollen, representing various pine, willow and birch tree species (Hahn, 2000).

Based on the pollen record, the Gravettian Upper Palaeolithic appears to be dominated by open grassland environments, dominated by herbs and grasses rather than the typical tundra one may expect of the period. Grüber (1995) concluded that the dominant environment throughout the Gravettian was that of open grassland, with little tree cover,

[8] Temperature values do not include the effects of wind chill and thus true temperatures may have been significantly colder than those stated in winter months.

extending throughout the central regions of Europe. There are two points which make this conclusion hard to accept: the first is that arboreal pollen is not as robust when compared to pollen of grass species, and is prone to degrade faster as a result which would yield disproportionate plant distributions for particular species; secondly, Grüber (1995) concentrates his pollen analysis on central Europe and thus has a limited pollen dataset with which to infer the environment throughout Europe unlike that employed by van Andel et al (2003) which features a greater amount of data from Gravettian layers spanning the entirety of the continental range providing a more representative image of the Gravettian landscape.

Though regional variations to these plant distributions existed within the Gravettian, southern regions being particularly dominated by grasslands rather than forests, the diversity of plants provided by the environment would have been able to support a range of faunal species, ranging from small mammals such as *Lepus sp* to large herding animals such as the woolly mammoth (*Mammuthus primigenius*).

Small mammal species such as the arctic fox (*Alopex lagopus*), red fox (*Vulpes vulpes*) and grey wolf (*Canis lupus*) were actively exploited during the Gravettian (Delpech, 1983; Musil, 1994) along with intermediate sized herding mammals such as *Rangifer tarantus* (Reindeer), *Capra ibex* (Ibex) and *Equus sp*. The larger sized faunal species alive during the Gravettian have no modern analogue in any contemporary environment: bison (*Bison sp*), woolly rhino (*Coelodonta antiquitatis*), and woolly mammoth all dominated the landscape at this time and provided modern human groups with a diversity of mammalian food resources (Churchill et al, 2000).

Archaeological assemblages throughout the period highlight that the majority of these resources were actively exploited, and that hunter-gatherers in different regions exploited different proportions of game or species entirely: the faunal record of Abri Pataud, France is dominated by herd animals such as deer and bison (Bazile et al, 1982; Djindjian, 2000); that of Geissenklösterle, Germany by cave bear, mammoth and horse (Torke, 1981); whilst Pavlov 1 in the Czech Republic features evidence of reindeer and hare exploitation (Musil, 1994, 1997) as well as a large collection of mammoth remains, the active exploitation of which is debateable (Soffer, 1993; Otte, 2003).

Large herbivorous migrations would have presented modern human groups with plenty of opportunities to acquire food, likely resulting in a collaborative nomadic lifestyle geared towards the pursuit of game (Klima, 1963; Churchill, 1993; Soffer, 2000). Such an opportunistic foraging strategy implies that frequent downturns in environmental productivity would have affected population density and distribution, the latter increasing within productive habitats; whilst the former would see a reduction in overall band composition so that local resources were not over exploited. This may not have had that much of an impact on the overall growth on human groups as hunting strategies would have remained relatively constant (Guthrie and van Kolfschoten, 2000) though it is possible that human population numbers would not have been immune to the more intense downturns.

The Gravettian was thus a variable, though highly productive, period of the Upper Pleistocene. Conditions were climatically variable yet environmentally balanced, whilst human populations, already familiar with regional geography, could exploit the native faunal populations. This is in contrast with the succeeding Solutrean which saw many parts of northern Europe covered by glacial ice, and the preceding Aurignacian which saw modern humans colonise an entire continent without prior knowledge of the region. The amount of resources available to modern humans in the period 29 – 21kya, the technological innovations which were developed, and the cultural explosion in symbolic artefacts and behaviours which can be viewed in the archaeological record confirm that this was truly a ‘Golden Age’ for hunter-gatherers.

Successful testing of the anthropological model relies on the completion of three analytical goals which need to be addressed prior to the application of the model onto Neanderthal populations of the Middle Palaeolithic:

- First, the analysis needs to determine if the ethnographic relationships relating to food resource acquisition and social behaviours can be identified in the archaeological record of the Gravettian. This analysis will determine if the proxy for environmental productivity employed within the ethnographic analysis, latitude, is a suitable proxy to employ within an archaeological context;
- Secondly, the large amounts of behavioural evidence employed within the ethnographic analyses rely upon the observations of social behaviours which do not leave archaeological traces. Therefore, material proxies within the archaeological record need to be identified which can be used to interpret the presence of defined social behaviours;
- Finally, with the use of behavioural proxies identified through the archaeological record analysis will focus on testing the association between social cohesive, social control, and spiritual behaviours identified within the anthropological analysis of contemporary hunter-gatherer societies against the archaeological data.

4.3.4 Sites

The Gravettian analysis features data from 21 archaeological sites and layers throughout the known Gravettian period. Following the taphonomic guidelines described above (Chapter 3, Section 3.2.3), Table 5.4 notes the 21 sites used within this section of the Upper Palaeolithic analysis, and the grading awarded to each assemblage according to the interpretations of the author. Figure 4.3 notes the geographical distribution of Gravettian sites employed in this analysis.

Site	Excav. Length (Yr)	Enviro. Info	Faunal Record	Tools	Symbolism	Dating	Site Preservation	Excavation Technique	Area (m^2)	No. Level(s)	Depth (cm)	Sieve (mm)	Site Ranking
Abri Pataud	6	✓	✓	✓	✓	C14	Cave	Grid	≤85	1	60	10	A
Avdeevo	50+*	✓	✓	✓	✓	C14	Open	Grid	800	1	30	10^{+}	B
Bockstein Torle	3	✓	-	✓	✓	C14	Open	Grid	-	3	≤50	-	C
Brno II	3	✓	✓	✓	✓	C14	Open	Accident	2	1	≥50	-	B
Dolni Vestonice	50+*	✓	✓	✓	✓	TL	Open	Structures	≥866	2	≥50	5^{+}	A
Geissenklosterle	7	✓	✓	✓	✓	C14	Cave	Grid	48	6	5	10	A
Hohle Fels	5*	✓	✓	✓	✓	C14	Cave	Grid	6000	2	≤50	5^{+}	B
Kostenki II	40+*	✓	✓	✓	✓	C14	Open	Grid	525	5	≤50	10^{+}	A
Molodova V	15+*	✓	✓	✓	✓	C14	Open	Grid	298	4	≤35	10^{+}	A
Paglicci	20+*	✓	✓	✓	✓	C14	Cave	Grid	15	5	≤90	-	B
Paviland Cave	100+*	✓	✓	-	✓	C14	Cave	Burial	132	1	≤100	5^{+}	B
Pavlov I	7	✓	✓	✓	✓	TL	Open	Grid	28	2	≥40	10	A
Petrokovice	15	✓	✓	✓	✓	C14	Open	Structures	-	1	40	-	C
Predmosti	100+*	✓	✓	✓	✓	C14	Open	Grid	-	2	≤100	10^{+}	B
Spadzista	6	✓	✓	✓	✓	C14	Open	Grid	≥24	4	≤30	-	B
Sunghir	16*	✓	✓	✓	✓	C14	Open	Burials	4500	-	≥50	10^{+}	B
Weinberghohlen	9	✓	✓	✓	✓	C14	Cave	Grid	≤20	2	≤50	10	A
Willendorf II	3	✓	✓	✓	✓	C14	Open	Grid	≥28	5	≤100	10	A
Grimaldi Caves	20+*	✓	✓	✓	✓	C14	Cave	Grid	≤600	≤5	≤40	10^{+}	B
Grotta La Cala	15+*	✓	✓	✓	✓	C14	Cave	Grid	≥50	1	≤70	10^{+}	B
Mezhirich	5+	✓	✓	✓	✓	C14	Open	Structures	≥65	1	≤100	-	B

Table 4.3. Individual assessments of each of the sites included within the Gravettian Upper Palaeolithic archaeological analysis to determine their suitability for this particular analysis. Factors relevant to this analysis relate not only to the quality of the excavation (length, sieve, technique) but also whether sites have the available environmental and symbolic associations within their assemblages. Variables marked '*' represent sites which have undergone multiple excavations, '+' indicate that sieving size and application may have been variable, '-' represent variables where information was unobtainable or not recorded (Klima 1955, 1969; 1976a, 1976b; Zotz et al, 1955; Bosinski, 1968; Klein, 1973; Riek, 1973; Kozlowski, 1974, 1986; Muller-Beck, 1974; Albrecht et al, 1976; Hahn, 1977, 1978, 2000; Hahn et al, 1977; Otte, 1981; David, 1985; Soffer et al, 1993; Svoboda, 1993; Aldhouse-Green, 2000; Bordes, 2002; 2006; Bordes, and Labrot, 1967; Bosinski, 2000; Bowen et al, 2000; Djindjian, 2000; Lowe, 2000; Olivia, 2000; Mussi, 2001; Pettitt, 2011)

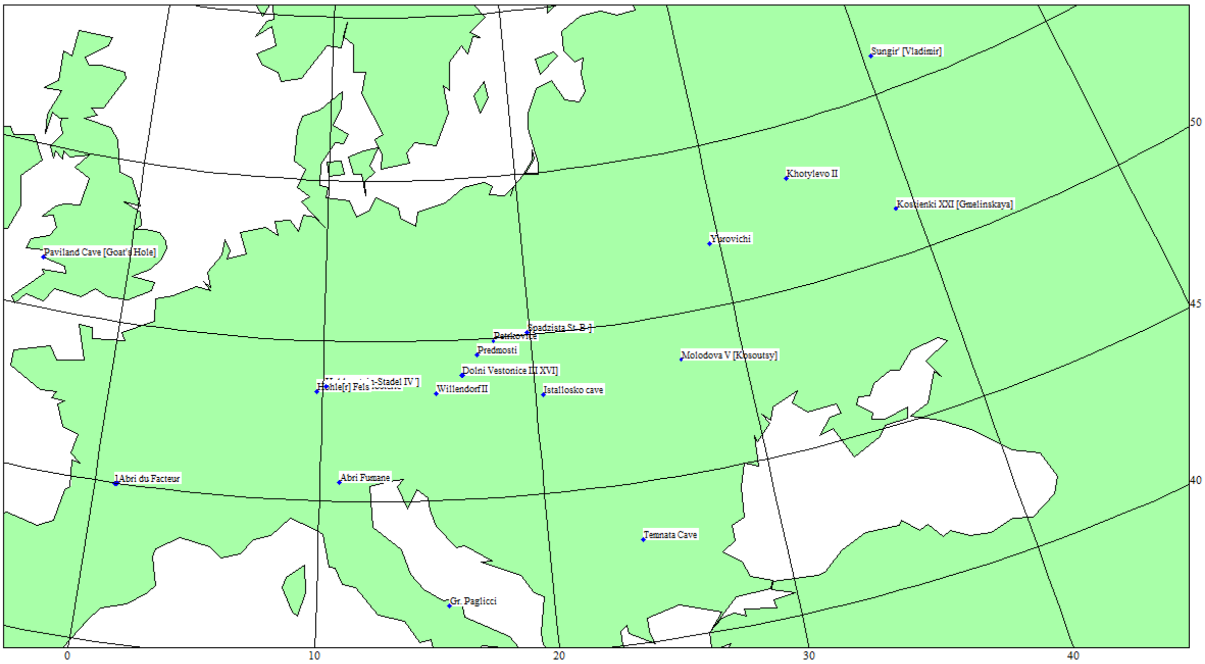

Figure 4.3. Gravettian Site distributions employed within this archaeological analysis.

4.3.5 Behavioural Predictions

The ethnographic model allows for the prediction of behavioural expressions based upon the environment where societies reside. Using this principle, it is possible to make predictions as to the level of behavioural expression within the Gravettian sites employed within this analysis. This predictive stage allows one to compare the accuracy of the ethnographic/latitudinal model when applied to the archaeological record, and will thus highlight whether such a model is suitable to be used in predicting the behaviours of earlier prehistoric human populations of OIS-3.

As noted above, the dominant environment throughout the Gravettian consisted of an evergreen taiga forest throughout Europe with regional variations found within northern and southern European latitudes. Northern areas, such as non-glaciated areas of England and Russia, featured shrub tundra whilst southern areas, for example Iberia and Italy, offered increasingly larger areas of temperate grassland (Van Andel et al, 2003). Europe during the Gravettian is broadly comparable to contemporary sub-arctic/higher latitude temperate environments: seasonally and climatically variable, yet environmentally stable, and able to support a variety of faunal life throughout the year (Soffer, 1993; Djindjian, 2000; Musil, 1994, 1997; Mussi, 2001).

The ethnographic model stipulates that human societies who reside in such environments should display a range of material and non-material behaviours, including a tool kit adapted to acquire a range of terrestrial and aquatic food resources, the use of social behaviours such as rites of initiation to create group cohesion and reinforce societal rules, and the creation of stylistic objects to be used as personal decoration or exchange. Brief outlines of the behavioural predictions for modern human populations in the Gravettian are presented in Table 4.4. As noted above, there are marked environmental changes within the higher (>55^{o}N) and lower (<45^{o}N) European latitudes, and as a result human groups residing within these areas may express different behaviours than those groups who reside within the broadly established Gravettian environments described above.

- **Prediction One.** *Gravettian groups who hunt and reside in the lower European latitudes (<45^{o}N) should display a reduction in their behavioural expressions in the realms of social cohesion, social control, and spiritual expression compared to groups who primarily hunt and reside within higher latitudes (Chapter 4, Section 2).*

Specifically, groups who reside in this band should have fewer material proxies for their social expressions and produce less stylistic artefacts reflective of a less variable climate and environment and a reduction in the need for populations to band together and share resources. As an aside, Roscoe (2004) has highlighted how hunter-gatherers who reside near coastal areas have a more complex tool kit than those who reside further in land due to their exploitation of marine resources. The behavioural predictions here refer to sites below 45^{o}N within the archaeological data, specifically the Italian sites of Grotta Paglicci, Riparo Mochi and the Grimaldi Caves which are within several kilometres of the coast. As a result, the tool kits of these assemblages are predicted to have a higher degree of variability within them compared to more centrally located populations situated below 45^{o}N.

- **Prediction Two.** *Gravettian groups who hunt and reside in the mid-European latitudes (45^{o}-55^{o}N) should display a more variable material record, with a greater production and variability within stylistic artefacts and an increase in material proxies reflecting a greater adoption of social behaviours within these populations.*

As predicted by the ethnographic model, this region should be more seasonally variable than those lower latitudinal regions, as a result there should be increases in the expressions of social cohesive behaviours and stylistic artefacts reflecting a greater need to maintain relationships and cooperative links between populations during seasonal downturns of greater variability than lower latitudes. Hunter-Gatherers who reside and hunt in this region should display a less variable tool kit according to the ethnographic model and the conclusions of Roscoe (2004), as resources (particularly animal) would have been less variable than those in lower latitudes who would have exploited both terrestrial and aquatic food resources whilst groups within this mid-latitudinal range would have solely exploited terrestrial food resources. Material and non-material predications for this range apply to the majority of archaeological sites.

- **Prediction Three.** *Gravettian groups who reside and hunt in higher European latitudes (i.e >55^{o}N), are predicted to employ a greater degree of stylistic artefacts, in both their representation and variability, display a complex and variable tool kit for the acquisition of variable terrestrial food resources, employ a sophisticated array of non-material behaviours that reinforce social bonds between individuals and groups and also feature more distinct spiritual behaviours than populations who reside within lower latitudes*

Evidence of social cohesion, social control and spiritual expression should be observable in the forms of proxies including increases in the variety and amount of symbolic materials; an increasingly animal focus to their nature, possibly reflective of the predominantly hunted animals. There will be a reduction in the expression of more typical material behavioural traits, including food resource acquisition and tool creation, as these sites are predicted to have a spiritual focus above other behavioural activities. These behavioural predications are applicable to the sites of Paviland Cave, Brno II and Sunghir.

Those behavioural categories whose predictions differ from the sub-arctic/high temperate behavioural predictions made by the ethnographic model have been highlighted within Table 5.5.

Behavioural Category	Expression as stipulated by Ethnographic Model
Food Resource Acquisition	▪ Hunting dominate ▪ Gathering supportive ▪ Fishing (if near suitable resource) ▪ Terrestrial herd animals dominant ▪ Small game support diet ▪ Underground Storage Organs dominant gathered materials
Tool Technology and Materials	▪ Dominance of Lithics ▪ Organic materials used ▪ Composite tools common ▪ Traps used for small game ▪ Bone/Ivory tools employed for specific tasks related to social occasions
Social Cohesive Behaviours*	▪ Ceremonies/Rituals common[1] (dancing, storytelling etc) ▪ Use of colour pigment in ceremonies ▪ Personal ornaments (beads, teeth)
Social Control Behaviours*	▪ Taboos in place ▪ Ritual violence ▪ Rite of Passage ceremonies[1] (male/female) ▪ Unique ornaments present ▪ Burials, with/without grave goods[2]
Spiritual Expression*	▪ Control mechanisms, inc. ritualised behaviour[1] ▪ Reflective of predominant faunal species ▪ Burials, inc. grave goods[2] ▪ Non-utilitarian tools reflective of shamanism
Symbolic Material Expression	▪ Use of pigments ▪ Linked to dominant faunal species ▪ Organic features incorporated (feathers etc) ▪ Unique output/styles within different regions

Table 4.4. Modern human behavioural predictions within the Gravettian based upon the sub-arctic/higher temperate analogies from the ethnographic model. Categories marked with (*) indicate some disparity within different geographical regions of Europe during the Gravettian. [1]: selected variables are co-dependent, each sharing a common repetitive element which links the variables together; [2]: burials serve a dual function in reinforcing both social control and cohesion within a society, with greater ritualistic bearing if grave goods are present within the burial area

4.4 RESULTS

Presented below are the analytical results of the social behavioural analysis of the Gravettian archaeological record, employing the statistical methodology described above on the compiled ordinal dataset featuring archaeological and inferred social behaviours from 21 Gravettian archaeological sites.

The original behavioural dataset of 41 distinct archaeological and inferred behavioural variables from 21 archaeological sites were reduced into 8 defined analytical components to ensure a comparable statistical process to that used in forming the ethnographic model during the later regression analyses. The eight recognised components are described below, including their associated variables descriptions and classifications of which can be found in Appenidx #2 and the Supplementary Disc respectively.

4.4.1 Food Resource Acquisition

Analysis began with the reduction of those variables which related to food resource acquisition into one analytical component variable. Table 4.5 lists those variables which were included within the variable, seven in total, which account for 65.22% of the explained variance within this component. The KMO score for this component was above the minimum required threshold at .680, and as all included variables relate to acquisition and processing of food materials it has been labelled ‘Food Resource Acquisition’.

Component Lane	Inclusive Variables	% Variance Explained	Factor Scores	KMO Score
Food Resource Acquisition	Hunting_Group	65.22	.892	.680
	Hunting_Individual		.902	
	Gathering_Plant		.709	
	Hunting_Terrestrial_Herd		.862	
	Hunting_Terrestrial_Single		.684	
	Domestic_Use		.753	
	Hunting_Time		.821	

Table 4.5. Component, and inclusive variables, believed to collectively represent food resource acquisition behaviours as inferred from the archaeological assemblages of the Gravettian period.

Following from the identification of other behavioural components, the Food Resource Acquisition behavioural component was placed within a series of Linear Regression analyses to determine if the expression of this component was influenced by environmental productivity, represented by the proxy of latitude. No significant results were found in this analysis, suggesting that latitude does not have a significant influence upon this behavioural component and that hunting and gathering are adopted regardless of environmental variation within the context of the Gravettian. This contradicts the predications of the ethnographic model, a conclusion to be drawn from this analysis is that latitude is not a suitable variable to measure environmental productivity within the context of the Gravettian.

Further to this, in a subsequent regression analysis, none of the other behavioural components recognised through PCA was shown to have a significant influence upon the intensity of food resource acquisition expression. However, as is noted below, the Food Resource Acquisition component does play an influence in the expression of other behavioural variables.

4.4.2 Tool Technology and Materials

As with the ethnographic analysis, tool technologies and materials were the focus of the second series of PCA. One component consisted of two variables related to the construction of tool kits (Table 4.6). The identified component has a KMO score of .500, and is recognised as one of the weakest components identified within this analysis along with the Site Return component (see below). As a result of this weak, though acceptable, KMO score behavioural relationships highlighted through this component must be regarded as tenuous.

Component Lane	Inclusive Variables	% Variance Explained	Factor Scores	KMO Score
Tools	Organic	92.35	.961	.500
	Composite		.961	

Table 4.6. Component, and associated variables, believed to represent influences upon the creation of tool kits by modern humans during the Gravettian.

As with the previous analysis, the Tool component displayed no significant relationship with the proxy variables of latitude or longitude, again suggesting that such variables provide insufficient range to act as a proxy for environmental productivity within the Gravettian.

4.4.3 Social Cohesion

Tables 4.7 and 4.8 describe the recognised components and their associated variables which are believed to represent elements of Social Cohesive behaviour. Table 4.8 with a KMO score of .614 and compromising material variables which have been inferred from the ethnographic record, has been labelled ‘Social Cohesive Artefacts’; Table 4.8 comprises non-material behaviours inferred from the archaeological record at archaeological sites, to be present. Labelled ‘Social Cohesive Behaviours’ the component features a KMO score of .722.

Component Lane	Inclusive Variables	% Variance Explained	Factor Scores	KMO Score
Social Cohesive Artefacts	Burials_GraveGoods	58.75	.741	.614
	Beads_Shells		.718	
	Beads_Pendants		.836	

Table 4.7. Component and associated variables labelled Social Cohesive Artefacts as inferred from both the archaeological and ethnographic records.

Component Lane	Inclusive Variables	% Variance Explained	Factor Scores	KMO Score
Social Cohesive Behaviours	Ceremonies	65.48	.805	.722
	Hearth_Arrangements		.642	
	Networks_Communication		893	
	Social_Cohesion		.872	

Table 4.8. Component and associated variables labelled Social Cohesive Behaviours as inferred from both the archaeological and ethnographic records.

Tables 4.7 and 4.8 highlight those component variables which display significant influences on the uses of social cohesive artefacts and behaviours. Table 4.9 shows that two variable components influence the expression/construction of social cohesive artefacts: Social

Cohesive Behaviour (T: 5.009; P: <.001), where the model suggests that as social cohesive behaviours increase, so too does the manufacture of related artefacts. Thus, artefacts which can be inferred to represent elements of social cohesion represent an established system of social cohesive behaviours which are otherwise invisible in the archaeological record. Further, the model also states that increasing latitude (T: -3.006; P: <.001) has a small negative influence upon the material expression of social cohesion. Higher latitudes typically offer fewer, but at times seasonally abundant, resources that have been noted above and also experienced sharp downturns in environmental productivity within the Gravettian the further north one ventured. In such intervals resources would become more limited, and the primary role of hunter-gatherers may have been the production of tools rather than the production of symbolic objects.

Model	Factors	d.f.	Std. Coefficient	T	P	Adj. R^2	Excluded Variables
Social Cohesive Artefacts	Social Cohesive Behaviour	14	.827	5.009	<.001	.611	Social Cohesive Behaviours, Spiritual Social Control, Food Resource Acquisition, Return to Site, Symbolic Artefacts, Tools
	Latitude		-.496	-3.006			

Table 4.9. Models and associated components predicting Social Cohesive Artefact expression within human groups of the Gravettian.

Table 4.10 presents variables which can be used to predict the presence of social cohesive behavioural expression, with two components identified of statistical significance: Social Control Behaviours (T:4.065; P: <.001) and Symbolic Artefacts (T:4.133; P: <.001). The model predicts that increases in the expression of both these variables will result in increases in the expression of social cohesive behaviours. The presence of social control behaviours should not be a surprise, as the ethnographic model has previously highlighted that cohesion and control behaviours are linked and the presence of symbolic artefacts can be attributed to the unique stylistic artefacts which contribute to the establishment of group identity, thereby providing a mode of social cohesion which would be of benefit during times of resource instability.

Model	Factors	d.f.	Std. Coefficient	T	P	Adj. R^2	Excluded Variables
Social Cohesive Behaviours	Social Control Behaviours	14	.511	4.065	<.001	.850	Latitude, Food Resource Acquisition, Return to Site, Tools, Social Cohesive Artefacts, Spiritual Social Control
	Symbolic Artefacts		.519	4.133			

Table 4.10. Model and associated components predicting the expression of Social Cohesive Behaviours.

4.4.4 Social Control

Following from the analysis of social cohesive behaviours, Table 4.11 lists those behavioural variables which together form the component ‘Social Control’. Six variables were included within the component, accounting for 78.59% of the variance within this grouping and features a KMO score of .736.

Component Lane	Inclusive Variables	% Variance Explained	Factor Scores	KMO Score
Social Control	Social Taboos	78.59	.822	.736
	Burials_Adult		.917	
	Shamanism		.888	
	Spiritual_Time		.938	
	Spiritual_Use		.959	
	Social_Control		.781	

Table 4.11. Component, and associated behavioural variables, believed to represent the expression of Social Control.

A linear regression analysis determined that four factors influence the expression of social control behaviours. The function of linear regression within this analysis is to determine if a particular component can be employed as a predictor for another analytical component, with the analysis providing details on how significant a predicator a component is compared to other components. As mentioned within the methodology, analytical components are composed of individual variables which display a common link. Results of the key components predicting for the expression for ‘Social Control’ are outlined below (Table 4.12), with the most significant predictors presented first.

Social cohesive behaviour (T: 6.017; P:<.001); Food Resource Acquisition (T: -3.985; P: <.001); Social Cohesive Artefacts (P: 4.583; P: <.001); and Latitude (T: 2.252; P: <.001) are the four predictor components for the ‘Social Control’ variable. The model stipulates that increases in the expression of social *cohesive* behaviours (in both non-material and material forms) will bring about corresponding increases in the expression of social *control* behaviours, mirroring similar behavioural predictions highlighted in the ethnographic model. In essence, this analysis predicts that those behaviours which aid in the expression of social cohesion (storytelling, ceremonies etc) develop into expressions of social control, for example taboos.

The model also predicts that latitude has a positive influence upon the expression of social control behaviours; thus, when latitudinal location increases, so too does the expression of social control behaviours within modern human groups of the Gravettian. The relationship identified between social cohesion and social control here mirrors that which has previously been identified between these two variables within the ethnographic model.

Model	Factors	d.f.	Std. Coefficient	T	P	Adj. R^2	Excluded Variables
Social Control	Social Cohesive Behaviours	12	.551	6.017	<.001	.918	Spiritual Social Control, Return to Site, Symbolic Artefacts, Tools
	Food Resource Acquisition		-.290	-3.895			
	Social Cohesive Artefacts		.415	4.583			
	Latitude		.193	2.252			

Table 4.12. Components, with significant influences upon the expression of social control behaviours in the Gravettian.

The final influential variable, Food Resource Acquisition, displays a negative relationship with the social control component. Therefore, any increases in the diversity of food resource acquisition behaviours results in a decrease in the expression of social control behaviours. Therefore, social controls are employed as methods to restrict the access to limited resources, in this instance food, to ensure that resources are maintained for as long a duration as possible (Boehm, 1999, 2004; Barnard, 2011: 74-78; Morley, 2011).

Further, the social control component also significantly influences the expression of both spiritual and social cohesion behaviours.

More than any other component or variable within this analysis, the social control behaviours and their relationships mirror those observed within the ethnographic record (Chapter 3, Section 3.4.3 and 3.4.4).

4.4.5 Spiritual Expression

Following from the social control analysis, focus was turned to the potential expression of spiritualism within Gravettian populations. Table 4.13 highlights the identified component and its associated variables which are believed to represent spiritual expression. The component features four behavioural variables inferred from the archaeological record, with the aid of the ethnographic data, and features a KMO score of .758.

Component Lane	Inclusive Variables	% Variance Explained	Factor Scores	KMO Score
Spiritual Expression	Shamanism	78.27	.822	.758
	Animal_Focus		.917	
	Pigment_Use_Specific		.959	
	Social_Control		.781	

Table 4.13. Identified component and associated variables labelled as representing the expression of spiritualism the Gravettian.

Linear Regression highlighted two variables which reflected the expression of spiritual expression (Table 4.14): Symbolic Artefacts (T: 6.151: P: <.001) and Social Control Behaviours (T: 3.647; P: <.001). Thus, as the variation and amount of symbolic artefacts increases, and the presence of social control behaviours increases, there will be a corresponding increase in spiritual behaviours. Two inferences can be made from this analysis: the first, that spiritual expression is a form of social control reliant upon a series of rules and material objects that used to reinforce certain cultural rules within a population to reduce the affect of freeloading individuals (Dunbar, 2007); and second, that symbolic material artefacts within archaeological assemblages can be employed as evidence for the presence of spiritualism at an archaeological site. The latter is dependant on the number and variety of such artefacts present. Further, spiritual control also significantly influences the expression of material symbolic artefacts (see below).

Model	Factors	d.f.	Std. Coefficient	T	P	Adj. R^2	Excluded Variables
Spiritual Control	Symbolic Artefacts	14	.656	6.151	<.001	.892	Latitude, Food Resource Acquisition, Return to Site, Tools, Social Cohesive Artefacts, Social Cohesive Behaviours
	Social Control Behaviours		.389	3.647			

Table 4.14 Behavioural model showing the variable influences upon the expression of spiritualism within the Gravettian Upper Palaeolithic.

4.4.6 Symbolic Material Artefacts

The final round of analysis conducted, in line with the ethnographic model, related to the use of material symbolic artefacts. One component (Table 4.15) was identified, featuring one behavioural variable and displaying a KMO score of .748.

Component Lane	Inclusive Variables	% Variance Explained	Factor Scores	KMO Score
Symbolic Artefacts	Pigment_Use_Broad	67.42	.880	.748
	Pigment_Use_Specific		.885	
	Ornamentation_Animal		.675	
	Ornamentation_Human		.826	

Table 4.15. Recognised component and inclusive variables believed to represent influences upon the creation and variety within material symbolic artefacts.

Linear Regression highlighted that one behavioural variable (Table 4.16) displayed a significant influence upon the expression of this component: Spiritual Social Control (T: 8.153; P <.001). According to the archaeological model, increases in the intensity of spiritual expression within a population will result in a corresponding increase in the amount and variety of symbolic artefacts produced. This relationship mirrors the ethnographic model, and as such highlights artefacts may be representative of features (i.e. animals, individuals, etc) who are spiritually important to the population in question. Further, as shown above, the symbolic artefact components also significantly influence the expression of both spiritual control and social cohesion behaviours (Tables 4.13 and 4.14).

Model	Factors	d.f.	Std. Coefficient	T	P	Adj. R^2	Excluded Variables
Symbolic Artefacts	Spiritual Social Control	15	.903	8.153	<.001	.804	Tools, Social Cohesive Artefacts, Social Cohesive Behaviours, Social Control Behaviours, Latitude, Food Resource Acquisition, Return to Site

Table 4.16. Archaeological model showing possible behavioural influences from archaeological materials of the Gravettian.

4.5. DISCUSSION

There were three analytical goals to this archaeological analysis: to determine whether latitude can be employed as a proxy for environmental productivity in the analysis of archaeological assemblages; to infer non-material social behaviours from the material archaeological record; and finally, to determine if the behavioural associations identified within the ethnographic model could be identified within prehistoric modern human populations.

As to the first goal, statistical analysis showed only a limited latitudinal influence in terms of behavioural patterns. In the ethnographic model, latitude is a key driver of a range of behaviours, primarily influencing how contemporary hunter-gatherer societies acquired food resources which in turn influenced the expression of other material and non-material behaviours.

This relationship was not seen in the archaeological analysis, where latitude is observable as only a secondary influence upon social cohesive artefact variation and social control behavioural expression. Further, the Gravettian record features more elaborate burials and grave goods (Pettitt, 2011: 142); inferred evidence of shamanic and spiritual behaviours (d'Errico 2011); the increased use of ochre and other forms of pigments (Lewis-Williams, 2011); and unique symbolic artefacts (Iakovleva, 2000; Lewis-Williams, 2011) providing material confirmation of the behavioural model's cohesive, control and spiritual predictions the expressions of which cannot be attributed to latitudinal and habitat stress as highlighted by the ethnographic model. Instead, the archaeological model stipulates that the key driver of social and symbolic expressions in Gravettian hunter-gatherer populations was the choice of food resource acquisition adopted by individual populations, specifically the pursuit of herd animals such as horse and reindeers, which required the development of cooperative and cohesive behaviours if the acquisition of game were to be successful. The development of these behaviours, in the form of cooperative hunting and material symbolic forms such as beads, would have helped to facilitate cooperative integration between individuals that would ultimately helped the acquisition of game by highlighting social and kin relationships. Though the behavioural analysis suggests that food resource acquisition rather than environmental variability (latitude) is the key driver for Gravettian behavioural expression it has to be noted that the presence of different game species changes depending on latitudinal location and it is feasible that environmental productivity still has an influence on Gravettian behavioural expressions (see below); especially when it comes to the gathering of plant, vegetable and fruit resources which may be seasonally variable.

It is surprising that latitude did not emerge as an influential variable considering the quality of research which has already been conducted on the issue, that have highlighted links between latitude and the acquisition of food resources (Oswalt, 1976; Hayden, 1986; Roscoe, 2002, 2003). The results presented above suggest that latitude is not the primary variable of influence, but merely a secondary influence within prehistoric populations on certain behavioural expressions whilst on other behaviours (i.e. food resource acquisition) latitude seems to play no influence whatsoever. It is unlikely though that these results reflect the true impact of latitudinal influence on Gravettian hunter-gatherer behaviour.

The latitudinal range employed within this analysis is limited compared to the range employed within the ethnographic model, the latter consisting of a range from the equator to

60^{o}N whilst the former mainly falls between the latitudes of 40^{O}N to 50^{O}N. The latitudinal range for this analysis, therefore, is not as extensive as that employed in the ethnographic model described above (or any previous ethnographic modelling featuring latitudinal proxies for that matter, e.g. Binford (2001)). This reduction in latitudinal range will inevitably result in a loss of sensitivity within the model and give the impression that latitude is not as influential as it may in fact be.

The restriction in latitudinal range is not primarily caused by the site choices within this analysis (though twenty-one assemblages is a mere fraction of the total Gravettian assemblages within the archaeological record), but rather by the site location choices of the Gravettian populations themselves as they restricted their movements to specific latitudinal and environmental contexts (Figure 4.3), including favouring specific altitudes for their sites. This conformity of Gravettian site choice reduces the variability of an analytical factor that may influence the impact of this model which relies of latitude as a proxy for environmental variation. As Figure 4.1 shows, the dominant environment during the Gravettian period was the evergreen taiga, which would have provided sufficient resources for humans to exploit and thrive (Guthrie and van Kolfschoten, 2000; Hahn, 2000; Stewart et al, 2003). This environment spans the entire European continent from east to west, but only covers a comparatively small geographical strip which does not include parts of Iberia, the Italian Peninsula, or regions above 45^{O}N. This restricted region therefore would have been entirely suitable for modern human hunting groups; so productive in fact that groups may have remained within this productive area rather than migrate to other regions and suffer a reduction in resources. Apart from six archaeological sites (Paviland Cave, Sunghir, Brno II, Grotta Paglicci, Riparo Mochi, and the Grimaldi Caves), all sites employed within this analysis can be found within this narrow environmental band (Figure 4.4 a,b,c,d).

With such a restricted habitat range throughout the Gravettian, latitude may not represent a reliable proxy especially when such a limited habitat band is being compared against a model based upon an extensive latitudinal range. Such issues need to be kept in mind by social anthropologists who aim to transpose anthropological theories onto the archaeological record.

Secondly, this analysis demonstrates that certain archaeological artefacts can be employed as proxies for behaviours that leave no material trace. Employing the ethnographic record, one can observe the social contexts of artefact use. Thus, one can identify the types of objects which are employed solely during symbolic and social events, distinctions that are not observable within the archaeological record.

In short, analogues must encompass a range of behaviours to maximise potential application. This increases the likelihood that artefacts within the archaeological record can be identified and interpreted in terms of the likely social context of use. Such multipurpose artefacts in the ethnographic record can include forms of personal ornamentation, which can represent items of decoration and can be employed within various social/spiritual contexts (Pearson, 1999), whilst unique artefacts featuring either human or animal representations may reflect elements of social cohesion and control. Also employed as analogues are those materials and artefacts which have previously been recognised by archaeologists as representing forms of symbolic expression: such as the use of colour pigments (Ambrose, 1998; McBreaty and Brooks, 2000); the inclusion of grave goods in burials (Pearson, 1999; McBrearty and Brooks, 2000); and hearth arrangements within sites (Klein, 1999; Binford, 1986, 2001).

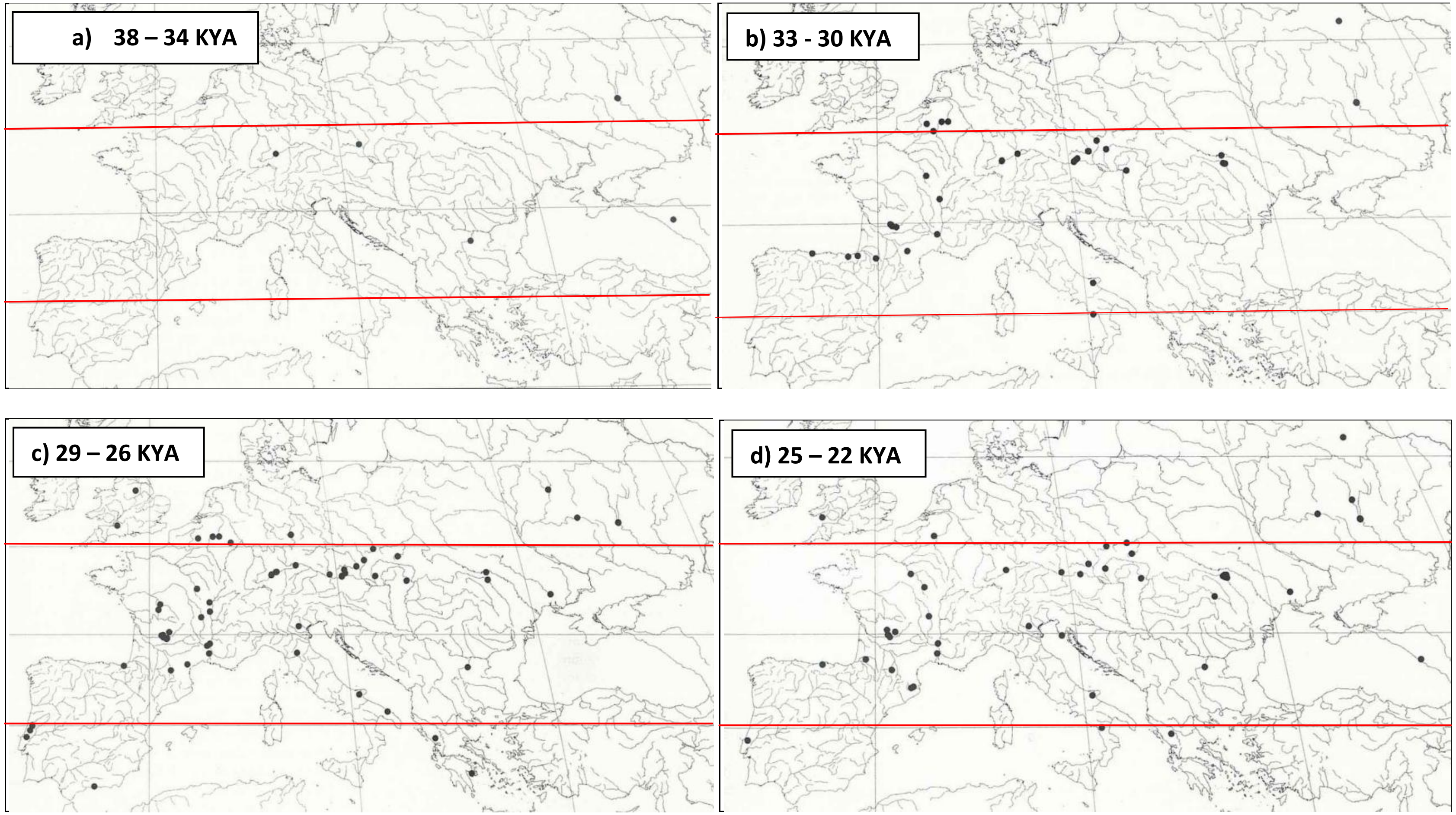

Figure 4.4. Upper Palaeolithic site distributions broadly ascribed to the Gravettian based upon lithic morphology (adapted from van Andel et al, 2003). (a) displays pre-Gravettian site locations, whilst (b-d) displays core Gravettian sites throughout the Upper Palaeolithic divided into periods of 3KYA until the terminus of Gravettian. Note that during this period, modern human settlements were primarily adopted within the European interior, between latitudes 40^{O}N and 50^{O}N. Only 17 sites (c) go above this threshold. When overlapped with the environment models these habitats correspond to the evergreen taiga conditions.

The final goal of the analysis was to determine if the social relationships identified within the ethnographic model could be recognised within a prehistoric population of modern humans. The ethnographic analysis highlighted the hierarchical relationships between cohesive, control and spiritual expression; with increases in the expression of one behaviour influencing another. The catalyst for the adoption of these behaviours is the reduction in food acquisition options brought about by a reduction in environmental productivity, with social behaviours employed as a method of maintaining resources at a sustainable level (Barnard, 2011: 74-89). We see similar relationships within the Gravettian archaeological record: inferred social control behaviours are shown to be influenced by both the social cohesive components (material and non-material) as well as latitude, though to a much lesser extent. These findings conform to the predictions of the ethnographic model: increasing expressions of social control are directly influenced by social cohesion and variation within environmental productivity (i.e. latitude), and reductions in the availability of food resources also impact upon the expression on these control behaviours. The adoption of these control behaviours ensure that limited resources are not over exploited by human populations, with corresponding punishments for those individuals who break the societal rules.

The ethnographic model and its findings are further validated with the recognition that social control behaviours influence the expression of spiritualism in Gravettian populations, and that social and spiritual behaviours are related to the expression and variety of symbolic material artefacts. This supports the original ethnographic interpretation that spiritualism is employed as a further means of social control within a population when resources are limited or external pressures are placed upon a society (Kelly, 1995:168-172; Dunbar, 2007; Barnard, 2011).

If the Gravettian behavioural model can be said to conform to the ethnographic expectations in relation to social behavioural and spiritual expression, it does not conform to the expectation that latitude, and by association environmental productivity, will act as the impetus for increased use of these behaviours. The ethnographic model stipulates that latitude is the primary variable which brings behavioural changes within hunter-gatherer populations, first influencing the food resource acquisition behaviours which prompt a domino-like effect upon other behavioural expressions. This relationship is not observed within the Gravettian data, bar those social expressions already discussed.

It is unlikely that latitude has no influence upon the behavioural expressions within the Gravettian Upper Palaeolithic societies; merely that the geographic range they chose to exploit is restricted to a definitive band across continental Europe. This band naturally restricted the latitudinal range which the majority of sites were located within it, though several sites were found outside this range. In short, the restriction of latitudinal variation within Gravettian site distributions resulted in a lack of statistical resolution within the Gravettian behavioural model. By expanding the latitudinal range of prehistoric sites, one may be able to overcome this statistical restriction. The Aurignacian provides such a testing ground as the geographic range for this period of the Upper Palaeolithic is quite varied as modern humans entered and colonised an environmentally variable continent. It needs to be noted, however, that the European latitudinal ranges (35^{O}N to 50^{O}N) still represent a significant latitudinal limitation compared to the range employed within the ethnographic model.

4.6 SUMMARY

The analysis has shown that the associations highlighted by the ethnographic behavioural model can be transposed onto anatomically modern human populations of the Gravettian, specifically those behaviours related to the expressions of social cohesion, social control and spiritual expression. Though latitude has not been shown within this analysis to influence the expression of certain behaviours within Gravettian populations, the extensive work of social anthropologists on similar issues (Oswalt, 1979; Binford, 1986; 2001; Roscoe, 2004, 2006; Kelly, 1995; Barnard, 2011) suggests that such a link does indeed exist and should not be ignored. Expansion of the latitudinal range in further archaeological analyses will be required to test these links between behavioural expression and environmental productivity.

5. APPLYING THE MODEL TO THE EARLY UPPER PALAEOLITHIC

5.1 INTRODUCTION

The social behavioural analysis of the Gravettian displayed a strong correspondence with the patterns observed in contemporary high latitude hunter-gatherer societies. This response supports the argument that ethnographic behavioural modelling can be applied to the UP archaeological record, though the results are not entirely surprising as the Gravettian provides an abundance of material proxies (i.e. figurines, beads, elaborate burials) that can be used to infer the existence of a range of behaviours which leave no direct trace. Furthermore there is no debate that human cognition during the Gravettian was anything but ‘modern’. The results of the analysis are as expected considering the material record of the Gravettian; indeed the only definitive conclusions one can make is that hunter-gatherer behavioural responses to environmental productivity, and the mechanisms used to enforce these social responses, may have remained broadly similar for (at least) 30 kya.

The challenge now is to assess the applicability of the model to earlier archaeological assemblages which are not as numerically abundant and typologically diverse as the Gravettian, and whose makers are AMH but may not have developed the full cognitive suite typically associated with so-called ‘modern human’ behaviour (McBrearty and Brooks, 2000). The aim of what follows is a test of the model to the EUP (i.e. Aurignacian) as a precursor to eventual application to the Neanderthal archaeological record.

The archaeological record of the Aurignacian is smaller and displays less material variation than the Gravettian and material behavioural proxies will be limited. The Aurignacian is also generally recognised to be a key period in the development of modern human behaviour due to the appearance of new material behavioural expressions. The model will test the behavioural responses on human groups who have either just adopted the full suite of modern human behavioural traits and cannot express their new behavioural repertoire fully, or are in the process of adopting this full behavioural range and as such do not yet display the full range of modern human behaviour.

This chapter presents a series of behavioural tests developed in previous chapters and applied to the archaeological record of the EUP. The aim of this stage of the analysis is to determine if ethnographic models are appropriate tools for predicting and identifying the existence of specific social behaviours among the very first *Homo sapiens* populations in Europe. The success of this analysis will determine whether the model is applied to the archaeological assemblages of Neanderthals during Oxygen Isotope Stage-3 (OIS-3).

What follows is an overview of the Aurignacian, including its geographical and chronological ranges as well as a behavioural definition of the culture employed in this analysis. Analysis will focus on the relationship between latitude and social behaviours following a methodology developed throughout previous chapters and described below with amendments relevant for the analysis for the Aurignacian archaeological record.

5.2 THE AURIGNACIAN

The migration of modern humans into Europe c. 45,000 years ago coincides with the appearance of the Aurignacian techno-complex in the archaeological record (Anikovich et al, 2007; Bailey et al, 2009; Teyssandier, 2010; Turq et al, 2010) . It is typically defined by an increase in the production of blade tools, the use of osseous materials in the production of tools, and an expansion of the faunal base hunted by human groups (Bar Yosef and Kuhn, 1999; Blades, 1999a, 1999b; Bar-Yosef, 2004, 2006; Liolios, 2006; Vanhaeren and d'Errico, 2006). Coupled with an abundant production of intricate symbolic artefacts the archaeological record of the Early Upper Palaeolithic suggests that modern human populations differed in their behavioural and material expressions from their Neanderthal contemporaries. Some researchers (Rouhani, 1989; Whallon, 1989; White, 1989; Klein, 1995) have interpreted this to represent a change within our species, a cognitive and behavioural revolution, whilst others have argued that the behavioural changes observed within the archaeological record represent the culmination of a continuum of behavioural evolution observed throughout the evolution of *Homo sapiens* (Blades, 1999b; Vanhaeren and d'Errico, 2006; Riel-Salvatore et al, 2008). Though debate is ongoing more researchers are now of the opinion that 'modern' human behaviour did not appear as a complete suite of responses but developed gradually over time (Barham, 2007; O'Shea, 2011).

The Aurignacian most likely developed from blade industries in the Near East (the so-called Initial Upper Palaeolithic industries (Bar-Yosef, 2004; Goring-Morris and Belfer-Cohen, 2003 though see Otte (2003) for a possible Asian origin) c.50 kya. A Near Eastern origin for the development of the Aurignacian is further underscored by the lack of Aurignacian-like precursors within the African record (Davies, 2001). The first examples of the Aurignacian within Europe are represented by the sites of Bacho Kiro and Temnata in Bulgaria, dated to c. 45 kya, which are believed to represent the initial modern human incursion into Europe (Kozlowski and Otte, 2000). New dating techniques applied to the site of Kent's Cavern possibly challenge this interpretation as a new date of 41 kya brings modern humans into the fringes of Western Europe earlier than expected if migration into Europe followed an East-West route. The earlier dates for Kent's Cavern suggest an alternative migration route, from North Africa through Iberia, may have occurred (Higham et al, 2010). These dates aside, the majority of archaeological evidence conform to an East to West migration of modern humans, and it is this hypothesis that is taken throughout this thesis. Another major assumption of this analysis is that the Aurignacian is associated solely with

Homo sapiens, and that the spread of the techno-complex throughout Europe is a proxy for the migration of modern humans across the landscape. References to the Aurignacian are therefore ubiquitously associated with the spread of modern humans.

Though flint and other stone materials remain the dominant raw material of choice during the Early Upper Palaeolithic (EUP), the Aurignacian tool kit is also defined by the presence of osseous materials (bone, antler and ivory) in the manufacture of both simple and split-based points which seem to have been incorporated within composite hunting tools (Hahn, 1988; Davies, 2001).

To associate the EUP, and by implication the Aurignacian, with merely an upgrade in raw material exploitation and an associated increase in tool complexity would be a gross simplification. There were also corresponding increases in the levels of symbolic expression which likely represent networks of social support between individuals and groups during times of resource stress (Gamble, 1989; 1991; Dunbar, 2007; Spikins, 2008; Barnard, 2011).

This increase in symbolic output is best represented by the abundance of pierced artefacts made from a range of materials including shells, animal teeth and bone. Believed to have been worn as personal adornments they may have represented the various kin and ethno-linguistic groups of modern human populations who resided in Europe during the EUP (Vanhaeren and d'Errico, 2006). Though primarily material, the presence of these adornments represent the presence of more complex social behaviours employed by human groups to maintain social bonds (Chapter 4, Section 4.2.5). Other symbolic artefacts begin to make their appearance in the archaeological record at this time, including the first figurative objects (Conard et al, 2010) that would later come to define the Gravettian; whilst we also see corresponding increases in the use of pigment for ornamental and possibly spiritual (Lewis-Williams, 2011) uses. Of all the symbolic acts typically associated with moderns, the act of deliberate human burial is lacking. As with the production of figurines we see only tentative traces of human burial and caching behaviour during the EUP (Pettitt, 2011).

Research into the behavioural aspects of the Aurignacian has in the past decade begun to focus on the chronological and stratigraphic aspects of Aurignacian sites in an effort to better determine artefact associations and to firmly identify when modern groups entered specific European regions (Davies. 2001; Zilhao and d'Errico, 1999). Though issues of dating and stratigraphy need to be addressed it has often occurred at the expense of behavioural interpretation. This has resulted in a slight bias within Aurignacian research: datasets are now available which catalogue *when* modern humans entered certain regions but they lack the interpretative *how* which is of key importance to researchers who want to understand the behavioural responses that allowed theses groups to survive. Even these new datasets, however, cannot provide the necessary analytical focus due to the debateable nature of the Aurignacian, its assemblages and their stratigraphic context. To highlight this point, Davies (2007) has attempted to assess the validity of hypotheses related to the spread of the Aurignacian into Europe, specifically evaluating the feasibility of two models of migration: the 'Wave of Advance' model (Ammerman and Cavalli Sforza, 1984) and Davies' own 'directional dispersal' model. The analysis proves inconclusive with Davies noting:

> "...to some extent it [Aurignacian analysis] exists in limbo, owing to the general lack of reliable chronometric data...Unless the chronological situation improves, quibbling over the associative stratigraphic relation between samples and assemblages will persist."
>
> (Davies, 2007: 272)

It is thus a priority that such gaps in chronology and stratigraphic interpretation are reliably resolved to ensure that the spread of the Aurignacian is fully understood; only when this occurs can researchers begin to focus on behavioural aspects of the Aurignacian. This is no easy task as any advances in dating methodology or stratigraphic assessment invariably support or contradict established interpretations of the archaeological record resulting in an intensification of the ‘quibbling’ that Davies warns against (see Higham et al, 2010b; Caron et al, 2011; and Higham et al, 2012 as recent examples).

5.2.1 Defining the Aurignacian

One can interpret the assemblages which comprise the Aurigancian in one of two ways, typologically or behaviourally. The majority of analyses have employed a typological approach using the criteria outlined in Tables 5.1 and 5.2. Davies (2001; 2007) has been particularly vocal in highlighting the issues with the current definitions of the Aurignacian techno-complex and provides his own, more behaviourally orientated, definition; preferring to view it not merely as a techno-complex but rather a techno-*behavioural* complex (Davies, 2001:204). Such a definition, detailed in Table 5.3, removes the typological associations from the analysis of Aurignacian assemblages and allows for broader behavioural interpretations to be inferred from assemblages. Davies (2001, 2007) assesses Peyrony’s phase sequence and suggests that they be reduced into two types: small, simple and uniform assemblages; and large, complex and diverse assemblages (Table 5.2). The former are referred to as *Pioneer* assemblages, whilst the latter are referred to as *Developed* assemblages (Davies, 2001: 207).

Typological Description	*Breuil* *(1912; 1937)*	*Peyrony* *(1933)*	*Garrod* *(1936)*
▪ Thick knives featuring abrupt retouch. Sometimes thin and tapering, sometimes short and squat; all are curved and backed. ▪ Mousterian tool types still persist. ▪ Bone tools rare/absent.	*Lower Aurignacian*	*Lower Perigordian* (Phases I & II)	*Châtelperronian*
▪ Blades feature 'Aurignacian retouch', they generally feature an end-scraper on one/both extremities. ▪ Thick flakes and cores feature Lamellar retouch allowing for the removal of thin and narrow bladelets. Also allows for the creation of nosed scrapers and 'rabots'. ▪ Bone tools are present and varied, with osseous points a standard assemblage feature.	*Middle Aurignacian*	*Aurignacian* (Phases I – V)	
▪ Long blades and bladelets feature abrupt retouch to create Gravette points. ▪ Font-Robert points present. ▪ Burins, particularly the Noaillian burin, present. ▪ Thin, laminar leaf-points (*fléchettes*) present.	*Upper Aurignacian* No relationship with preceding phases	*Upper Perigordian* (Phases IV & VI)	*Gravettian* Independent from all other preceding cultures

Table 5.1. Historical descriptions of the typological classifications of Upper Palaeolithic tool industries. Shaded areas represent definitions which are currently accepted by scholars denoting divisions between different industries. Adapted from Davies (2001).

Associated Tool Typologies and Index Fossils	*Peyrony* (1933)	*Sonne-Bordes* (1958); *Delporte* (1968)
Dufour bladelet and carinated scrapers present, though assemblages not numerous.	Perigordian II	Aurignacian 0
Carinated and nosed scrapers; retouched blades; assemblages sometimes feature *busqué* burins; Split-based antler points.	Aurignacian I	
Busqué burins more dominant in assemblages; nosed scrapers become dominant scraper typology; Flattened, lozangic osseous points.	Aurignacian II	
Similar to Phase II, but burins and scraper numbers decline; Vachons-type burins appear; Oval-sectioned lozangic osseous points.	Aurignacian III	
Similar to Phase III, with a further reduction in nosed and carinated scrapers; increase lateral retouch on pieces; Biconical osseous points.	Aurignacian IV	
Carinated and nosed scrapers once again become dominant; Conical osseous points with round cross-section and bevelled base	Aurignacian V	'Aurignacian V'dissociated from the Aurignacian-proper by Sonneville-Bordes (1982) on the grounds of stratigraphic and typological discontinuity.

Table 5.2. Subdivisions of the Aurignacian based upon Peyrony's (1933) phases and subsequently reworked by scholars based on findings from the western European archaeological record. Adapted from Davies (2001)

5.2.2 Behavioural Definitions of the Aurignacian

Pioneer assemblages represent small, highly mobile hunter-gatherer groups (Davies, 2001) and if one is to employ contemporary hunter-gatherer analogues, one would expect them to be composed mainly of near kin and extended family units (Fitzhugh, 2007). Such groups followed easily navigable pathways, such as rivers, that allowed them to cover large geographic distances in relatively short time spans (Davies, 2001: 211). As a result, Pioneer assemblages are scattered throughout the European landscape and can be found on or close to river systems. The primary pull factor for these groups may have been food resource acquisition, which would explain why tool kits were limited in their diversity: they were reflective of hunting needs to ensure the survival of the group. The material and behavioural inferences of Pioneer assemblages suggest that the priority of these populations was to acquire food and gather raw materials. Pioneer assemblages first emerge between 44 – 40kya with sequences at Bockstein-Torle, Istallosko, Willendorf II, and the aforementioned sites of Bacho Kiro and Temnata (Conard and Bolus, 2006; Davies, 2001, 2007; Kozlowski and Otte, 2000; Pettitt, 2011; Szmidt et al, 2010; Svoboda, 2003; Teyssandier, 2003).

Pioneer	*Developed*
Small assemblages with little tool variability	Complex assemblages with larger tool variability indicative of wider behavioural activity.
Equivalent of Aurignacian '0' and 'I' typologies and predates more complex assemblages.	Equivalent of more complex Aurignacian phases 'II – IV' which post-date Pioneer assemblages.
Wide geographic dispersal throughout Europe following easy migration routes restrictive to specific environments.	Variety of environments inhabited more consistently.
Small groups and wide dispersals yield low population densities of modern humans throughout Europe.	Larger groups represent larger population densities of modern humans consistently occupying Europe.
Use of local raw materials dominant, no caching of artefacts evidenced.	Local raw materials still employed, and complimented by the use of exotic materials.
Symbolic activity limited or not present.	Symbolic activity in evidence.

Table 5.3. Material and behavioural characteristics of the two-phase Aurignacian dispersal of Pioneer and Developed populations into Europe (after Davies, 2001: 206).

The Developed Aurignacian emerges after initial Pioneer incursions, with assemblages occurring after 40 kya (Davies, 2001). Such assemblages are larger and more complex than those of the Pioneer phase. Tool variability increases, local and extra-local raw materials are increasingly employed and material forms of symbolic behaviour become increasingly diverse. The increase in material culture and associated behaviours represents an increase in population diversity and longer occupation lengths whilst Developed assemblages are also found in a greater range of environments than their Pioneer predecessors. Davies (2001) believes these behavioural adaptations are responses to the climatic and environmental fluctuations which occurred throughout Europe during this period (van Andel et al, 2003) (see below).

Two models of migration have been proposed to highlight how modern human populations came to dominate the European interior: the ‘Wave of Advance’ model (Ammerman and Cavalli Sforza, 1984) and a resource driven migration model referred to by Davies (2001) as the “directional dispersal” model, with both models expecting the fissioning of established populations to drive migration. The ‘Wave of Advance’ model places population density as the key push factor for migration, with larger populations breaking up into smaller bands that then moved into other regions. Such a process of fission and migration is expected to be gradual as populations are required to grow to a certain density prior to disbanding. The directional dispersal model also relies on population fission, but in this instance fission occurs due to the presence of pull factors, such as food and material resources, which break larger populations into smaller, more mobile groups that follow lines of least resistance (i.e. coastlines and rivers) (Bowdler, 1990; Davies, 2001: 202). Such a style of migration would allow modern humans to cover a large geographic area comparatively quickly, but with smaller population densities such groups may not have left distinct archaeological traces. Both models present viable hypotheses on modern human migration into Europe, but it is only the resource driven directional dispersal model which conforms to the migration patterns one would expect prehistoric hunter-gatherer populations to observe: food and raw material acquisition would be the priority for human groups as these are the resources that would guarantee survival in an unknown landscape. Further, the ‘Wave of Advance’ model relies on adequate population data to understand when fission would occur; currently this data is not available within the archaeological record, whilst the contemporary ethnographic record presents no reliable data on hunter-gatherer population dynamics during migrations into unknown landscapes (Davies: 2001:205).

The directional dispersal hypothesis stipulates that the break-up of larger groups prompts migration into newer, hopefully resource rich, areas with Pioneer groups disbanding from larger Developed populations which then follow easily traversable routes into new regions. These Pioneer groups will be highly mobile as they adapt to the landscape and the resources it provides, moving further afield if resources are lacking. As different Pioneer groups begin to settle in the same region population density will steadily increase. As densities and kin affiliations between groups increase Developed populations may emerge. Further migrations can emerge with the disbanding of these Developed populations into new Pioneer groups; as a result Pioneer groups can directly precede or succeed Developed populations. Due to the possibility of precession-succession-precession, the issue of chrono-stratigraphy of sites becomes more important in recognising the behaviours of modern human groups within the EUP. Though the archaeological and behavioural record of the EUP is ambivalent about the feasibility of the two-phase model (Davies, 2007), the pattern of fission and fusion during times of resource abundance and stress conforms to known behaviours displayed by chimpanzee groups (Lehmann et al, 2007) and contemporary hunter-gatherer societies (Fitzhugh, 2001; Grove, 2009; Littleton and Allen, 2007; Morgan, 2009).

The two-phase, directional dispersal model proposed by Davies (2001, 2007) provides a more useful framework than artefact typologies for making behavioural interpretations of the Aurignacian based on ethnographic comparison and analogy. As a result a greater range of behavioural inferences can be extracted from the data which are more relevant to this thesis and its goals from both the archaeological and ethnographic records.

5.2.3 Chronology and Geographic Ranges

Entering Europe from the east, Pioneer populations spread into what are now modern day Bulgaria, Germany, France, Italy, Spain and England (Otte, 2000); with initial migrations confined to environments which provided the best chances for survival (Davies, 2001; Teyssandier, 2011).

Eastern European sites, represented by Temnata and Bacho Kiro, show the first modern human incursions into the continent occurring between 46.0 and 43.0 kya (Conard and Bolus, 2006; Kozlowski and Otte, 2000; Szmidt et al, 2010; Svoboda, 2003; Teyssandier, 2003) These early Pioneer assemblages (referred to as Pre-Aurignacian by Otte, 2000) most likely disbanded from larger groups in the Near East (Bar-Yosef, 2007) and represent the first phase of Davies' two-phase migrational model (Davies, 2001; 2007). Pioneer expansion throughout Europe was swift: dates from Gleissenklosterle III and Willendorf II indicate that central Europe played host to human groups between 44.7 and 41.7 kya respectively (Pettitt, 2011). The French site of Isturitz suggests a modern human presence sometime c. 40.2 kya (Szmidt et al, 2011), and in north western Iberia by 37.9 kya (Otte, 2000) whilst groups reached southern England sometime between 44.2 – 41.5 kya (Higham et al, 2011). By 39 kya, modern human pioneer groups spanned the majority of Europe; with only the Italian peninsula and central and southern Iberia remaining unoccupied (Davies, 2001: 209; Zilhao, 2000).

By restricting their migrations into environments that they were familiar with, one would expect modern groups to adapt quickly to the regional landscape. With finite routes into Europe provided by rivers and coastlines, population densities within particular regions would have increased in some regions faster than others. Considering the dominant use of the Danube and its tributaries in the migration of Pioneer groups (Svoboda, 2007; Teyssandier, 2011) it can be hypothesised that central European regions initially experienced larger population growth compared to more westerly regions. This hypothesis is supported by the largest concentration of pioneer sites during this period (n = 7), and the largest concentration of developed assemblages (n = 11) during the second phase of European migration. One may conclude that central Europe was the nexus for population dispersal into western and southern Europe. It is curious to note that Iberia also displays a large regional concentration of pioneer assemblages (n = 6) in the north west though Pego de Diablo, dated to between 37-29kya, suggests a more westerly presence which may lend support to a North African crossing into Europe (Higham et al, 2011), but most likely represents a later Pioneer migration into the region from the east after Neanderthal population density and subsistence had fallen (Zilhao, 2000).

Developed assemblages within eastern Europe begin to appear 41.7 – 37.8 kya (Pettitt, 1999), quite quickly after the emergence of Pioneer assemblages within the region. These Developed assemblages may represent groups banding together during times of resource stress or instances of kin groups coming together for seasonal activities. A third explanation could be that developed assemblages represent pioneer groups coming together to consolidate their resources prior to further migration into central Europe. Regardless, Developed Aurignacian assemblages began to appear after 40,000 years throughout all Europe, but are concentrated in central and south-western regions (Davies, 2001; 2007). Developed assemblages emerged in central Europe c. 38 kya as represented by sequences at sites such as Willendorf II, Gleissenklosterle, Krems-Hundssteig, Hohle Fels and Hohlenstein-Stadel. By c. 37 kya developed assemblages are visible in south-western Europe in sequences at Isturitz, Abri Castanet, Abri Pataud and La Ferrassie with further migrations in the region occurring at c. 36 kya in La Vina (Southern France), El Castillo (Northern Spain) and Abric Romani (North west Spain) (Bordes, 2003; Movius Jr, 1960; Niven, 2003; Otte, 2000; Zilhao and d'Errico, 1999). From these regions further migrations of pioneer groups brought human populations to southern and north-western Europe, specifically Italy (Mussi et al, 2003), to begin the final stage of modern human colonisation of Europe which would only be completed with the extinction of the Neanderthals and the later onset of the Gravettian.

The initial incursion into Europe was exceptionally quick, most likely helped by a broad familiarity with the environment, easy migration routes, and possibly the establishment of cooperative social behaviours between hunter-gatherer groups (Spikins, 2008). Unfamiliar landscapes beyond the core areas and climatic variations would have hindered further expansion, as would competition with other human groups whether these were Neanderthals or other modern humans. The initial incursion would not have impacted local human populations (i.e. the Neanderthals) significantly as population densities would have been too low (Davies, 2001, 2007). Only with the establishment of Developed Aurignacian assemblages c. 40 kya would population densities of modern humans have become a significant threat to the incumbent human populations (Davies, 2001; 2007) and the resources they exploited.

5.2.4 Environment and Climate during the Aurignacian

Like the Gravettian, the environment and climate of the Aurignacian needs to be understood as they are the primary factors which underline the basis of our behavioural predications. Environmental factors played a more important role within the Pioneer Aurignacian c. 46 kya that warrants particular attention due to the occurrence of Dansgaard-Oeschger event Greenland Interstadial (GIS) 12 (NGRIP members, 2004).

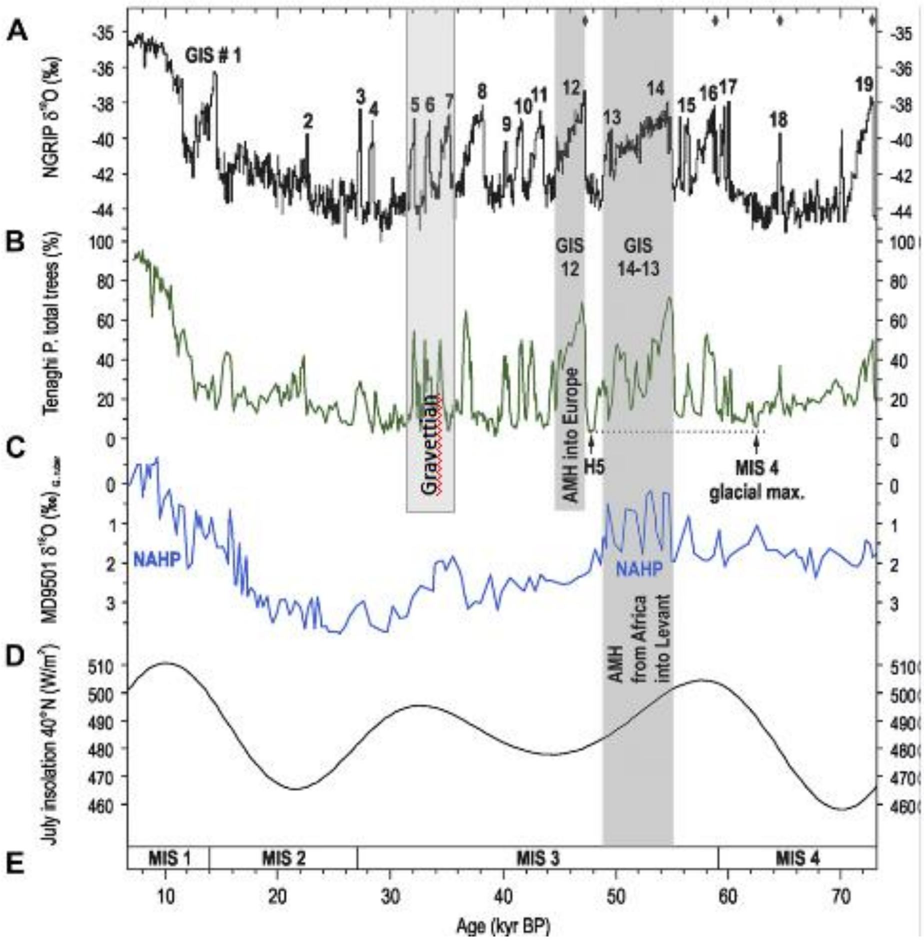

Figure 5.1. Environmental fluctuations experienced by modern human groups migrating into and throughout Europe during OIS-3 as based on: (A) oxygen isotope record from Greenland (NGRIP Members, 2004) with characters representing Greenland Interstadials; (B) Tree pollen record from Tenaghi Philippon; (C) Oxygen isotope record inferred from plankton from site MD9501 (Almogi-Labin et al, 2009) where NAHP = North African humid periods; (D) Summer isolation at c.40^{o}N (Berger and Loutre, 1991). (E) MIS = Marine Isotope Stages, also referred to as Oxygen Isotope Stages (OIS). Note the brief increase in temperature inferred form the pollen and oxygen isotope records which coincided with the first migrations of modern humans into Europe c.45kya. This burst of favourable conditions would have aided modern migration into the European interior by providing a resource rich environment ready for exploitation. Adapted from Muller et al (2011).

GIS 12 represents a warm event that corresponds with the first migrations of modern humans into Europe (Huntley and Allen, 2003; Muller et al, 2011) (Figure 5.1). This climatic improvement saw a biome change from desert-steppe to open forest throughout eastern Eurasia in what is geographically referred to as the ‘gateway to Europe’ (Muller et al, 2011: 278). This biome change occurred throughout Europe between the 45 – 55^{o}N latitudinal range (though persisted in some areas to 60^{o}N, Figure 5.2), and allowed modern human groups to quickly migrate across the continent in an environment that was stable and with which they were broadly familiar (Davies, 2001; Huntley and Allen, 2003; Muller et, 2011).

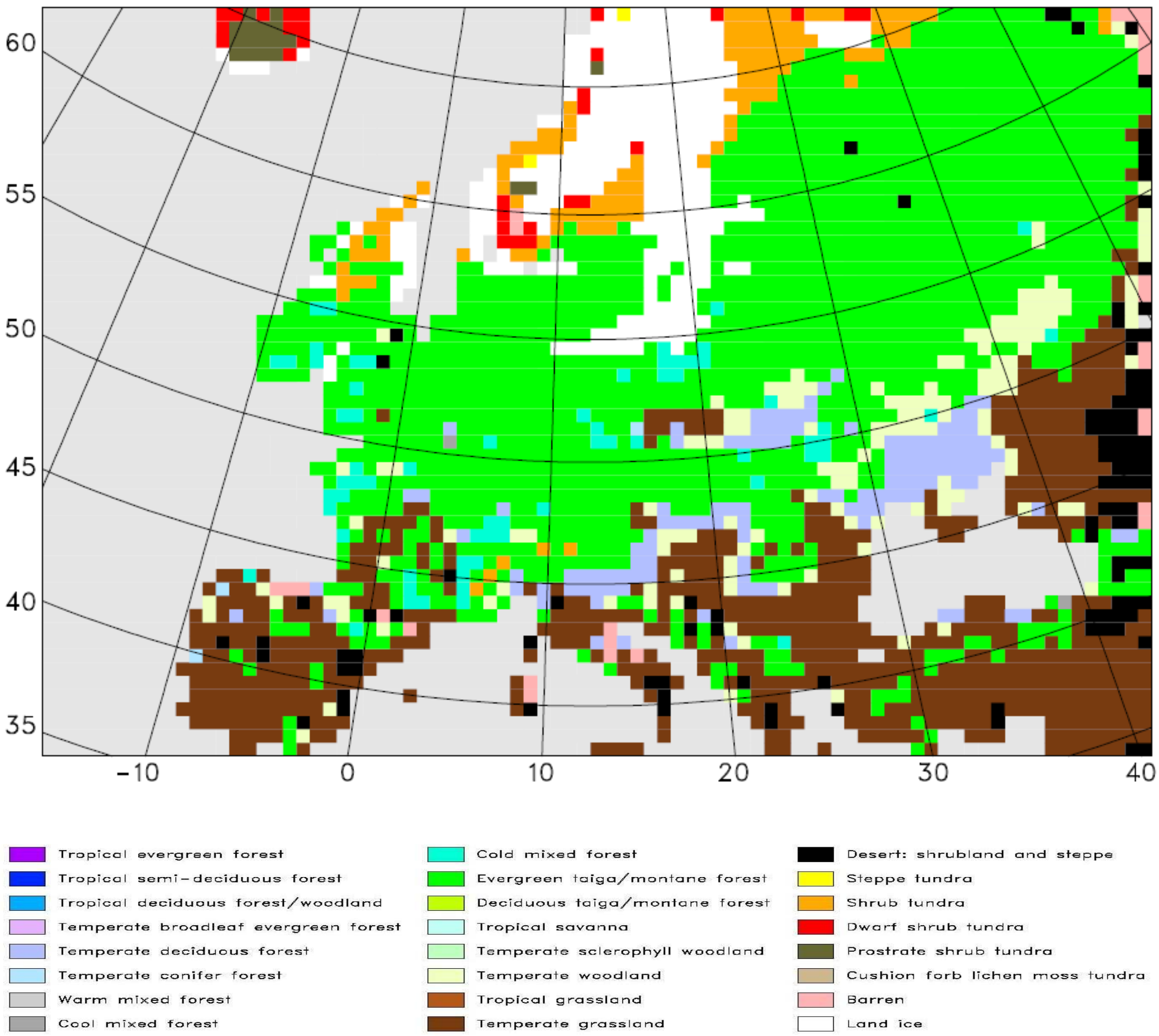

Figure 5.2. Environmental reconstructions throughout Europe c. 45kya during the warm phase brought about by the GIS 12 event based on the pollen and faunal data (van Andel et al, 2003). Note the increased distribution of the open forest, evergreen environment compared to that of the succeeding Gravettian. This relatively uniform distribution would have allowed modern humans to migrate throughout central and northern Europe without the need for any significant behavioural or technological adaptations.

Pollen records indicate this band of open forest was a mixture of evergreen and deciduous plant species including *Quercus* (both evergreen and summergreen variants), *Pinus*, *Ulmus* and *Tilia* interspersed with smaller herbaceous (*Caryophyllaceae*) and other arboreal species (Hardy, 2010; Muller et al, 2011: 278). Indeed, the species range would have been very similar to that experienced in the Gravettian but on a much larger scale. Pollen tolerances suggest that summer temperatures ranged from 12 – 18^{o}C, whilst winter temperatures varied between 4 ^{o}C to minus 4^{o}C (Barron et al, 2003). North of this band (>55^{o}N) the open woodland would have gradually given way to shrub tundra, with extreme northern landscapes covered by glacial ice, whilst southern Europe (<45^{o}N) was dominated by a temperate grassland biome (Figure 6.2). Temperatures varied within these regions, with summer temperatures averaging 10^{o}C in the north and 16^{o}C in the south whilst mean winter temperatures in the north are estimated at -4^{o}C and in the south 2^{o}C (Barrow et al, 2003). These mean temperatures are not expected to be uniform throughout Europe, and regions away from the north Atlantic current (i.e. the eastern European interior) and regions of high altitude (i.e. the Alps) no doubt experienced significant drops in temperature below the continental average (Muller et al, 2011).

This range of environmental biomes in Europe around c. 47 – 30 kya is broadly comparable to those experienced by Gravettian populations, though as a result of the warmer conditions brought about briefly by GIS-12 the open forest and temperate grassland environments stretched over a larger geographic range than their Upper Palaeolithic counterparts. Resources within these biomes would also have been similar to those experienced by Gravettian groups: *Capra ibex* and *Equus sp* dominated, whilst smaller species such as red fox and grey wolf were also exploited (Delpech, 1983; Stewart et al, 2003). Though Aurignacian hunters primarily focused upon medium and small-sized terrestrial game, they would have come into contact with larger species such as woolly rhino and woolly mammoth (Stewart et al, 2003).

Regional clusters of occupation do not begin to emerge within the Aurignacian until the appearance of Developed assemblages c. 37 kya, and are then limited to three areas: North west Spain, the Perigord of South-West France, and large site clusters within the Danube basin (Davies, 2001, van Andel and Davies, 2003). The archaeological record from sites in each of these regions confirms that Aurignacian hunters exploited a range of species for their dietary requirements, but also show the beginnings of regional exploitation of certain species: the south-west displays a slight dominance of deer (Djindian, 2000; Stewart et al, 2003) whilst the central European record shows that animal exploitation concentrated on bison and reindeer (Stewart et al, 2003; Niven, 2007). Though no single species significantly dominates the record during the Aurignacian, the focus on certain species will partially define these regions during the Gravettian.

The primary exploitation of herd animals by Aurignacian hunters would have meant a highly migratory lifestyle for Pioneer groups, more so than later Developed and Gravettian populations. The initial Pioneer migration into Europe would have presented modern human groups with a familiar environment rich in resources that they could exploit quite easily, but a new landscape that they would have needed to interpret if they were to succeed. This active migration would have ensured that group sizes remained small, and it is only when populations understood the landscape they inhabited, in particular its seasonal changes, that they would have been able to restrict their migrations and keep to within a defined region. The appearance of Developed assemblages within the archaeological record therefore represents populations who have become familiar enough with their local environment and its resources to remain for longer time periods whilst the cluster of Developed assemblages within the regions already noted suggests either that such groups were in close proximity to each other and employed networks of communication (Gamble, 1989; Zilhao and d'Errico, 1999) or that site clusters represent the full range of modern human migration within these regions.

In many respects, Aurignacian Europe was not totally dissimilar to Gravettian Europe, with the latter only marginally cooler than the former. The major difference in the habitat of the Aurignacian Europe is the presence of two human populations, modern *Homo sapiens* and the Neanderthals.

The arrival of Aurignacians is often interpreted as the beginning of the demise of Neanderthals (Mellars, 1989) as a result of competition for food and raw materials; but only with the settlement of Developed groups, c. 37 kya, would incumbent Neanderthal groups have been in direct competition for resources. Pioneer groups would have been too small and highly mobile to significantly impact Neanderthal foraging patterns (Davies, 2001, 2007). Developed groups occupied specific regions throughout the year, and as a result this would have permanently excluded Neanderthal groups from these areas and their resources. Continuing migrations of further Pioneer groups from these Developed regions would have further encroached on Neanderthal resources, especially if Developed populations emerged from these Pioneer groups. If the dates for Western European Pioneer assemblages are accurate one can deduce that the migration of modern human populations across the continent was swift and from this a further inference can be made that contact with Neanderthal hunting groups (if they occurred on a regular basis) posed no serious problem for either species.

Europe was therefore a resourceful and welcome environment for modern human populations which presented few dangers that hunter-gatherer groups would have not already been broadly familiar with. Incumbent Neanderthal populations would have been one of the few variables which modern humans would have had no prior experience with (assuming of course no prior contact with the Denisovans and no migration through North Africa and Spain prior to 40kya (Hublin and Klein, 2011): small highly mobile modern human groups may have not had to deal with 'the Neanderthal problem' until they became more settled within the European landscape.

5.2.3 Methodology

Aspects of the Gravettian analysis above highlighted that the ethnographic model can be used to predict some behavioural outputs of modern human groups during the Upper Palaeolithic. Specifically, material proxies were identified that were linked to the expression of social behaviours and through these social behavioural relationships were identified that mirror those highlighted in the ethnographic model. Based on the Gravettian results the following Aurignacian analysis has two related goals which need to be addressed before applying the model to Neanderthal assemblages of the Middle Palaeolithic:

1. To determine if the material proxies for behavioural expression can be employed to determine the behavioural responses of highly mobile modern human hunter-gatherer groups of the Early Aurginacian with their limited archaeological assemblages.
2. To assess the potential range of cohesive, control and spiritual behaviours in the Aurignacian using the ethnographic database.

The statistical methodology employed broadly mirrors that used in the ethnographic and Gravettian analyses which gives direct comparability to, and forms the basis for, interpreting behavioural similarities and differences. As a behavioural definition of the Aurignacian has been employed within this EUP analysis, the model applies a two tier analysis method which aims to highlight the possible behavioural differences between Pioneer and Developed Aurignacian groups. This approach will allow for a greater clarification between modern human groups during the Aurignacian rather than assuming that human behavioural expression was constant throughout the entirety of the EUP. Each analysis incorporates stages of Principal Components Analysis, Correlation, Stepwise Linear Regression analysis and General Linear Modelling.

5.2.6 Aurignacian: Pioneer and Developed Sites

A total of 72 Aurignacian sites were included representing 32 Pioneer assemblages and 40 Developed assemblages. Sites span the known geographical and chronological range and in accordance with the behavioural descriptions employed by Davies (2001) they represent both short term hunting occupations (Pioneer) and long term hunting occupations (Developed).

As with the Gravettian analysis, each site employed was assessed for its stratigraphic and chronological integrity to ensure that recovered artefacts can adequately reflect the range of behaviours. Further variables including excavation length, spit levels, sieve quality and size were also taken into account when assessing the integrity of the deposits excavated (Trinkaus et al, 2000; Trinkaus et al, 2010; Woital, 2005; Zilhao and d'Errico, 1999).

Interpretation of the duration and type of occupation at each archaeological site is based on the amount, type, and quality of artefacts at each site and their distributions throughout each stratigraphic level.

It has to be noted that the majority of the sites employed within the EUP analysis are located within caves. This maybe a reflection of taphonomic processes during the later-LGM when retreating glaciers destroyed the majority of open-air sites and their assemblages (Romanoska, 2011). Though cave sites can preserve a large amount of material culture they cannot be assumed to be representative of the complete behavioural repertoire of a group at a given place or time. It is possible that these biases in cave sites could thus result in the dominance of certain behavioural expressions over others which are important to consider when interpreting the behavioural responses of modern human populations during the EUP. Further, cave sites play host to species other than humans that may alter the archaeological assemblages left by groups and the taphonomic impact of these also need to be taken into account.

By taking note of these, and other, taphonomic variables one can begin to understand the overall context of the artefacts which form the foundation for subsequent behavioural interpretations. Tables 5.2b and 5.2c list the sites and criteria (n =12) used to determine if they were suitable for this particular analysis and are graded accordingly. Variables and site grades are identical to those employed in the Gravettian analysis to ensure comparability between the datasets. For definitions of the variables and grading system employed in this analysis refer to Chapter 4, Section 4.3.4.

Finally, it has to be noted that specific chronological and stratigraphic issues are relevant to the Aurignacian. Zilhao and d'Errico (1999) have highlighted that several sequences within Aurignacian sites need to be reassessed due to inadequate excavation, misunderstood taphonomic factors, and unreliable dating techniques. This has prompted several reassessments of typical Aurignacian sequences (Richter et al, 2000; Conard and Bolus, 2003; Pettitt et al, 2003; Adams and Ringer, 2004; Conard et al, 2004; Szmidt et al, 2010; Higham, 2011), with many undergoing new investigations and applications of improved dating methods. Where possible, the most recent chronological and stratigraphic data are used to determine site and assemblage integrity. If data are believed to have been influenced by researcher bias/misunderstanding or taphonomic processes that may have lowered the integrity of associated assemblages this has been highlighted within the site assessment tables (5.2b and 5.2c) and reflected in a site's overall 'grade'.

5.3.4 Sites

The Aurignacian analysis features data from 72 archaeological layers. Following the taphonomic guidelines described above (Chapter 5, Section 5.2.3), Tables 5.2a and 5.2b list the layers used and grades awarded.

Site	Excav. Length (Yr)	Enviro. Info	Faunal Record	Tools	Symbolism	Dating	Site Preservation	Excavation Technique	Area (m^2)	No. Level(s)	Depth (cm)	Sieve (mm)	Site Ranking
Temnata	7*	✓	✓	✓	✓	C14	Cave	Grid	~325	9	<15	10	A
Riparo Fumane	20+*	✓	✓	✓	✓	C14	Cave	Grid	15	5	≤90	-	B
Willendorf II	3	✓	✓	✓	✓	C14	Open	Grid	≥28	5	≤100	10	A
Istallosko	10*	✓	✓	✓	✓	C14	Cave	Grid	~450	10	<80	-	B
El Pendo	4+*	✓	✓	✓	✓	C14	Cave	Grid	>500	11	<20	-	B
Reclau Viver	20+*	✓	✓	✓	✓	C14	Cave	Grid	≤600	≤5	≤40	10^{+}	B
Trou Magrite	12*	✓	✓	✓	✓	C14	Cave	Grid	<250	9	<25	-	B
Keilberg-kirche	5	✓	✓	✓	✓	C14	Cave	Grid	48	7	5	-	B
Pesko	9+*	✓	✓	✓	✓	C14 AMS	Cave	Grid	≤600	≤5	≤40	10^{+}	B
Bacho Kiro	8*	✓	✓	✓	✓	C14/TL	Cave	Grid	~200	11	<45	-	B
L'Arbreda	5*	✓	✓	✓	✓	C14 AMS	Cave	Grid	≤450	8	≤35	10^{+}	B
El Castillo	5	✓	✓	✓	✓	C14 AMS	Cave	Grid	-	25	<100	-	A
Abric Romani	6+*	✓	✓	✓	✓	C14	Cave	Grid	<100	17	<10	-	B
Geissenklosterle Cave	7	✓	✓	✓	✓	C14	Cave	Grid	48	6	5	10	A
Abri Pataud	6	✓	✓	✓	✓	C14	Cave	Grid	≤85	1	60	10	A
Pego do Diablo	4	✓	✓	✓	✓	C14	Cave	Grid	<75	13	<20	-	B
Rascano	20+*	✓	✓	✓	✓	C14	Cave	Grid	≤600	9	<15	10^{+}	B
Kent's Cavern	10*	✓	✓	✓	-	C14 AMS	Cave	Grid	-	8	<50	-	C
Uphill	14	✓	✓	✓	-	C14 AMS	Cave	Grid	-	7	<45	-	C
Les Pecheurs	6*	✓	✓	✓	✓	C14 AMS	Cave	Grid	-	19	15	-	B
La Salpetriere	15	✓	✓	✓	✓	C14	Cave	Grid	-	1	40	-	C
Riparo Mochi	20+*	✓	✓	✓	✓	C14	Cave	Grid	150	18	≤100	-	B
Castelcivita	20+*	✓	✓	✓	✓	C14	Cave	Grid	175	5	≤70	-	B
Paglicci	20+*	✓	✓	✓	✓	C14	Cave	Grid	15	5	≤90	-	B
Bockstein-Torle	5+*	✓	✓	✓	✓	C14	Cave	Grid	-	7	5	10	A
Vinija	40+*	✓	✓	✓	✓	C14/TL	Cave	Grid	<800	13		10	A
Mitoc Malul Galben	4	✓	✓	✓	✓	C14	Open	Grid	-	17	<10	-	B
Siuren	6*	✓	✓	✓	✓	C14	Cave	Grid	~450	14	<25	-	B

Table 5.4a. Individual assessments of each of the sites included within the Pioneer Aurignacian Early Upper Palaeolithic archaeological analysis to determine their suitability for this particular analysis. Factors relevant to this analysis relate not only to the quality of the excavation (length, sieve, technique) but also whether sites have environmental and symbolic associations within their assemblages. Variables marked '*' represent sites which have undergone multiple excavations, '+' indicate that sieving size and application may have been variable, '-' represent variables where information was unobtainable or not recorded. (Bartolomei et al, 1992; Bazile and Sicard, 1999; Benini et al, 1997; Bhattacharya, 1977; Bordes, 2006; Cassoli and Tagliacozzo, 1991; Conard and Bolus, 2006; Fortea, 1995; Gambassini, 1997; Hahn, 1977, 1978, 2000; Hahn et al, 1977; Higham et al, 2011; Kozlowski and Otte; 2000; Liolios, 2006; Miracle et al, 2010; Montes Barquin et al, 1998; Movius Jr, 1960; Mussi, 2001; Mussi et al, 2006; Niven, 2006; Pettitt, 2011; Svoboda, 2006; Szmidt et al, 2010; Teyssandier et al, 2006; Teyssandier and Liolios, 2006; Valladas et al, 1996; Zilhao and d'Errico, 1999).

Site	Excav. Length (Yr)	Enviro. Info	Faunal Record	Tools	Symbolism	Dating	Site Preservation	Excavation Technique	Area (m^2)	No. Level(s)	Depth (cm)	Sieve (mm)	Site Ranking
Istallosko	10*	✓	✓	✓	✓	C14	Cave	Grid	~450	10	<80	-	B
Bacho Kiro	8*	✓	✓	✓	✓	C14/TL	Cave	Grid	~200	11	<45	-	B
La Vina	7+*	✓	✓	✓	✓	C14	Rockshelter	Grid	<50	14	<50	-	B
Isturitz	30+*	✓	✓	✓	✓	C14	Cave	Grid	~100	9	<15	10	A
Abri Castanet	4	✓	✓	✓	✓	C14 AMS	Cave	Grid	~120	12	<400	10	A
Krems-Hundssteig	60+*	✓	✓	✓	✓	C14	Cave	Grid	170	7	<100	-	B
El Castillo	10+*	✓	✓	✓	✓	C14	Cave	Grid	<75	25	<10	-	B
Abric Romani	6+*	✓	✓	✓	✓	C14	Cave	Grid	<100	17	<10	-	B
Geissenklosterle Cave	7	✓	✓	✓	✓	C14	Cave	Grid	48	6	5	10	A
Esquicho-Grapaou	6	✓	✓	✓	✓	C14	Cave	Grid	~100	14	15	-	B
La Flageolet	10+*	✓	✓	✓	✓	C14	Cave	Grid	<50	9	<35	-	B
Abri Pataud	6	✓	✓	✓	✓	C14	Cave	Grid	≤85	1	60	10	A
La Ferrassie	~25+*	✓	✓	✓	✓	C14/TL	Cave	Grid	50-100	18	<35	-	B
Hohlenstein-Stadel	60+*	✓	✓	✓	✓	C14	Cave	Grid	170	7	<100	-	B
Hohle Fels	5*	✓	✓	✓	✓	C14	Cave	Grid	6000	2	≤50	5^+	B
Castelcivita	20+*	✓	✓	✓	✓	C14	Cave	Grid	15	5	≤70	-	B
Mitoc Malul Galben	4	✓	✓	✓	✓	C14	Open	Grid	-	17	<10	-	B
Mladec	50+*	✓	✓	✓	✓	C14	Cave	Cave Areas	<1000	2	25	-	B
Cueva Morin	4	✓	✓	✓	✓	C14	Cave	Grid	-	11	<50	-	B
Les Mallettes	3	✓	✓	✓	✓	C14	Open	Grid	-	-	-	-	C
Grotte des Hyenes	6	✓	✓	✓	✓	C14	Cave	Grid	~450	12	350	-	B
Chauvet	5+	-	✓	✓	✓	C14	Cave	Grid	<1000	-	-	-	C
Roc de Combe	5	✓	✓	✓	✓	C14 AMS	Cave	Grid	<100	7	<150	-	A
Le Piage	14	✓	✓	✓	✓	C14	Open	Grid	<100	6	<50	-	C
Le Facteur	6*	✓	✓	✓	✓	C14 AMS	Cave	Grid	-	19	15	-	B
La Rochette	7	✓	✓	✓	✓	C14 AMS	Cave	Grid	-	-	-	-	C
La Quina	5	✓	✓	✓	✓	C14	Cave	Grid	-	14	15	10	A
Trou Al'Wesse	8*	✓	✓	✓	✓	C14	Cave	Grid	>100	11	<15	-	B
Trou Walou	12*	✓	✓	✓	✓	C14	Cave	Grid	<250	9	<25	-	B
Lommersum	6	✓	✓	✓	✓	C14	Open	Grid	-	7	<10	-	C
Wildscheuer	60+*	✓	✓	✓	✓	C14	Cave	Grid	170	7	<100	-	B
Grotte du Renne	10+*	✓	✓	✓	✓	C14 AMS	Cave	Grid	210	14	<30	10	A
La Cala	15+*	✓	✓	✓	✓	C14	Cave	Grid	≥50	1	≤70	10^+	B
Vogelherd	60+*	✓	✓	✓	✓	C14/TL	Cave	Grid	170	7	<100	-	B
Krems-Galgenberg	60+*	✓	✓	✓	✓	C14	Cave	Grid	170	7	<100	-	B
Milovice I	15+*	✓	✓	✓	✓	C14	Open	Grid	298	4	≤35	10^+	A
Stranska skala	60+*	✓	✓	✓	✓	C14	Cave	Grid	175	7	<50	-	B
Grottes des Enfants	7+	✓	✓	✓	✓	C14 AMS	Cave	Grid	~480	11	<50	10	A
Willendorf	3	✓	✓	✓	✓	C14	Open	Grid	≥28	5	≤100	10	A

Table 5.4b. Individual assessments of each of the sites included within the Developed Aurignacian Early Upper Palaeolithic archaeological analysis to determine their suitability for this particular analysis. Factors relevant to this analysis relate not only to the quality of the excavation (length, sieve, technique) but also whether sites have the available environmental and symbolic associations within their assemblages. Variables marked '*' represent sites which have undergone multiple excavations, '+' indicate that sieving size and application may have been variable, '-' represent variables where information was unobtainable or not recorded. (Bartolomei et al, 1992; Bazile and Sicard, 1999; Benini et al, 1997; Bhattacharya, 1977; Bordes, 2006; Cassoli and Tagliacozzo, 1991; Conard and Bolus, 2006; Fortea, 1995; Gambassini, 1997; Hahn, 1977, 1978, 2000; Hahn et al, 1977; Higham et al, 2011; Kozlowski and Otte; 2000; Liolios, 2006; Miracle et al, 2010; Montes Barquin et al, 1998; Movius Jr, 1960; Mussi, 2001; Mussi et al, 2006; Niven, 2006; Pettitt, 2011; Svoboda, 2006; Szmidt et al, 2010; Teyssandier et al, 2006; Teyssandier and Liolios, 2006; Valladas et al, 1996; Zilhao and d'Errico, 1999).

5.2.8 Behavioural Predictions for the Aurignacian

As with the Gravettian analysis, the ethnographic model can be employed to predict the behavioural expressions of both Pioneer and Developed Aurignacian modern human populations. This stage of the Aurignacian analysis is comparable to that done for the Gravettian, allowing a comparison of predictive power of the ethnographic/latitudinal model to the archaeological record of the EUP. As the Gravettian predictive stage was ultimately employed to determine if the behavioural inferences of the ethnographic model could be applied to modern human populations of the Upper Palaeolithic, so too will this Aurignacian predictive stage be used to determine if the ethnographic behavioural associations also apply to the first modern human populations in Europe.

The environment and resources available during the EUP are broadly similar to those experienced by Gravettian groups, with the exception that temperatures were on average slightly warmer and the range of the open forested environment would have covered a larger area. These environmental conditions presuppose that the behavioural responses of human groups are likely to be similar. Given these environmental similarities the best analogues for the Aurignacian data are those of lower latitude sub-arctic/higher latitude temperate hunter-gather societies.

Gravettian behavioural expression, however, is that of a human population already attuned to the European landscape. Their behaviour is a cumulative response, adapted over generations, to European resources. This context is comparable to that of the contemporary hunter-gatherer populations used in the ethnographic analysis as they too reflect generations of knowledge and adaptation to specific habitats. The Aurignacian analysis offers a different scenario: that of the migration of modern human groups into a landscape in which they had *no prior knowledge*. There are no comparable contemporary hunter-gatherer analogues for a migratory population.

The issue of analogy can be addressed by basing the behavioural predictions of those societies who share commonalities with Pioneer and Developed Aurignacian groups: they need to be highly mobile, reside within seasonally fluctuating environments, and rely on terrestrial resources to survive. Broadly, these factors correspond to sub-arctic societies such as the Blackfoot, Mistassini Cree, Plains Cree and Dogrib Indians of North America as well and the Koryak, Evenk and Chuckchee of Eastern Asia.

Using these populations as analogues, tentative predictions can be made about Aurignacian modern human populations though it needs to be restated that they are not completely representative of Aurignacian groups as these contemporary groups would still have prior landscape knowledge that would have been unavailable to Pioneer groups entering Europe.

Two sets of behavioural predictions have been made, one predicting Pioneer behavioural expressions and the second for Developed Aurignacian behavioural expressions. Davies (2001) has previously hypothesised about the behavioural expressions of each of these groups (summarised in Table 5.19 above), the predictions below build on these by employing ethnographic behavioural data.

- **Prediction One.** *Pioneer groups migrating into new European landscapes should display a variety of social cohesive behaviours, but have limited expressions in the realms of social control and spiritualism. Symbolic material expression will be limited, but those that are present will tend to reflect kin relationships.*

The priority for Pioneer groups, either those migrating into Europe or migrating from established Developed populations, would have been the acquisition of food and material resources. Behavioural expressions should therefore tend to reflect this primary aim with social cohesive behaviours ensuring during hunting. As population densities within Pioneer groups would have been low, the need for social control behaviours would be restricted to related kin groups, though higher latitude Pioneer groups such as those represented by the sites of Trou Magrite, Kent's Cavern and Uphill are expected to have a significant increase in social control reflecting the need to conserve available resources in a limited environment. These higher latitude groups should also display higher rates of social cohesive behaviours to increase the success of foraging endeavours. All Pioneer groups should display a restricted tool kit, with limited variability and made from local resources.

- **Prediction Two.** *Developed groups will display a higher level of social cohesive behaviour than their Pioneer counterparts; social control behaviours should now be a feature within these populations due to an increase in population density. Spiritual expression should be more common throughout all Developed groups, and particularly visible within higher latitude groups. Symbolic material expression should display regional variation and reflect the dominant animal resource exploited by groups.*

As Developed Aurignacian groups have greater population densities than their Pioneer counterparts, there will be a greater need to restrict the actions of freeloaders by employing greater methods of social control. Further, social cohesive behaviours should be increasingly employed to maintain relations between groups within increasingly defined regions. Evidence of social cohesion, social control and spiritual expression should be observable through the use of proxy artefacts from the archaeological record. The use of beads and the transport of raw materials would be material indicators of social cohesive behaviour; whilst statuettes and extensive cave art would suggest spiritual behaviours are present within a population (Lewis-Williams, 2011). Higher latitude groups, such as those represented by assemblages at sites such as Höhle Fels and Mládec Cave, should begin to display distinct evidence of spiritual behaviour that is focused upon animal representation. Developed groups would have had a greater understanding of the regional landscape and its resources. As a result of this knowledge, Developed tool kits will employ more varied raw material exploitation to create more complex tools (Davies, 2001; 2007).

5.3 RESULTS

The Pioneer behavioural dataset features 23 distinct archaeological and inferred behavioural variables from 32 sites that were reduced into 4 defined analytical components, whilst the Developed behavioural dataset features 26 archaeological and behavioural variables from 40 sites that were then reduced into 5 analytical components. The variable reduction methodology employed here is comparable to the statistical process used in forming the ethnographic and Gravettian components used during later regression analyses. Tables 5.4 and 5.5 describe the recognised behavioural categories for the Pioneer and Developed analyses respectively.

Behavioural Category (Pioneer)	Expressions as stipulated by Ethnographic Model
Hunting Behaviour	▪ Hunting Dominates ▪ Gathering supportive ▪ Terrestrial herd animals dominate ▪ Small game exploited ▪ Stone and Bone used ▪ Organic materials employed
Social Networks*	▪ Long migratory periods[1] ▪ Contact with local and regional neighbours ▪ Kinship links ▪ Seasonal group ceremonies[1] ▪ Use of pigments ▪ Personal ornamentation
Social Control*	▪ Rules in place to limit resource exploitation ▪ Focus on food resources[1]
Spiritual Expression*	▪ Reflective of predominant faunal species[1] ▪ Burials, inc. grave goods[2]

Table 5.5. Modern behavioural predications within the Pioneer Aurignacian based upon the sub-arctic/temperate H-G analogies from the ethnographic model. Categories marked with (*) indicate some disparity within the different geographical regions of Europe during the Pioneer Aurignacian; [1]selected variables are co-dependent, each sharing a common repetitive element which links the variables together; [2] burials serve a dual function in reinforcing both social control and social cohesion within a society, with greater ritualistic bearing if grave goods are present within the burial area.

The results are presented in two sections: the Pioneer analysis is addressed first as these assemblages represent highly mobile modern human groups who have left smaller archaeological assemblages than their Developed counterparts. The former reflect the very first migrations of modern human groups into Europe and as a result these assemblages will better represent the behavioural choices of the first behavioural modern human populations of Europe. The Developed analysis represents modern human populations already established within the European landscape and thus should reflect behavioural differences from their Pioneer counterparts. The division of this analysis therefore aims to mimic the process in which the Aurignacian spread into Europe: initial Pioneer analysis followed by Developed exploitation.

Behavioural Category (Developed)	Expression as stipulated by Ethnographic Model
Food Resource Acquisition	▪ Hunting dominates
	▪ Gathering supportive
	▪ Terrestrial herd animals priority
	▪ Small game for food and other resources
	▪ Stone and Bone primary tool materials
	▪ Organic materials used for cordage
Social Cohesion*	▪ Ceremonies/Rituals common[1]
	▪ Use of colour pigments
	▪ Linked to dominant faunal species
	▪ Material expressions reflective of kin groups
Social Networks*	▪ Contact with local or regional neighbours[1]
	▪ Kinship links[1]
	▪ Seasonal group ceremonies[1]
Social Control*	▪ Taboos and rules in place
	▪ Unique ornaments present
	▪ Rites of passage ceremonies[1]
	▪ Burials, with/without grave goods[2]
Spiritual Expression*	▪ Control mechanisms, inc. ritualised behaviour
	▪ Reflective of predominant faunal species
	▪ Burials, inc. grave goods[2]
	▪ Non-utilitarian tools reflective of shamanism.

Table 5.6. Modern behavioural predications within the Developed Aurignacian based upon the sub-arctic/temperate H-G analogies from the ethnographic model. Categories marked with (*) indicate some disparity within the different geographical regions of Europe during the Developed Aurignacian; [1] selected variables are co-dependent, each sharing a common repetitive element which links the variables together; [2]burials serve a dual function in reinforcing both social control and social cohesion within a society, with greater ritualistic bearing if grave goods are present within the burial area.

5.3.1. Identification of Behavioural Components within the Pioneer Aurignacian

As with the previous Gravettian archaeological test the analysis began with the reduction of analytical variables into workable components. Principal Component Analysis of the Pioneer dataset resulted in the four behavioural components (Table 6.6) which were individually placed within a series of Linear Regression analyses to determine if the expression of a component was influenced by either environmental productivity, using latitude as a proxy, or other behavioural components.

All recognised components display sufficient KMO scores that permit their use within further statistical analysis.

Component Lane	Inclusive Variables	% Variance Explained	Factor Scores	KMO Score
Hunting Behaviour	Organic (Materials)	65.11	.766	.694
	Bone (Materials)		.632	
	Hunting_Medium		.898	
	Hunting_Small		.900	
Social Networks	Beads_Shells	64.812	.574	.643
	Beads_Pendants		.869	
	Beads_Teeth		.746	
	Networks_Communication		.914	
	Social Cohesion		.875	
Social Control	Ornamentation_Animal	64.724	.791	.669
	Social Taboos		.842	
	Social Control		.779	
Shamanism	Shamanism	95.628	.972	.739
	Animism		.988	
	Animal_Focus		.973	

Table 5.7. Identified behavioural components from the Pioneer Aurignacian dataset compiled after Principal Component Analysis.

5.3.2. Hunting Behaviour

As with the Gravettian model, Linear Regression analysis began with the analysis of Hunting Behaviour, including tool material and food resource acquisition, to determine the variables which influence this behaviours expression.

Table 5.7 notes those components which display an influence upon the behavioural component 'Hunting Behaviour'. As with the Gravettian analysis, latitude does not have a significant influence upon this behavioural component. Two other variables display significant influence upon the component. The first is longitude (T: -3.072; P: .001), a secondary proxy for environmental productivity, which displays a negative relationship with the expression of behaviours associated with hunting. As longitudinal position of human groups increases, as one gets further away from the Atlantic coast, Pioneer groups will reduce their hunting behaviours. The second influence is Social Networks (T: 2.340; P: .001). As the presence and frequency of social networks increases Pioneer groups will increase their hunting behaviour.

Model	Factors	d.f.	Std. Coefficient	T	P	Adj. R^2	Excluded Variables
Hunting Behaviour	Longitude	29	-.457	-3.072	.001	.320	Latitude, Social Control, Spiritualism
	Social Networks		.348	2.340			

Table 5.8. Model and associated components predicting the expression of Hunting Behaviour within human groups associated with the Pioneer Aurignacian.

The relationship between hunting behaviour and the presence of social networks is not surprising when one takes into account that Pioneer groups migrated into landscapes in which they have little, or even no, prior knowledge. Thus, cooperation between groups would ensure a greater success rate in the hunting of game, but would also provide opportunities for groups to pass on knowledge of other localities. The influence of longitude increases as one progresses further away from the Atlantic from east to west. The model states that Pioneer groups will reduce their hunting behaviour the further they migrate away from the Atlantic coast. Habitable environments within Eastern Europe would have been sparse with restricted food resources. These environmental factors would have restricted Pioneer migration into Eurasia; indeed it seems that they did, with no Pioneer assemblages being recorded in Eastern Eurasia past 30^{O}E longitude (Davies, 2001). Hunting is also reduced the further groups migrate eastwards simply because there are fewer (if any groups) present, and so reduced the potential for social networks.

5.3.3 Social Networks

Table 5.8 presents two components which can be used to predict the presence of social networks, and the variables associated with it, within groups associated with Pioneer Aurignacian assemblages.

Model	Factors	d.f.	Std. Coefficient	T	P	Adj. R^2	Excluded Variables
Social Networks	Social Control	29	1.176	6.205	<.001	.565	Latitude, Longitude, Hunting Behaviour
	Spiritualism		-.688	-3.629			

Table 5.9 Model and associated components predicting Social Network expression within human groups associated with Pioneer Aurignacian assemblages.

The increasing presence of social control (T = 6.205; P = <.001) results in a corresponding increase in the importance of social networks to Pioneer groups whilst increases in the expression of spiritual (T: -3.629; p = <.001) behaviours bring about decreases in the importance of social networks between groups.

At first this trend seems hard to reconcile as spiritualism has been taken to represent further efforts by human groups to exert social control over individuals (Dunbar, 2001, 2007). This assumption has been supported by previous analysis within this thesis in both the contemporary ethnographic record (Chapter 4) and the Gravettian archaeological record (Chapter 4, Section 4.3.6). Analysis shows that typically social control and spiritualism are on a continuum of sorts possibly influenced by demographic variables. Social behaviour in this context centres on the successful acquisition and handling of resources, cooperative behaviour would ensure that suitable resources are acquired whilst control behaviours ensure that resources are maintained. It is by no means a definitive continuum as sudden resource stress would prompt even the smallest hunter-gatherer band to adopt control behaviours to restrict the activities of freeloaders who may take more than they contribute (Barnard, 2011; Dunbar, 2007). Social controls could have been a feature within social networks, such as extended kin groups, to ensure that groups did not over exploit resources in regions to the detriment of not only their own immediate group but also others who may have need to migrate through that region. The 'deterrent' of spiritualism is an anomaly as typically this behavioural repertoire would act to bring groups together. One can surmise that as Pioneer groups were small and population densities generally low, the expression of spiritualism may not have been a suitable device for social control. According to the model, those groups who did employ such a mechanism may have been less likely to form social networks with other Pioneer groups who may have inhabited the landscape most likely due to the inadvertent creation of social boundaries.

5.3.4. Social Control

Table 5.9 presents variables which can be used to predict the presence of social control behavioural expression within Pioneer Aurignacian groups. Two components were identified as showing a significant impact on the expression of social control behaviours: Spiritualism (T = 8.554; P = <.001) and Social Networks (T = 6.205; P = <.001).

Model	Factors	d.f.	Std. Coefficient	T	P	Adj. R^2	Excluded Variables
Social Control	Spiritualism Social Networks	29	.669 .485	8.554 6.205	<.001	.820	Latitude, Social Control, Hunting Behaviours

Table 5.10. Model and associated components predicting Social Control behavioural expression within human groups associated with Pioneer Aurgnacian assemblages.

Increases in both spiritualism and social network expression bring about corresponding increases in the expression of social control behaviours within Pioneer groups. It is likely that the relationship between social control and spiritualism represent the control continuum mentioned above, helping to keep freeloading individuals within groups to a minimum; whilst the relationship between social control and social networks has been hypothesised above to represent inter-group control to maintain those resources within the landscape to a sustainable level at a time when modern human groups were unsure of their level of abundance.

5.3.5 Spiritualism

Table 5.10 presents variables which can be used to predict the presence of spiritual behavioural expression within Pioneer groups. Two components are shown to have an influence in the expression of spiritual behaviour: Social Control (T = 8.554; P = <.001) and Social Networks (T: -3.629; P = <.001).

Model	Factors	d.f.	Std. Coefficient	T	P	Adj. R^2	Excluded Variables
Spiritualism	Social Control	29	1.071	8.554	<.001	.713	Latitude, Hunting Behaviour
	Social Networks		-.454	-3.629			

Table 5.11. Models and associated components predicting Spiritual expression within modern human groups associated with Pioneer Aurignacian assemblages.

The model stipulates that increases in the expression of social control behaviours led to corresponding increases in the expression spiritualism. A similar relationship between these two variables was suggested previously (Chapter 4, Section 4.4.8.5), however, the larger Standard Coefficient within this model would seem to suggest that the influence of social control behaviours upon spiritualism is the stronger relationship of the two. Finally, the model shows that the increasing importance of social networks decreases the expression of spiritualism within Pioneer groups. The larger negative Standard Coefficient value within the previous analysis, which highlighted that spiritualism had a negative effect on the establishment of social networks, suggests that the expression of spiritualism has a greater effect on social networks than social networks have on the expression of spiritualism; lending support to the hypothesis that spiritualism and its higher degrees of population control may have acted as a deterrent to inter-group cooperation.

It is clear that these social variables, each of which aims to reinforce social bonds either by cooperation or control, share an intricate relationship with each other. What these analyses make clear, however, is that with small group sizes and low population sizes spiritualism (and the control mechanisms it represents) deters cooperation. As such, one may conclude that Pioneer groups relied more on cooperation between other groups that inhabited the landscape and employed minor social controls on their immediate kin groups only when needed. With such low population densities, spiritualism may not have been expressed as strongly as it may have done within larger populations who already had a working knowledge of the landscape.

5.3.6 Identification of Behavioural Components within the Developed Aurignacian

The archaeological and inferred behavioural dataset for Developed Aurignacian assemblages featuring 26 behavioural components was reduced into five analytical components via Principal Component Analysis (Table 5.11). Each component was individually placed within a series of Linear Regression analyses to determine if the expression of a component was influenced by either environmental productivity, using latitude as a proxy, or other behavioural components.

All recognised components display sufficient KMO scores that permit their use within further statistical analysis.

Component	Inclusive Variables	% Variance Explained	Factor Scores	KMO Score
Food Resource Acquisition	Composite Tools	75.43	.941	.689
	Hunting_Group		.964	
	Hunting_Individual		.953	
	Beads_Teeth		.543	
Social Cohesion	Engravings	48.54	.697	.740
	Beads_Pendants		.824	
	Beads_Teeth		.707	
	Ceremonies		.840	
	Social Cohesion		.853	
	Social Time		.834	
Social Networks	Beads_Shells	19.79	.779	.669
	Networks Communication		.802	
Social Control	Ornamentation_Animal	62.28	.812	.736
	Ornamentation_Human		.660	
	Social Taboos		.784	
	Social Control		.884	
Spiritual Expression	Ornamentation_Animal	75.30	.881	.800
	Ornamentation_Human		.523	
	Shamanism		.908	
	Animism		.976	
	Animal_Focus		.969	

Table 5.12. Identified behavioural components from the Developed Aurignacian dataset compiled after Principal Component Analysis.

5.3.7 Food Resource Acquisition

As with previous statistical stages the analysis began by highlighting potential influences in the expression of those variables associated with the acquisition of food resources (Table 5.12). Three components were identified to exert an influence upon the food resource acquisition behaviours of modern human groups within the Developed Aurignacian: Longitude (T = -7.9975; P = <.001), Social Cohesion (T = 5.182; P = <.001) and Social Networks (T = -3.342; P = <.001) (Table 5.12).

Model	Factors	d.f.	Std. Coefficient	T	P	Adj. R^2	Excluded Variables
Food Resource Acquisition	Longitude	35	-.735	-7.975	<.001	.686	Latitude, Spiritualism, Social Control
	Social Cohesion		.475	5.182			
	Social Networks		-.308	-3.342			

Table 5.13. Model and associated components predicting the expression of Food Resource Acquisition behaviours within modern human groups associated with Developed Aurignacian assemblages.

As with the Pioneer analysis latitude has no identifiable relationship within this analysis in relation to groups associated with Developed assemblages whilst longitude has a negative relationship with the expression of behaviours associated with food acquisition. This would suggest that similar behavioural responses were being employed by modern human who resided within Eastern Europe during the Aurignacian. The relationship highlighted within the Developed analysis, however, is stronger than that highlighted within the Pioneer analysis. It is likely that the unfavourable environments restricted the establishment of Developed groups within Eastern Europe in the same manner that it restricted the migrations of Pioneer groups. There is only one Developed Aurignacian assemblage east of 30^{o}E (Sagaidak), and located along the coastline of the Black Sea which would have provided a variety of food resources to exploit (Rigaud and Lucas, 2006). As with the Pioneer Aurignacian, the limited human presence within eastern region would have seen a logistical drop in food resource exploitation behaviours as a reduction in population density would have hindered the variability of acquisition behaviours. Social networks also display a negative association with the expression of hunting behaviours within Developed groups. The negative relationship of social networks to the expression of behaviours associated with food resource acquisition could reflect the beginnings of territoriality within the Upper Palaeolithic. Larger populations that focused on a more regionally restricted migration pattern due to their familiarity and reliance with the landscape, groups may have been less inclined to cooperate and share their resources with other, non-kin, groups.

Finally, the social cohesive component displays a positive relationship with the expression food resource acquisition behaviours, which suggests that cooperative behaviours were employed by Developed groups in the hopes of increasing the success of hunts.

5.3.8 Social Cohesion

Table 5.13 highlights the variable of Social Control associated with Social Cohesion (T = 5.305; P = <.001).

Model	Factors	d.f.	Std. Coefficient	T	P	Adj. R^2	Excluded Variables
Social Cohesion	Social Control	37	.657	5.305	<.001	.417	Latitude, Spiritualism, Social Networks, Food Resource Acquisition

Table 5.14. Model and associated components predicting the expression of Social Cohesion behaviours within modern human groups associated with Developed Aurignacian assemblages.

The model suggests that increases in the expression of social control behaviours respond with increases in the adoption of social cohesive behaviours, i.e. acts that reinforce social bonds. This reinforces the link between social cohesion and social control; though it is notable that other behavioural influences such as food resource acquisition do not significantly influence these behavioural expressions. The lack of influence by food resource acquisition behaviours is notable as one would expect social cooperation and cohesive behaviours to be employed by groups to ensure more successful returns when hunting. It has to be noted, however, that the exploitation of specific types of game throughout the Aurignacian conformed to a specific range: medium-sized, terrestrial herd animals such as deer and ibex. As the statistical methodology employed within this thesis relies on the presence of *variability* within analytical components, the conformity observed within Aurignacian populations would ensure that any significant relations between components are overlooked. It is likely that food resource acquisition behaviours did influence the expression of social cohesive behaviours within Aurignacian modern humans (it is observed within the contemporary ethnographic, and Gravettian archaeological, record), but the overall (behavioural?) conformity of assemblages masks this relationship.

5.3.9 Social Control

Table 5.14 highlights those behavioural components which display significant influences upon the expression social control behaviours within Developed Aurignacian groups. Three components are recognised by the model: Spiritualism (T = 9.589; P = <.001); Social Cohesion (T = 4.153; P = <.001) and Social Networks (T = 2.112; P = <.001).

Model	Factors	d.f.	Std. Coefficient	T	P	Adj. R^2	Excluded Variables
Social Control	Spiritualism	35	.722	9.589	<.001	.832	Latitude, Food Resource Acquisition
	Social Cohesion		.314	4.153			
	Social Networks		.142	2.112			

Table 5.15. Model and associated components predicting Social Control expression within human groups associated with Developed Aurignacian assemblages.

The model states that increases in the expression of spiritualism, social cohesive behaviours, and social network importance result in a corresponding increase in the expression of social control behaviours. The influence of spiritualism and social cohesion on the expression of social control within Developed Aurignacian populations is not surprising as previous analyses have shown that these variables aim to restrict the action of freeloaders. The Developed analysis confirms that these variables are interconnected, and each influences the expressions of the other variables. Spiritualism, and any inherent ritualism involved in this expression, will help to reinforce social control rules within groups. Such controls are likely to have reflected an animal focus, and were no doubt entailed to ensure resources were not over exploited by the threat of metaphysical punishment.

The final variable in the model, social networks, reflects an increased importance of links between groups in Developed Aurignacian communities. This is similar to what is observed within Pioneer Aurignacian groups; however, there is a weaker relationship between social networks and social control expression within Developed groups. This loss of importance of social networks may reflect that Developed groups had a sufficient understanding of their regional landscapes and their resources that intricate control systems between groups were no longer needed to ensure resources aren't over exploited.

5.3.10 Spiritual Expression

Table 5.15 presents a model predicting those components which have a significant influence upon the expression of spiritual behaviour. Two behavioural components have been recognised by linear regression: Social Control (T = 10.807; P = <.001) and Social Networks (T = -2.072; P = <.001).

Model	Factors	d.f.	Std. Coefficient	T	P	Adj. R^2	Excluded Variables
Spiritualism	Social Control	36	.881	10.807	<.001	.752	Latitude, Food Resource Acquisition, Social Cohesion
	Social Networks		-.169	-2.072			

Table 5.16. Model and associated components predicting Spiritual expression within human groups associated with Developed Aurignacian assemblages.

The model predicts that increases in social control will result in corresponding increases in spiritual expression, which is in line with the results from the previous ethnographic, Gravettian and Pioneer Aurignacian analyses. As spiritualism is also an influential factor on the expression of social controls it needs to be determined which variable has the stronger influence. In this instance social control has the larger coefficient values, suggesting that the relationship ‘Social Control > Spiritualism’ dominates and that increases in social control expression results in the development of further spiritual controls if needed. The relationship ‘Spiritualism > Social Control’ may be a secondary influence that helps to reinforce already established social bonds.

The final variable, Social Networks, has a negative relationship with the expression of social control suggesting that as social networks increase in importance the expression of spiritualism is reduced. This is similar to the relationship highlighted within the Pioneer analysis though the relationship is weaker in Developed groups. This suggests that spiritualism may have been seen as a negative aspect in relation to social cooperation between different groups and its negative influence was less in larger populations. It is an interesting point to note that larger populations (i.e. Developed groups) would have required more forms of social control to reduce the effect of freeloaders (Dunbar, 2001, 2007) but such controls were not universally applied within the Aurignacian. These Developed groups, with their larger population densities and need for more complex forms of social control, could conceivably have been the point of expansion of spiritual expression within the Early Upper Palaeolithic.

5.4 DISCUSSION

The primary focus of the Aurignacian analysis, like that of the prior Gravettian analysis, was to determine if the behavioural predications of the anthropological model can be applied to the modern human archaeological record of the Upper Palaeolithic using a latitudinal proxy for environmental productivity. The secondary goal of the analysis was to determine if the smaller archaeological assemblages of the EUP could provide enough behavioural proxies in the form of symbolic and utilitarian materials on which to base behavioural interpretations.

With regard to the first goal, statistical analysis showed no significant latitudinal influence on either the Pioneer or Developed Aurignacian behavioural expressions. In both, latitude was not recognised as either a primary or secondary influence upon any behaviour. These results suggest that latitude is not a suitable variable to use as a proxy for environmental productivity when applied to prehistoric populations in Europe. The Gravettian analysis displayed a similar lack of latitudinal influence though not to the extent observed within the Aurignacian analysis, but before accepting this conclusion one must refer to the latitudinal range employed within the EUP analysis.

Though incorporating more assemblage data in the Aurignacian (n=72) compared to the Gravettian (n = 21), the latitudinal range within both analyses are very similar with the majority of sites falling between 45^{o}N to 55^{o}N (Figures 5.4 and 5.5). Furthermore, sites used in the analysis represent a more accurate geographic distribution of the Aurignancian than those used in Gravettian, and with Spain, South-West France and the Danube Basin representing the major occupational regions and England and Italy representing outlying occupational zones. It would seem that the number of sites included in the analysis is not the issue, but instead the restricted regions occupied. Similar to the Gravettian, Aurignacian populations preferred open forested environments which provided them with sufficient resources for food and raw material exploitation. As this biome was restricted to certain latitudinal ranges, modern human groups unfamiliar with the European landscape may have considered migration to higher, unknown latitudes and different environments too great a risk to undertake. As with the Gravettian, a highly productive landscape may have acted as an anchor to migration.

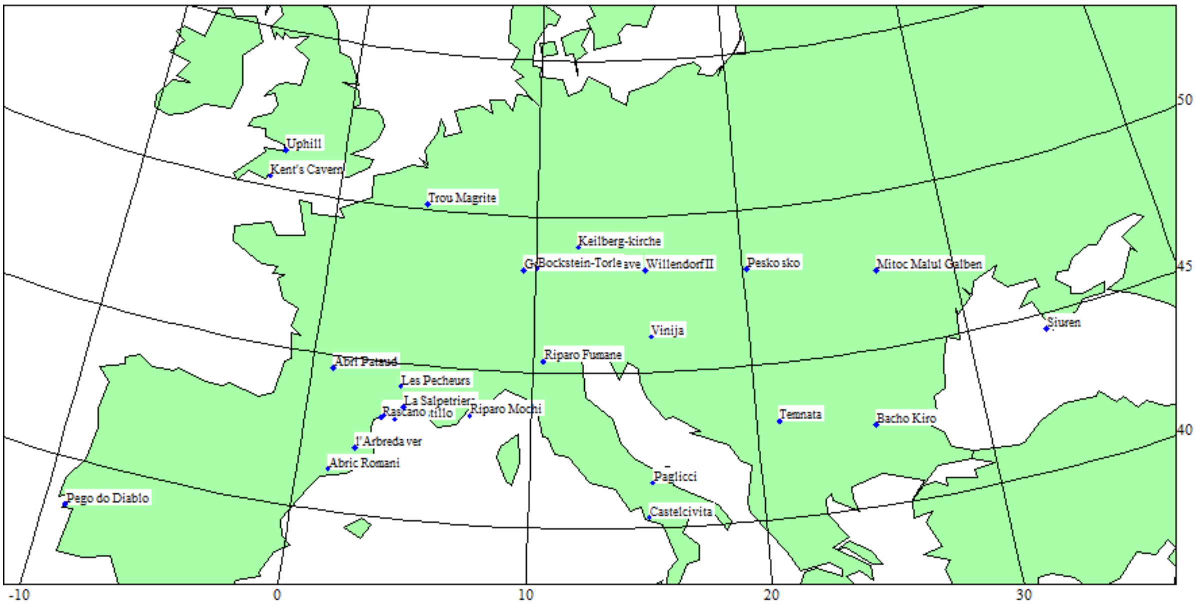

Figure 5.3. Distribution of Pioneer Aurignacian sites employed within this analysis, note that the majority of sites fall within the 40°N and 50°N range, with a few sites established beyond these limits.

Figure 5.4. Distribution of Developed Aurignacian site employed within this analysis. Note a lack of sites within the North East.

By their own behavioural choices with regard to habitat choices, modern human groups during the EUP restricted the latitudinal range available for analysis. Whether a conscious decision or not, these site distributions represent a behavioural response to environmental productivity though not in the manner this methodological analysis anticipated. The behavioural models employed in this thesis analyse the responses of human groups to environmental productivity, but specifically responses to *downturns in environmental productivity*. The responses of EUP populations represent behavioural responses to *productive* landscapes and an unwillingness to move away from available resources.

The latitudinal range employed within this analysis is significantly restricted compared to that employed within the ethnographic analysis, which ranged from 0^o to $>60^o$N. The loss of sensitivity may be having an effect on the lack of influence of the proxy of environmental productivity as much as the decisions of modern human groups to remain within certain environmental zones. Such a restriction suggests that for regional analyses such as those described in this thesis latitudinal modelling may be an inappropriate methodology for predicting behavioural responses within prehistoric human populations. Coupled with the restriction of human migration, any subsequent behavioural analyses which aim to focus on regional landscapes should look to employ other proxy variables for environmental productivity rather than rely solely on latitude.

It is clear, therefore, that latitude cannot be used as a reliable proxy for environmental productivity within the contexts of Upper Palaeolithic behavioural analysis: modern human ranges are too restricted. Though a latitudinal approach has been shown to be inappropriate for this type of analysis within the context of the Upper Palaeolithic, one cannot discount the use of the latitudinal proxy entirely. Ethnographic analyses (Binford, 2001; Oswalt, 1976; Roscoe, 2006) have shown that latitudinal proxies do work if given sufficient variation; Neanderthal site distributions may yet offer this range of variation whilst the expansion of the Upper Palaeolithic analysis to incorporate chronologically contemporary sites from the Near East and North Africa may provide sufficient variation for future analyses to employ latitudinal proxies.

Though the analysis has highlighted latitude as an ineffectual proxy for environmental variation, a secondary proxy was highlighted: longitude. Both the Pioneer and Developed analyses showed that longitude had a significant influence on hunting behaviour; specifically as longitude increases (i.e. as one goes further east) the expression of hunting behaviours and associated tool materials decreased. The Aurignacian dispersal of sites display a wider longitudinal dispersal than those within the Gravettian analysis, suggesting that with a large enough range and sufficient variation in environment, longitude can be used as an environmental proxy. Analysis by Roscoe (2002) has presented similar findings in the context of behavioural expressions between inland and coastal groups of Papua New Guinea.

It is doubtful that this relationship is reflective of the actual behavioural responses of EUP groups, and is most likely due to the lack of archaeological sites included from North-Eastern Europe that may skew the analysis. Regardless, such a result highlights the potential of longitude as a proxy for environmental productivity and the importance of have a sufficient range of variation to ensure it is an effective proxy.

The analysis shows that limited archaeological assemblages and their artefacts can be used as a basis for behavioural interpretation for human groups during the Early Upper Palaeolithic. The artefacts and materials featured within these assemblages display a fraction of the variability seen within both Gravettian and contemporary ethnographic hunter-gatherers but from these assemblages interpretations have been made regarding the social cohesive, control and spiritual expressions of the first modern humans to enter Europe. The social relationships highlighted by both sets of EUP statistical analyses broadly conform to the pattern associated with contemporary hunter-gatherer data: environmental productivity influences food resource acquisition behaviour which in turn influences the expression of social cohesive behaviours. Finally, social expressions are observed to be a part of a network of behavioural expressions with aspects of social cohesion, control, and spiritualism influencing each other. This relationship is observed within the contemporary hunter-gatherer record, the Gravettian archaeological record and now the archaeological record of the EUP. The broad conformity in social expressions suggests that the behavioural responses of *Homo sapiens* to environmental productivity have been a feature of our cognitive repertoire since at least 45 kya, though the archaeological record of Africa suggests that such responses emerged significantly before this (McBrearty and Brooks, 2000; Barham, 2007; McBrearty, 2007; O'Shea, 2011)

Though the behavioural associations highlighted within both Aurignacian analyses broadly conform to the predictions of the ethnographic model, there were several associations which differ from the ethnographic model which may represent unique behavioural adaptations employed by Aurignacian hunter-gatherers. Specifically these are the differing roles of social cohesive behaviours within Pioneer and Developed groups, and the influence of spiritualism upon the expression of these cohesive behaviours.

Interpretation of the influence of spiritual expression on social relationships is straightforward, and so we shall begin with this behavioural aspect before discussing the differences in social cohesive behaviours of Pioneer and Developed groups. The analysis suggests that increasing expressions of spiritual behaviour have a negative influence upon the establishment of social networks in both Pioneer (T: -3.629; P = <.001) and Developed (T = -2.072; P = <.001) groups. This negative influence can be attributed to low population densities within the EUP which may not have required the high level of social control that is implied by the threat of spiritual punishment. Overt acts of spiritualism may have thus acted as deterrents in the establishment of networks between different kin groups, with groups possibly discouraged by such high levels of social control. This is not to say that modern humans in the EUP were somehow less spiritual or did not believe in the supernatural but that spiritual expression may have been reduced in favour of more fluid forms of social cohesion and cooperation behaviours which would have been of benefit in the acquisition of food resources. Research on the role of cooperative behaviour in prehistoric hunter-gatherers by Spikins (2008) has highlighted how prestige and cooperation play important roles in reducing unwanted variable behaviour in individuals prior to the hunting of game. It is feasible that during the initial migrations of modern human groups within the EUP, cooperative behaviours had a much more important role than control behaviours. Those groups which were perceived to have been more cooperative would have been able to establish social links with different hunting groups, whilst those groups who relied on social control behaviours may have found creating such networks harder.

This selection for social cohesive and cooperative behavioural traits is again highlighted in the distinction of social cohesive behaviours between Pioneer and Developed groups. The Pioneer analysis highlighted a specific form of social cohesive behaviour dominating above others: social networks, i.e. the creation of link between different kin groups across different regions highlight by the transport and possible trade of raw materials and symbolic objects (Gamble, 1989, 1991). A similar occurrence is observable within the Developed analysis as general social cohesive behaviours conform to the predictive model by leading to increases in the expression of social control behaviours, whilst 'social networks' is recognised as a stand alone variable. Within the Gravettian and ethnographic models 'social networks' have previously been incorporated into the more general social cohesion variable. This division within the Developed Aurignacian between social cohesive behaviour and the establishment of social networks may be the model highlighting the differences between social behaviours employed within a group which shares kin affiliations and behaviours used with groups that do not share kin affiliations. These two analyses suggest that cooperative behaviour within the Aurignacian was essential for survival, especially during Pioneer migrations. The establishment of social networks between groups would have provided valuable opportunities for knowledge exchange on the location of food and material resources. As Pioneer groups are typically associated with migrations into unknown landscapes, such exchanges would have proved invaluable if a group were to successfully survive and exploit regional resources. It is posited that human *travel* into new regions would have been possible without such cooperative behaviours and social networks, but successful *migrations* may not have been. Though the Pioneer analysis suggests social networks were valuable and actively utilised, the Developed analysis shows a negative relationship between food resource acquisition and the establishment of social networks between groups (T = -3.342; P = <.001). This is not to say that the creation of social networks was actively neglected, but the importance afforded to them may have been reduced. There are two reasons why this may have been the case: first, Developed populations would have had ample knowledge of the regions they inhabited and thus would be familiar with the seasonal food availability and resource locations and as such the need to create networks to highlight key areas of resource abundance would not have been as pressing as it was in Pioneer migrations; and second, Developed populations are associated with increases in modern human population densities. Increases in population numbers would have resulting in increased competition for available resources between other human groups, and it needs to be kept in mind that it was not just modern humans exploiting the landscape but possibly Neanderthal groups too. The reduction in the importance of the social networks may be a behavioural response by Developed populations to help maintain resources where population densities were highest. As such an argument for the beginnings of modern human territoriality in Europe can be made, especially in Iberia, South-West France and the Danube basin occurring between 40 – 35 KYA.

These interpretations will be developed further in Chapter 9, and regardless of the differences highlighted in social cohesive behavioural expression, this analysis shows a successful application of the model to the limited archaeological assemblages of the EUP and thus supports its use to predict the behaviours of Neanderthal populations.

5.5 SUMMARY

The analysis has shown that the behavioural associations highlighted by the ethnographic model can be transposed onto the limited archaeological sites of modern human populations of the Aurignacian given the use of appropriate ethnographic analogues.

Though latitude displays no significant influence on modern human behavioural expression in the EUP, the use of longitude as a proxy for environmental productivity may be effective given a sufficient range. Expansion of both the latitudinal and longitudinal ranges in any subsequent analyses may provide enough range to ensure both variables can be employed as proxies for environmental productivity, though the expansion of such ranges may prove problematic for regional analyses.

6. SUMMARY OF THE BEHAVIOURAL APPLICATION TO THE MODERN HUMAN ARCHAEOLOGICAL RECORD

6.1 CONFORMITY TO THE ETHNOGRAPHIC MODEL

The principal aim of all the Upper Palaeolithic analyses was to determine if the behavioural responses to environmental productivity highlighted within the ethnographic model could be recognised in the archaeological record of modern humans; with a second aim determining if the archaeological record could provide sufficient material proxies that reflected the expression of non-material social behaviours.

As to the second aim, the archaeological record provides adequate material proxies for social behaviour. The presence of artefacts such as beads made from bone, shells and teeth can be seen to be reflective of kin and social cohesive expressions seen within contemporary hunter-gatherer societies; the use of colour pigment can be used to infer the presence of ceremonial activity, particularly if the use of said pigment is employed as decoration; whilst the presence of animal symbolism tentatively suggests spiritual expression. The arrangement of hearths, the location and amount of lithic débitage and faunal remains also aid interpretations of specific behaviours conducted at sites; in particular social, domestic and hunting behaviours. Finally, burials suggest that social cohesive and control behaviours are present. Thus the archaeological record provides enough material proxies comparable to the ethnographic record for the model to be applied to the Upper Palaeolithic; though whether this is due in part to the diversity of the Upper Palaeolithic archaeological record itself will only become apparent during the analysis of the Middle Palaeolithic record.

The principal aim of this analysis, however, was to determine if the behavioural associations identified within the ethnographic model could be recognised in the Upper

Palaeolithic record. If comparable behavioural associations cannot be found using Upper Palaeolithic archaeological proxies, then it is pointless to apply the predictive model to the Middle Palaeolithic on the basis that if the model cannot be applied retrospectively to one species (*Homo sapiens*) it cannot be applied to an entirely different hominid species (the Neanderthals).

The ethnographic model made certain predictions for behavioural output of the Upper Palaeolithic, summarised below:

- **The Gravettian.** Populations are predicted to display large amounts of social cohesive and control behaviours, reinforced by large amounts of material symbolism. Northern Gravettian populations should display stronger spiritual expressions, and these should incorporate distinct animal connotations.
- **The Developed Aurignacian.** Populations should display large amounts of social cohesive and control behaviours whose expressions are related, reinforced by material symbolism reflecting different kin groups. Larger populations may express minor spiritual behaviours, but in general the majority of populations should lack this behavioural expression. Material artefacts should be more varied compared to their Pioneer counterparts.
- **The Pioneer Aurignacian.** Groups should display social cohesive behaviours, but social control expressions should be limited to instances when several groups come together. As population densities will be low, spiritual expression should not be in evidence. Material artefacts should be focused on utilitarian needs.

The Upper Palaeolithic analyses (Chapter 4 Sections 4.4.6 and 4.5.7) highlight that inferred behavioural responses by modern human groups broadly conform to the predictions made by the ethnographic model; with the intricate relationships between the various non-material social behavioural expressions mirroring the relationships identified within the ethnographic model. Indeed, when one takes into consideration that several behavioural components have had to have been amalgamated due to the general conformity of the archaeological record (i.e. food resource acquisition and tool materials have been incorporated into the same component: hunting behaviour) the majority of behavioural associations identified within the ethnographic model have been recognised through statistical interpretation of the Upper Palaeolithic record.

As previously mentioned, there is only one variable which does not conform to the ethnographic model: latitude does not act as the catalyst for behavioural expression. In both the Gravettian and Aurignacian analyses, latitude is not recognised as a primary influence upon either Food Resource Acquisition/Hunting Behaviour or social behavioural expression. Though other environmental proxies such as longitude display an influence upon Upper Palaeolithic behavioural expression, this only occurs when a sufficient range is employed (as in both the Pioneer and Developed Aurignacian analyses).

This suggests that though *overall* the ethnographic model's behavioural predictions can be successfully applied to prehistoric modern human populations, the proxy variable for environmental productivity (latitude) is insufficient for a regional analysis conducted here. It is likely, as happened with longitude, that latitudinal ranges employed within these analyses were too finite and should be expanded in any subsequent analysis.

Though it is impossible to accurately know the true behavioural repertoires of modern human populations during the Upper Palaeolithic, the results of the statistical analyses described above suggest that the responses to environmental productivity by *Homo sapiens* have remained constant since at least 45 kya, though most likely before this time. Reductions in the levels of environmental productivity bring about more social cooperation between individuals and groups, with further reductions promoting human groups to actively reduce the effects of freeloaders by employing control mechanisms such as social taboos and spiritualism if population density allows.

The success of the ethnographic model, when applied to the archaeological record of the Upper Palaeolithic, suggests that it can be broadly applied to the archaeological record of the Middle Palaeolithic to infer the behavioural responses of Neanderthal populations to fluctuations in environmental productivity.

6.2 SUMMARY

This section attempted to transpose the behavioural predictions of the ethnographic model onto the archaeological record of the Upper Palaeolithic. Analysis indicates that though the latitudinal proxy is not suitable for a regional analysis such as that advocated here, the behavioural relationships of the Upper Palaeolithic mirror those of contemporary hunter-gatherer societies. Though there are some considerations one needs to take into account when interpreting the presence of these behaviours, notably how social control behaviours would affect relationships between modern human groups, we can conclude that *Homo sapiens's* behavioural responses to productivity have remained constant throughout our species' history from at least 45 kya.

7. APPLYING THE MODEL TO THE MIDDLE PALAEOLITHIC

7.1 INTRODUCTION

The social behavioural analysis of Pioneer and Developed Aurignacian archaeological assemblages shows that ethnographic behavioural modelling can be applied to the limited archaeological contexts of the Early Upper Palaeolithic. The results of the analysis are as expected, suggesting that limited archaeological assemblages can be used to infer prehistoric behavioural expressions and highlight particular behavioural expressions which may deviate from the models predictions. The similarity of the behavioural responses by both Pioneer and Developed Aurignacian populations to the original anthropological model suggests that hunter-gatherer behavioural responses to environmental productivity have remained similar for approximately 40 kya.

With the recognition of the behavioural model's applicability to archaeological assemblages containing somewhat limited artefact variations, the model and its associations can be applied to the Neanderthal record of the Middle Palaeolithic as it applies to OIS-3. The archaeological record of the Middle Palaeolithic displays less artefact variation when compared to assemblages associated with Upper Palaeolithic contexts. When variations in the Neanderthal material record do appear, such as the production of Upper Palaeolithic typologies and the presence of symbolic artefacts, they are followed by intense debate as to their validity and association with Neanderthal individuals (Chapter 2). Aspects of these debates as they relate to material culture, specifically Châtelpérronian and Uluzzian artefacts, need to be addressed before the model can be applied to the Neanderthal record.

This chapter present a series of behavioural tests developed through previous chapters and applies them to the Neanderthal archaeological record of OIS-3. The aims of this final stage of the analysis are 1) to determine if ethnographic modelling and analogy are appropriate tools for predicting/identifying social behaviours among Neanderthal foragers, 2) identify any similarities and/or differences between Neanderthal and AMH social behaviours, and finally 3) to identify other variables which may influence human social behavioural expression.

What follows is an overview of the Middle Palaeolithic archaeological record of OIS-3, including the geographical and chronological ranges employed in this analysis as well as a behavioural definition of the featured culture. The Neanderthal analysis will focus on the relationship between environmental productivity (measured by a latitudinal variable) and social behavioural expressions, including cooperative and control behaviours, following the methodology and framework developed throughout previous archaeological chapters with amendments relevant for the Neanderthal analysis described below.

7.2 THE MIDDLE PALAEOLITHIC

The majority of the information and data specifically regarding the Middle Palaeolithic, and OIS-3 in particular, has already been covered to a large extent in Chapter2 and in various contexts throughout Chapters 4 and 5. These sections will overview information relating specifically to Neanderthal populations. For specific details on OIS-3 refer back to Chapter 2.

7.2.1 Chronology and Geographic Range of the Sample

A total of 72 sites was included within the Neanderthal analysis, a larger dataset than any of the previous Upper Palaeolithic analyses (Gravettian: n = 21; Developed Aurignacian: n = 40; and Pioneer Aurignacian: n = 32) or the original ethnographic dataset (n = 55). This increase of the archaeological dataset reflects the need to have a comprehensive representation of sites for the period. The dataset does not assume to be a 100%

representation of Neanderthal behaviour, merely a better representation of Middle Palaeolithic 'culture' compared to previous analytical datasets. Compared to the previous archaeological analyses the Middle Palaeolithic analysis covers the majority of OIS-3 from c. 65 to 28 kya (a period of 40 kya compared to the c. 20 kya periods for the Gravettian and Aurignacian). Due to the doubling of the chronological timeframe of the behavioural model, there must also be a corresponding increase in the representation of sites which compose the dataset as a whole.

Table 7.1 lists all the 72 sites and associated layers which feature in the Middle Palaeolithic, i.e. Neanderthal, analysis. Sites span the full Neanderthal chronology of OIS-3 with sites such as La Ferrassie (75 – 60kya), Roc de Marsal (c. 70 kya), Kiik-Koba (~60 kya), La Quina (65 – 55kya) and Divje Babe (55 kya) representing the earliest OIS-3 occupations whilst Mezmaiskaya (29 kya) and Bajondillo Cave (28.5 kya) represent the later occupations within the analytical dataset. The majority of sites used in the analysis fall within the time range of 55-30kya. Where possible absolute dates for each site have been used as the *de facto* age of a site and its associated assemblage; where no absolute dates are available standard radiocarbon dates have been used. Where conflicting or debateable dates are featured, for example at Grotte du Renne (Higham et al, 2010, 2012; Caron et al, 2011), the prior date has been used to ensure a level of continuity with previous arguments that have also used the date to base their interpretations on (though new dates have been considered in the interpretation of Neanderthal social behaviour in Chapter 8).

The Neanderthal dataset covers a larger geographical area compared than previous archaeological data, with the majority of modern day geo-political countries represented. Previous analyses have been constrained by a lack of latitudinal variation in the sample size, though such analyses have also shown the importance of longitude to behavioural expression (Chapter 4). In response, the Neanderthal dataset has a larger latitudinal and longitudinal range featuring sites from Eurasia, with the site of Shanidar Cave located in Iraq and Shlyakh in Russia, broadening the range of the analysis from its European confines. The addition of Shanidar in particular expands both the latitudinal and longitudinal ranges of the dataset.

Of the 72 sites used within the Neanderthal dataset, Pinhole Cave, England and Shlyakh, Russia represent the northern most sites in this analysis at 53.15N and 50.1N respectively whilst the Gibraltar cave and Shanidar sites represent the southern most and Columbeira, Gruta Nova and Shanidar represent the western and eastern most fringes of the dataset (Figure 7.1).

Though the Neanderthal range would have expanded and contracted throughout the course of OIS-3 and its variable climatic phases, the Neanderthal analytical dataset is an accurate representation of the distribution throughout OIS-3 in general; with all chronological and geographical ranges present.

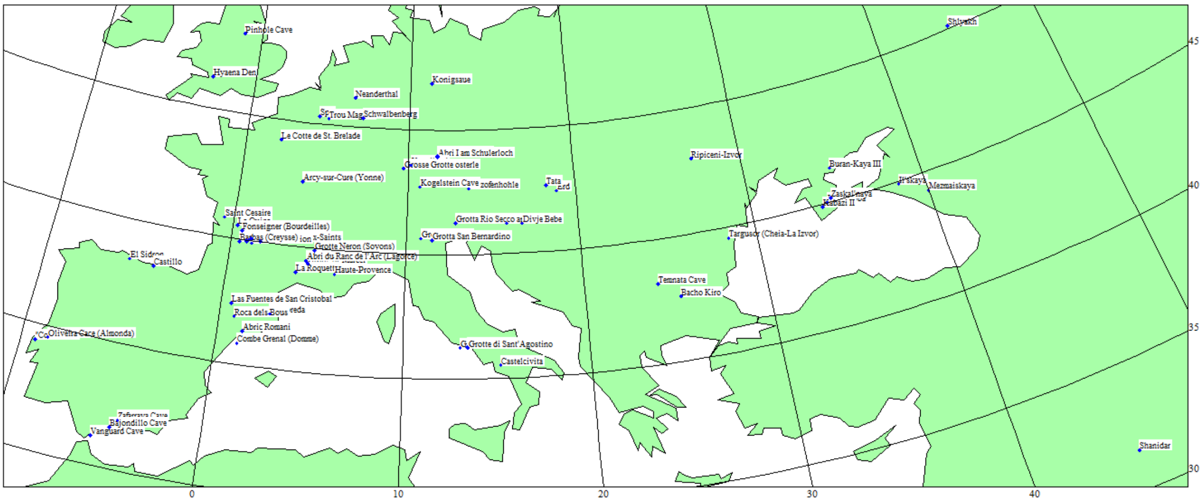

Figure 7.1. Distribution of Neanderthal archaeological sites used in the Middle Palaeolithic statistical analysis described in this chapter.

7.2.2 Environment and Climate during OIS-3

To a large extent the climate and environment of OIS-3 has been covered in detail in Chapter 2, and broadly in Chapters 5 and 6 in relation to environmental conditions in the

Gravettian (~30-20kya) and Aurigancian (~40-30kya) respectively. Presented here is a brief overview of the climate and environment of OIS-3 which directly relates to the Neanderthals represented by the sites within the analytical dataset, i.e. ~60 – 28 kya.

The onset of OIS-3 is marked by greater periods of relative warmth interspersed between cold conditions, with the majority of Eurasia habitable throughout the period. Conditions were similar to sub-arctic environments today, with summer temperatures ranging between 10 and 20^{o}C and snow fall remaining on the ground for three to six months depending on latitudinal location (van Andel et al, 2003; Burroughs, 2008: 87). Heinrich Event 5, or GS12, brought about a relatively warm and mild period c. 40kya which would have allowed tree and faunal species to migrate north; and possibly played a significant role in the initial migration of modern humans into Europe (Davies, 2001; van Andel and Davies, 2003a; Hardy, 2010).

Herbaceous vegetation was suited to local conditions and compromised of short-lived flora that could quickly migrate into favourable landscapes once conditions improved and just as quickly die as conditions deteriorated. This rapid migration of flora would have led to drastic changes in the landscape, but regardless the European Plain helped sustain large herbivorous animals such as reindeer, bison, woolly rhinoceros and woolly mammoth (Bar Yosef, 2004; Cochard et al, 2012; Hockett, 2012). Away from Europe, the Middle East would have been warmer and conditions no less abundant. The location of Shanidar cave close to water sources, and the existent palynological record, suggests that the region was a plains-type environment that could support a variety of small- and medium-sized animals as well as human groups (Rabinovick and Hovers, 2004; Hockett, 2012).

Variations aside the climate and environment of OIS-3 was far from inhospitable and provided a sufficient range of resources which could be exploited by human groups.

7.2.3 Material Affiliations of the Neanderthal Sample

The material affiliations of Neanderthals throughout OIS-3 have been detailed in Chapter 2, and what follows is a brief overview of archaeological information relevant to this analysis.

Neanderthals are typically associated with the Mousterian tool industry and its variants (Bordes, 1973, 1978; Boeda, 1991, 1993, 1994, 1995; Bourguignon, 1996; Bourguignon et al, 2006; Delagnes and Meignen, 2006; Delagnes et al, 2007; Delagnes and Rendu, 2012; Meignen, 2006; Soressi, 2004), and as such is the dominant tool industry represented within the analytical dataset

The majority of these industries are either associated with Neanderthal remains or have been dated to before the modern human migration into Europe. Due to their associations such variants have been taken to represent the activities of Neanderthal populations and have thus been included within the analytical dataset.

Sites which feature Châtelperronian assemblages have not been included within the dataset. Believed by some to represent a natural development of the Mousterian industry into an Upper Palaeolithic culture (Caron et al, 2012; d'Errico et al, 2012; Zilhao et al, 2006), the Châtelperronian poses a problem for behavioural analyses such as the one attempted here. If it could be proved that the Neanderthals alone created Chatelperronian assemblages then the behavioural context between individual and artefact would be similar to those already highlighted by the ethnographic analysis and subsequently transposed on each of the Upper Palaeolithic analyses; if one accepts the proposition that Neanderthals 'adopted' the Châtelperronian from modern humans then incorporating these assemblages into the Neanderthal analysis would defeat the purpose of this analysis. As the analysis cannot guarantee the transition of behavioural associations in Neanderthal acculturation there would be no *a priori* reason to suggest that the analysis will instead measure modern human behaviour rather than the original behavioural traits of the Neanderthals. Though Neanderthal remains have been associated with Châtelperronian assemblages (David et al, 2001; Leroi-Gourhan, 1964; Schmider, 2002), the imprecise chronology of these, and other, assemblages (Caron et al, 2011; Higham et al, 2010; Higham et al, 2012) leaves a large amount of uncertainty as to the true creators of the Châtelperronian. Due to their association with Neanderthal remains, Mousterian and Micoquian assemblages have been included in this analysis.

7.3 METHODOLOGY

The Neanderthal dataset was subject to the same statistical methodology described in the previous Upper Palaeolithic analyses: ordinal scaling of variables dependent on their observation within the archaeological record; principal component analysis to categorise variables into workable components; and a series of correlation and regression analyses to determine the relationships between behavioural components. Due to the methodological similarity between this and previous analyses a full methodological description won't be repeated here. Certain considerations regarding the Neanderthal analysis have prompted methodological amendments which are detailed below.

7.3.1 Assumptions of the Neanderthal Analysis

The Upper Palaeolithic analyses succeeded in highlighting that behavioural associations made from the contemporary ethnographic record can be retroactively transposed onto modern human societies throughout prehistory given the appropriate use of material proxies. Before applying the model directly to the Neanderthal record several assumptions about the model and Neanderthal behaviour need to be made.

(1) Ethnographic modelling, based on contemporary hunter-gatherer data, is appropriate for predicting behaviour of Middle Palaeolithic populations.

Though the Upper Palaeolithic analysis suggests that prehistoric application of the ethnographic model is suitable for use in prehistoric contexts, it is based on behavioural concepts that are typically referred to as 'modern' in scope and application. The Upper Palaeolithic analyses all span the chronology after the supposed 'Human Revolution' and as such also represent what most researchers would call behavioural modernity. The chronological span of the Middle Palaeolithic, and the focus on the Neanderthal material record, occurs prior to the onset of so-called 'behavioural modernity'. The application of the behavioural model assumes that all human species will respond to fluctuations in environmental productivity in similar and predictable ways via migration and widening of the resource base which will bring about social behavioural expressions.

(2) Neanderthal behavioural responses were consistent throughout the Middle Palaeolithic.

As noted above the chronological span of the Neanderthal sample is double of that employed in each of the Upper Palaeolithic analyses. Chronological spans did not significantly impact the analyses of the Upper Palaeolithic due to the relative environmental stability in OIS-3 after c.40kya, though seasonal fluctuations in resource abundance did occur (Burroughs, 2005; Guthrie, 1999). The Neanderthals, represented by sites in this sample, have experienced a more variable European environment. Between 60kya and 28kya Neanderthal populations would have experienced three Heinrich events and their associated changes in climate and resource availability could have brought about the expression of unique behavioural adaptations not addressed by the ethnographic analysis. Thus the analysis assumes that Neanderthal behavioural responses remained constant throughout the chronology of the sample, and the climatic and environmental changes brought about by the variability of OIS-3 did not precipitate a unique behavioural shift in the Neanderthal social repertoire.

(3) Neanderthals communicated verbally

The non-material social behaviours which are the focus of this analysis, including rites of passage and various ceremonies, are reliant upon the presence of language to facilitate the transfer of knowledge as quickly and efficiently as possible. Communicating kin relations and other abstract concepts via gesture would prove to time consuming. Language in this context implies the presence of syntax and grammar, the presence of which is fiercely debated by researchers who question the cognitive capacity of Neanderthals (Bickerton, 2007a, 2007b). To assume that Neanderthals were capable of such a behaviour when the evidence is at best ambivalent is foolhardy, but language is only one, albeit highly efficient, form of verbal communication: primates display a range of vocalisations that help to warn against predation, recognition of kin and to indicate the presence of food (Cheney and Seyfarth, 1982, 1988; Seyfarth 1987, 2007; Gouzoules and Gouzoules, 1989; Tomasello and Call, 1997 and references therein).

The assumption of this analysis is that Neanderthals had a capacity for verbal communication, possibly a proto-language on either the synthetic or the holistic approach[9] (Tallerman, 2007).It is not the place of this thesis to debate the mechanism of the origins of

[9] The *synthetic* approach suggests that single words for key items/actions/concepts developed initially and were then combined to form more evolved words and concepts via syntax. In contrast, the *holistic* approach stipulates that languages developed from the fractionation of longer utterances which have no initial structure but represent whole messages. Phonetic similarities to these utterances, or ‘strings’, eventually lead to the creation of words based on common meanings.

language (though see Tallerman, 2007 for a synthesis of the arguments for each approach), rather to highlight that Neanderthals could have communicated large amounts of social information between individuals verbally by a number of methods. It is the assumption of this analysis that Neanderthals had the capacity to employ aspects of either of these lingual evolutionary traits to facilitate the communication of social concepts.

7.3.2 Ordinal Classification of Social Behavioural Variables.

Behavioural variables were classified using an ordinal scale depending on their representation in the archaeological record. The Neanderthal analysis features 29 variables which have been classified in this manner.

Middle Palaeolithic assemblages do not have the same variability compared to those of the Upper Palaeolithic with regard to symbolic artefacts. Though the interpretation of social behaviours is still possible with a reduced archaeological assemblage, associations will be inherently weaker. It is tempting to view the appearance of single artefacts which represent social and/or symbolic behaviour as definitive proof of the presence of such behaviours within Neanderthal populations. To classify variables in this manner would disproportionately place Neanderthal social behaviours on a level above their actual expression. As a result the ordinal classification of behavioural variables in the Neanderthal analysis has been approached conservatively in an attempt to reduce the embellishment of any inferred social behaviours. A conservative approach to variable classification also presents some problems in that it can reduce, or even ignore, the appearance of certain non-material behavioural expressions. Such a conservative approach, however, does provide a base line for Neanderthal behaviour that does not favour an argument either for or against Neanderthal symbolic and social expression. This ‘behavioural base’ may over- and/or under-estimate certain behavioural expressions but it is hoped that a conservative approach will ultimately find the middle ground to give a fuller representation of Neanderthal behavioural expression throughout OIS-3.

7.3.3 Site Sample Reliability

An interpretation of the reliability of each of the 72 Middle Palaeolithic sites which constitute the Neanderthal analysis was undertaken. A range of excavation and dating data has been brought together to determine the reliability of artefact association and context within each site, though this is ultimately a subjective assessment based on the interpretation of the author. The aim of such an assessment is to ensure that artefacts which act as behavioural proxies are associated within a distinct Neanderthal archaeological context and is especially important in the Middle Palaeolithic analysis due to various arguments regarding Neanderthal behavioural modernity. A reliable context of Neanderthal artefacts is important to ensure that all behavioural inferences are associated with those of the Neanderthals of OIS-3 and not modern human populations.

Each site has been graded according to its inferred reliability of artefact association. In this context sites are 'graded' either (A), (B) or (C); with (A) representing sites which have little to no contamination and strong associations of artefacts to Neanderthal layers, whilst a (C) grading represents sites that have some possible cross-associations of artefacts but still have distinct associations with Neanderthal populations. Finally, (B) grades represent sites which have some associations with Neanderthal populations and minor cross-associations of cultural layers. Table 7.1 below lists all sites including in this analysis and their ratings.

Site	Excav. Length (Yr)	Enviro. Info	Faunal Record	Tools	Symbolism	Dating	Site Preservation	Excavation Technique	Area (m^2)	No. Level(s)	Depth (cm)	Sieve (mm)	Site Ranking
La Ferrassie	>100*	✓	✓	✓	Burial	C14	Rockshelter	Grid	20	1	50	>5	A
La Quina	>30*	✓	✓	✓	-		Rockshelter	Grid	27	3	100	>5	A
La Chapelle-aux-Saints	>75*	✓	✓	✓	Burial		Rockshelter	Grid		2	100	>5	B
Le Moustier	>50*	✓	✓	✓	Burial	ESR	Rockshelter	Grid		3	100	>5	A
Roc de Marsal	>20*	✓	✓	✓	Burial	C14	Cave	Grid	70	2	<100	<5	A
Le Regourdou	>50*	✓	✓	✓	Burial		Cave	Grid	25	2	<100	>5	A
Saint Cesaire	>50*	✓	✓	✓	Burial		Cave	Grid		1	<100	>5	A
Spy	>100*	✓	✓	✓	Burial	C14	Cave	Grid	>40	2	<100	>5	A
Shanidar	>50	✓	✓	✓	Burial	C14	Cave	Grid	<40	1	<75	<5	A
Kiik-Koba	<25	✓	✓	✓	-	C14	Cave	Grid	-	3	<50	-	B
Zaskalnaya	<10	✓	✓	✓	-	C14	Cave	Grid	-	4	<50	-	B
Mezmaiskaya	<10	✓	✓	✓	-	C14	Cave	Grid	-	3	<50	-	B
El Sidron	25*	✓	✓	✓	-	C14	Cave	Grid	>18	2	<20	<5	A
Grotte du Renne	10+*	✓	✓	✓	?	C14 AMS	Cave	Grid	210	14	<30	10	A
Hyaena Den	>3	✓	✓	✓	-	C14 AMS	Cave	Grid	>30	2	<20	<10	A
Grotte La Cala	15+*	✓	✓	✓	✓	C14	Cave	Grid	≥50	1	≤70	10	B
Krapina	>100	✓	✓	✓	Burial	C14	Rockshelter	Grid	>50	8	<50	<10	B
Trou Magrite	12*	✓	✓	✓	✓	C14	Cave	Grid	<250	9	<25	-	B
Sesselfelgrottee	>40*	✓	✓	✓	-	C14	Cave	Grid	>30	14	<10	<5	B
Pech de l'Aze	>100*	✓	✓	✓	?	C14	Rockshelter	Grid	-	1	<20	>5	C
Castillo	5	✓	✓	✓	-	C14 AMS	Cave	Grid	-	25	<100	-	C
Divje Bebe	>10	✓	✓	✓	?	C14	Cave	Grid	<500	10	<100	-	B
Il'skaya	<15	✓	✓	✓	✓	C14/TL	Cave	Grid	~200	11	<45	-	B
Gorham's Cave	>100*	✓	✓	✓	?	C14 AMS	Cave	Grid	<15	1	<10	<5	A
Grotte de Broion	>15*	✓	✓	✓	-	C14	Cave	Grid	≥30	4	≤20	<5	A
Das Geissenklosterle	7*	✓	✓	✓	?	C14	Cave	Grid	48	6	5	10	A
Erd	<10	✓	✓	✓	-	C14 AMS	Rockshelter	Grid	30	2	≤10	-	B
Kulna Cave	<25	✓	✓	✓	-	C14	Cave	Grid	-	3	<50	-	B
Konigsaue	>50*	✓	✓	✓	-	C14	Open Air	Grid	<25	3	<25	<5	B
Vanguard Cave	<10*	✓	✓	✓	Burial	C14	Cave	Grid	<20	2	<20	<5	A
Grotte St-Marcel	10+*	✓	✓	✓	-	C14	Cave	Grid	200	5	<30	<10	A
La Roquette	10+*	✓	✓	✓	-	C14	Cave	Grid	>25	3	<25	>5	A
Grotte Guattari	<10*	✓	✓	✓	?	C14	Cave	Grid	<25	2	<20	<5	A
L'Arbreda	5*	✓	✓	✓	?	C14 AMS	Cave	Grid	≤450	8	≤35	10^+	B
Castelcivita	20+*	✓	✓	✓	-	C14	Cave	Grid	175	5	≤70	-	B
Temnata Cave	7*	✓	✓	✓	?	C14	Cave	Grid	~325	9	<15	10	A
Grotte dei Moscerini	-	✓	✓	✓	Burial	C14	Cave	Grid	-	2	>20	<10	B
Salzofenhohle	>20	✓	✓	✓	-	C14	Cave	Grid	<25	3	<25	<5	A
Zafarraya Cave	>20*	✓	✓	✓	?	C14	Cave	Grid	>30	7	<25	<5	A
Tata	<10	✓	✓	✓	?	C14	Cave	Grid	-	3	≤25	-	A
Columbeira, Gruta Nova	>15*	✓	✓	✓	-	C14	Cave	Grid	≥26	6	≤20	<5	A
Combe Grenal (Domme)	>30	✓	✓	✓	-	C14	Cave	Grid	≤70	2	≤50	-	C
Grotte Neron (Soyons)	>20	✓	✓	✓	-	C14	Cave	Grid	-	5	≤100	-	C
Zaskal'naya	>20	✓	✓	✓	-	C14	Rockshelter	Grid	43	2	<30	<10	B
Fonseigner (Bourdeilles)	<10	✓	✓	✓	-	C14	Rockshelter	Grid	≤77	3	≤25	<10	B
Ripiceni-Izvor	20+*	✓	✓	✓	-	C14	Cave	Grid	<20	2	≤50	-	B
Oliveira (Almonda)	>50*	✓	✓	✓	?	C14	Cave	Grid	≤18	4	≤30	<5	A
Barbas (Creysse)	<20	✓	✓	✓	-	C14	Rockshelter	Grid	<50	2	≤100	≤5	A
Abri I am Schulerloch	>10	✓	✓	✓	-	TL	Rockshelter	Grid	-	3	≤100	-	C
Targusor (Cheia-La Izvor)	<10	✓	✓	✓	-	C14	Rockshelter	Grid	-	2	≤20	<10	C
Kabazi II	<10	✓	✓	✓	-	ESR	Rockshelter	Grid	≥13	3	≤50	-	B
Buran-Kaya III	<10	✓	✓	✓	-	C14AMS	Rockshelter	Grid	30	2	≤10	-	B
Neanderthal	>100*	✓	✓	✓	-	Stratigraphy / C14	Quarry	Dynamite/Mixed	10	2	30	<5	C
Shlyakh	<20	✓	✓	✓	-	C14/TL	Open Air	Grid	62	1	≤100	≤5	A
Roca del Bous	>20	✓	✓	✓	-	C14	Cave	Grid	-	5	≤100	-	C
Abri du Ranc de l'Arc (Lagorce)	25*	✓	✓	✓	-	C14	Cave	Grid	>18	2	<20	<5	A
Le Cotte de St. Brelade	>40*	✓	✓	✓	-	C14	Cave	Grid	>20	2	30	<5	A
Schwalbenberg	>15	✓	✓	✓	-	C14/TL	Open Air	Grid	46	2	≤25	<10	C
Bacho Kiro	8*	✓	✓	✓	✓	C14/TL	Cave	Grid	~200	11	<45	-	B
La Baume Bonne	>30	✓	✓	✓	-	TL	Cave	Grid	≤70	2	≤50	-	B
Abric Romani	>100*	✓	✓	✓	-	C14	Rockshelter	Grid	>25	12	<20	>5	A
Las Fuentes de San Cristobal	<10	✓	✓	✓	-	C14	Rockshelter	Grid	-	2	≤15	<5	A
Vogelherd	>70*	✓	✓	✓	?	C14	Cave	Grid	-	4	<20	>5	B
Grosse Grotte	>20*	✓	✓	✓	-	C14	Cave	Grid	<30	6	<30	<5	A
Bajondillo Cave	22*	✓	✓	✓	-	C14	Cave	Grid	42	6	<20	<5	A
Grotta Fumane	20+*	✓	✓	✓	?	C14	Cave	Grid	15	5	≤90	-	B
Grotta San Bernardino	20+*	✓	✓	✓	-	C14	Cave	Grid	<20	2	≤50	-	B
Grotta Rio Secco	5*	✓	✓	✓	-	C14	Cave	Grid	<20	2	≤10	<5	A
Pinhole Cave	>50*	✓	✓	✓	-	C14	Cave	Grid	<25	2	<10	<5	A
Arcy-sur-Cure (Yonne)	10+*	✓	✓	✓	?	C14 AMS	Cave	Grid	210	14	<30	10	A
Kogelstein Cave	>30	✓	✓	✓	-	C14	Cave	Grid	8	3	≤70	<5	A

Table 7.1. Individual assessments of each of the sites included within the Middle Palaeolithic archaeological analysis to determine their suitability for this particular analysis. Factors relevant to this analysis relate not only to the quality of the excavation (length, sieve, technique) but also whether sites have environmental and symbolic associations within their assemblages. Variables marked '*' represent sites which have undergone multiple excavations, '+' indicate that sieving size and application may have been variable, '-' represent variables where information was unobtainable or not recorded '?' were the is a possible case for the interpretation of symbolic behaviour. Assigned grades reflect the interpretation of the author (Alhaique et al, 2005; Ahern et al, 2004; Barton et al, 1999; Barroso Ruiz and de Lumley, 2006; Baumer and Koller, 2002; Beaval et al. 2005; Bertran et al, 2008; Bordes, 1955; Bordes and Lafille, 1962; Burdukiewicz et al, 2003; Cesnola, 1996; Chabai, 2000; Debenath and Jelinek, 1998; Delporte et al, 1984; d'Errico et al, 2002; Djnindijian, Koslowksi and Otte, 1999;Fernandez-Laso et al, 2011; Finlayson et a, 2006, 2008; Gagnepain and Gaillard, 2011; Garcia-Anton et al, 2011; Goudot, 1999; Hoyos Gomez, 1983; Hublin and Tattersall, 1998; Joris et al, 2011; Kind, 2000; Leroi-Gourhan, 1984; Malez and Ullricg, 1982; Mania and Toepfer, 1973; Marks and Monigal, 2000; Matrinez et al, 2005; Mehoroshev and Vishnyatskya, 2000; Moot, 1988; Mora and de la Torre, 2004; Muro et al, 1987; Paletta, 2005; Pasda, 2000; Peresani et al, 2011; Peyrony, 1934; Proeto Carrera et al, 2001; Raposo and Cardoso, 1998;Richter, 1997; Richter et al, 2000; Rosendahl, 2006; Sanchez et al, 2011; Soressi et al, 2007; Thoma, 1975; Tillier, 1996; Tsonec, 2000; Turk, 1997; Turq, 1989; Valladas et al, 1986; Vallois, 1958; Vandermeersch and Bonifay, 1962; Vaquero, 2008; Wagner, 1983; Weissmuller, 1995; Zilhao, 2001; Zilhao et al, 1993).

7.3.4 Neanderthal Behavioural Predictions for the Middle Palaeolithic

Behavioural predictions for the Neanderthals are based on the original ethnographic model described in Chapter 4 which suggests that as environmental productivity decreases (measured here by increasing latitudinal location) social expressions will become more frequent. The climatic and environmental conditions described above and in Chapter 2, are broadly comparable to contemporary sub-arctic/arctic conditions with some sites displaying a temperate environment: medium to high range latitudinal location, a range of interior-continental and coastal environments, seasonal changes in the availability of resources and lengthy winter seasons often featuring snowfall. Due to these factors sub-arctic and lower latitude arctic analogies were used to form the behavioural predictions prior to statistical analysis. This conforms to previous studies which have employed Inuit and higher latitude hunter-gatherer analogies to infer Neanderthal behavioural patterns (Snodgrass and Leonard, 2009; Sorenson and Leonard, 2001; Steegman et al, 2002; Hockett, 2012; Verpoorte, 2006).

> ***Prediction One:*** *As environmental productivity decreases, Neanderthal societies will broaden their food resource behaviour.*

To ensure an adequate supply for food and other resources throughout the year it is predicted that Neanderthals would have actively exploited terrestrial herd species particularly in the seasonal transition to winter. Medium sized species such as horse, deer and reindeer are predicted to be the dominant food source for Neanderthal societies due to the variety of resources they could provide, including meat, hides and bone materials for tools/marrow etc. High risk-high yield species, for example woolly mammoth and woolly rhino, are predicted to be (i) hunted as a highly valued supplementary resources by societies in the mid-latitudinal range and (ii) hunted exclusively by Neanderthal populations in higher latitudes and eastern regions. The ethnographic model also predicts that various edible plants and their fruits would have supplemented Neanderthal diet.

> ***Prediction Two:*** *Social Cohesive/Cooperative Behavioural expression is linked to the level of intensity and risk inherent in Food Resource Acquisition.*

The focus on herd species is predicted to influence the expression of a suite of social cohesive behaviours in Neanderthal societies including cooperative hunting in and between bands, rites of passage for individuals, regional migration, ceremonies held to promote the exchange of knowledge, and the care for the elderly are predicted to feature heavily in and between Neanderthal hunter-gatherer groups.

The goal of these behaviours would be to increase the chances of acquiring food from hunting excursions, with all these behaviours promoting the transition of information from hunter to hunter (i.e. rites of passages so the young can learn how to hunt effectively), from generation to generation (i.e. care for the elderly and the transmission of knowledge from experienced hunters to new ones), and from band to band (i.e. regional migration and cooperative hunting in attempts to track and acquire prey). Such acts are not just communicative in nature they also help to bind individuals to their direct kin group by facilitating the integration of an individual into a society (McNamara et al, 2009; Gamble, 1982, 1998; Grant and Gino, 2010; Lehmann and Keller, 2006; Zilhao et al, 2009; Zilhao et al, 2010). Thanks to this dual interaction/communication between individuals and groups social bonds are created which help to bind both together in a mutually cooperative system.

Prediction Three: *Social Control behaviours should be in evidence by Neanderthal societies who reside in higher latitudes or in areas of high population density. Spiritual expression may also be a feature of these societies.*

The employment of social controls and spiritual behaviours should only be expressed when population densities increase and a need to control resource availability is needed. The presence of such behaviours in Neanderthal groups is dependent upon the number of individuals of such groups or the productivity of the regions they inhabited. Aiello and Dunbar (1993) have noted that Neanderthals can theoretically maintain social groups comparable in size to those of modern humans, ~150 individuals. The only instance where sub-arctic/arctic group populations rise to this level are during group and seasonal hunts, and this corresponds with the greatest display of social control and spiritual behaviours (Birket-Smith, 1953; Antropova, 1964; Antropova and Kuznetsova, 1964; Conkey, 1980; Conaty and Beierle, 1997; Lehmann et al, 2007; Grove, 2009). Behaviours such as the implementation of social taboos, ritual violence, animism and shamanism are predicting to appear in the Neanderthal record during the winter months as resources become scarcer and group's band together to share resources and the actions of freeloaders will need to be restricted. Though seasonal expressions of such behaviours may be the most common in Neanderthal societies, several climatic downturns occurred in the chronological period covered by this analysis. Therefore social control and spiritual behaviours may have been visible during these downturns during Heinrich events 4 and 5 at 38kya and 45kya respectively (Hemming, 2004) when resources were restricted and groups would have had a greater need to control the actions of freeloaders.

Prediction Four: *Kin affiliation will be the dominant symbolic expression on material artefacts, with secondary expressions reflecting the dominant source of food, possibly in the form of art or unique artefacts.*

Finally the ethnographic model makes certain predictions regarding the material expression of Neanderthal societies based on sub-arctic/arctic analogy. Material expressions should be divided into two distinct forms: kin on the one hand and spiritual expression on the other. Material kin expressions in the form of beads, pigments, tool engravings and body art act to bring a society together by reflecting a shared kinship in material form (Gamble, 1982, 1998).

Material spiritualism represented by burials, grave goods, the unique arrangement of artefacts, the presence of rare materials and the construction of figurines serve three purposes: (i) they reinforce social controls within a group; (ii) highlight people of importance and influence in a band; and (iii) highlight those resources which are important to a particular band or kin group.

The expression of certain material artefacts are dependent on the expression of the behaviours they physically represent, therefore spiritual artefacts will be more abundant in groups which actively employ social control behaviours and material expressions of kin would be more common in general as these are based on natural kin relationships rather than linked to demographic factors.

As Chapter 2 has previously noted there are currently several debates centred on the disparity between the Neanderthal and modern human archaeological records, with modern humans producing an abundance of symbolic artefacts whilst the Neanderthal record in such items is limited. It is clear that the material predictions of this analysis may over estimate the material capabilities of the Neanderthals but this should not be taken to mean that Neanderthal social behaviours were also inferior.

7.4 RESULTS AND DISCUSSION

Presented below are the analytical results for the social behavioural analysis of the Middle Palaeolithic archaeological record, employing the compiled ordinal dataset featuring archaeological and inferred social behavioural variables from 72 Neanderthal archaeological assemblages throughout OIS-3. Though there are certain assumptions within this analysis that do not feature within those of the Upper Palaeolithic, the analytical methodology remains the same.

7.4.1 Identification of Behavioural Components used within the Middle Palaeolithic

The archaeological and inferred behavioural dataset for the Middle Palaeolithic contained 29 variables which were reduced into 5 analytical components through Principal Component Analysis (PCA). Each component was placed within a series of Linear Regression analyses to determine if the expression of a behavioural component was influenced either by resource availability (i.e. a latitudinal proxy) or other behavioural components. All recognised components display sufficient KMO scores that permitted their use in further statistical analysis in that they had scores above the basic requirement of .500. Table 7.2 lists the recognised behavioural components and their inclusive variables which are employed throughout the remainder of this analysis.

Of the five behavioural components, two are related to the acquisition of food (Food Resource Acquisition and Migration), two are related to non-material social behaviours (Social Behaviour: Cohesion and Social Behaviour: Spiritual) and one encompasses material production of both tool and symbolic artefacts (Material Artefacts).

Component Lane	Inclusive Variables	% Variance Explained	Factor Scores	KMO Score
Food Resource Acquisition	Hunting (Medium)	37.002	.785	.675
	Single		.696	
	Herd Exploitation		.890	
	Hunting Time		.573	
	Butchering Time		.682	
Migration	Migration (Short)	21.59	.594	.675
	Hunting (Large)		.695	
	Migration (Long)		.841	
Social Behaviour – Cohesion	Rites of Passage	42.35	.931	.821
	Ceremonies		.670	
	Social Cohesion		.921	
	Social Time		.682	
	Social Control		.669	
Social Behaviour – Spiritual	Spiritual Time	29.25	.720	.821
	Burial		.743	
	Burial - Caching		.808	
Material Artefacts	Communication Networks	42.54	.745	.714
	Pigment (General)		.657	
	Hearth Arrangements		.774	
	Composite Tools		.563	

Table 7.2 Behavioural components and their associated variables used in the Middle Palaeolithic statistical analysis.

7.4.2 Food Resource Acquisition behaviour

Analysis began with determining the influences on Neanderthal food resource acquisition behaviours (Table 7.3). One variable was identified as exerting an influence: Latitude (T:-2.054; P: .044).

Model	Factors	d.f.	Std. Coefficient	T	P	Adj. R^2	Excluded Variables
Food Resource Acquisition	Latitude	69	-.240	-2.054	.044	.044	Social Cohesion; Social Spiritual; Migration; Material Artefacts

Table 7.3 Model and associated components predicting the expression of Food Resource Acquisition behaviours within Neanderthal groups during OIS-3.

The model states that Neanderthal groups in higher latitudinal ranges would decrease their reliance on medium-sized and herd species as the primary food resource. Though the environmental landscape of Europe varied in its reaches during the climatic shifts of OIS-3, environments above 50^{o}N were often characterised as tundra (van Andel and Davies, 2003; Hardy, 2010). Such landscapes would not have been able to support large populations of medium-sized herbivores, especially if they migrated in large herds. As such the frequency of such herds being encountered at or above these latitudes would be less likely and the reliance of them as the primary food source would decrease as other available food sources supplemented the diet.

Such a result conforms to the predictions of the ethnographic model with regard to sub-arctic hunter-gatherer societies who rely on terrestrial herd species whose presence markedly decreases above certain latitudes, at which point secondary food sources are acquired. If contemporary hunter-gatherer analogy applies (and such results suggest that it does) this would suggest that Neanderthals supplemented their diets with other food sources, most likely gathered foods such as fruits and underground storage organs which were widely available in the landscape (Hardy, 2010) though the Neanderthal acquisition of aquatic resources is more likely but evidence is sparse (Barton, 2000; Hockett, 2012; Zilhao et al, 2010).

This is the only archaeological analysis were latitude displays a singularly significant influence on the behaviours of an archaeological population. Previous models have suffered due to a lack of latitudinal variation, and the inclusion of Eurasian sites and an increase in the sample size has shown that behavioural modelling of the archaeological record is possible if both variables (latitudinal range and sample size) are adequate.

7.4.3 Influences on Migratory behaviour in the Middle Palaeolithic.

The behavioural component labelled ‘migration’ is composed of variables related to the acquisition of food resources which do not readily fit into the previous behavioural component. As a result the component was analysed prior to the modelling of social behavioural influences in an effort to remain consistent with previous methodologies. Table 7.4 presents the data of the model and the components which have an influence upon its expression.

Model	Factors	d.f.	Std. Coefficient	T	P	Adj. R^2	Excluded Variables
Migration	Material Artefacts	67	.500	5.069	<.001	.327	Social Spiritual; Food Resource Acquisition
	Social Cooperation		.266	2.675			
	Latitude		.219	2.202			

Table 7.4. Model and associated components predicting the expression of Migration within Neanderthal groups of OIS-3.

Three components are shown to have an influence on Neanderthal migration: Material Artefacts (T: 5.069; P: <.001); Social Cooperation (T: 2.675: P: <.001) and Latitude (T: 2.202; P: <.001). The increase of each of these behaviours in turn leads to an increase in the frequency of migrations across the landscape and it is likely that their combined effects in relation to the acquisition of large game (notably woolly Rhino and Mammoth) prompt greater migratory behaviour. The 'Migration' component features the 'Food Resource Acquisition – Large Species Exploitation' variable and thus the component measures not only the movement of groups but also the possible *reason* for such movement. Material artefacts (which feature utilitarian variables) and social cohesive behaviour (i.e. cooperative hunting) would all be needed to track, hunt and butcher a large animal such as a mammoth and if Neanderthal foragers were actively hunting larger prey such behaviours and materials would be linked together.

The positive influence of latitude presents an issue for interpretation: on the one hand latitude could influence migration merely because larger species were located in northern regions and exploitation of these species could represent seasonal exploitation, a not altogether unlikely conclusion as a large amount of faunal remains come from northern sites

(Richards and Trinkaus, 2009; Schreve et al, 2012). A second possibility is that northern Neanderthal populations relied on large game as the primary source of food. A single mammoth would have been able to provide enough food for a small group for a number of weeks, longer if supplemented by other food sources (Barton, 2000; Stiner et al, 2000; Hardy, 2010; Cochard et al, 2012). Not only would this type of behaviour have differed from southern Neanderthal societies but it would also have meant that northern Neanderthals would have had to have migrated much more frequently to keep track of potential prey. Both interpretations are currently supported by the archaeological record, but the stronger positive influence of latitude on Neanderthal migration in this analysis compared to the negative influence of latitude on the acquisition of food by hunting herd animals suggests that two different forms of food acquisition behaviour were present in Neanderthal populations: the mobile hunting of medium-sized species that travel in herds below 50^{o}N (a Local Opportunist Strategy), and the high intensity migration and hunting of larger game above 50^{o}N (an Extensive Regional Strategy). This dual foraging strategy runs against Djindjiian (2009) who suggests that Neanderthals only employed one Local Opportunist foraging strategy. Neanderthals in northern regions would therefore have been involved in a high-risk/high-yield foraging strategy that would need to feature social cooperative behaviours to ensure the successful acquisition of food. This strategy would have resulted in a reduction in Neanderthal population density within the northern European landscape (Hublin and Roebroeks, 2009), with foraging groups possibly limited to the familial band leaving little archaeological trace (contra Conard, 2010 who suggests Neanderthals did not inhabit these northern regions).

7.4.4 Influences of Material Artefact expression in the Middle Palaeolithic

The ‘Material Artefact’ component is composed of variables that are observable within the archaeological record: the transfer of raw materials (Networks of Communication); Hearth Arrangements; the presence of composite tool typologies; and the use of pigment[10] and the influence this component has on other behaviours is detailed in Table 7.5.

Model	Factors	d.f.	Std. Coefficient	T	P	Adj. R^2	Excluded Variables
Material Artefacts	Migration	69	.503	4.836	<.001	.242	Social Spiritual; Food Resource Acquisition; Latitude; Social Cooperation

Table 7.5. Model and associated components predicting the expression of Material Artefacts by Neanderthal groups in OIS-3.

The model shows that only one component has an influence upon the expression of material artefacts: migration (T: 4.836; P: <.001). Increases in migratory behaviour for the acquisition of food result in a corresponding increase in material artefacts, a not unsurprising result and one that is also mirrored in the previous Migratory analysis above (Table 7.3). This association between migration and material artefacts is weaker than in the previous analysis, where material artefacts influence migration. One can infer that the presence of material artefacts has a stronger influence on migration than vice versa. The relationship highlighted within this analysis reinforces an already existing behavioural association, with the relationships serving to help reduce the risk of Neanderthal groups when hunting large game species. This would seem to reinforce the suggestion that northern Neanderthal societies

[10] Note that pigment use in this context is referred to in a general use rather than a symbolic one. The presence of pigment at sites such as Cueva de los Aviones and Cueva Anton (Zilhao et al, 2010) is limited and a solely symbolic association cannot be inferred. Rather the pigment could have been employed in domestic activities such as preserving animal hides. The behavioural variable ‘Pigment – General’ thus represents the broad use of iron oxide pigments with an emphasis on domestic use but not entirely dismissive of possible symbolic applications.

exhibited distinct behavioural differences from their more southern contemporaries. This is not to suggest that southern Neanderthal groups lacked material expression, hide working, or composite tool use but that such artefacts were of greater importance to northern groups who would have relied upon them to a far greater extent. This may correspond with social cooperative behaviours and may represent links that have developed between different kin and foraging groups. This material reinforcement of cooperative networks is evidenced in the ethnographic record, where the Ju'/hoansi act of hxaro established cooperative links between groups via material gift exchanges (Weissner, 1982, 2002). It is possible that the artefacts used by northern Neanderthals, especially those made from non-local resources, could represent a material link to distant kin located elsewhere in the European landscape.

7.4.5 Influences on Social Behavioural expressions in the Middle Palaeolithic

The final analysis focuses on the overall goal of this entire analysis: the prediction of social behaviours within Neanderthal societies of the Middle Palaeolithic. Results are summarised in Table 7.6 which suggest that two behavioural components influence the expression of social cohesive behaviour in Neanderthal societies: Food Resource Acquisition (T: 3.403; P: <.001) and Migration (T: 2.868; P: <.001).

Model	Factors	d.f.	Std. Coefficient	T	P	Adj. R^2	Excluded Variables
Social Cohesion	Food Resource Acquisition	68	.368	3.403	<.001	.187	Social Spiritual; Latitude;
	Migration		.310	2.868			

Table 7.6. Model and associated components predicting the expression Social Cohesive behaviour within Neanderthal groups of OIS-3.

The model states that these two variables lead to increases in the expression of social cohesive behaviour in Neanderthal societies. This is in line with the predictions put forward by the ethnographic model which states that food resource acquisition would be the impetus for social cohesive behaviour (Chapter 3).

Such a behavioural response is understandable as cohesive behaviours would have been required for hunting migratory herd species and large game. Cohesive behaviours such as cooperative behaviour between individuals and bands would ensure a greater success in hunting whilst rites of passage behaviours and knowledge exchange ceremonies would ensure that individuals know their roles in hunting parties and in society in general. Additional ceremonies would have further helped to reinforce social/kin bonds between individuals and bands.

Interestingly, food resource acquisition (herd) has a stronger influence on the expression of social cohesion behaviours than migration (and the acquisition of large game). This would suggest that there is a stronger social need when hunting herd animals than larger ones and that there were behavioural distinctions between northern and southern Neanderthal societies reflective of the greater need for cooperation and control that would have been beneficial to survival in such high risk-high yield environments. Behavioural differences would be evidenced in levels of social cooperation, control and possibly spiritual expression which should all be higher in northern populations that would have employed these mechanisms as social barriers to prevent failure.

7*.4.6 Influences on Spiritual Expression in the Middle Palaeolithic.*

The final analysis, determining factors which influence spiritual expression in Neanderthal societies, yielded no significant results when placed through Linear Regression. Of all the behavioural aspects of this analysis the spiritual component has been the least influential and has not influenced the expression of other behavioural variables.

There are two possible explanations for this, one behavioural and one methodological. The behavioural explanation would seem to indicate that Neanderthals were not overtly spiritual. If a behavioural explanation is accepted then Neanderthal burials represent something other than spiritualism, and may instead represent other forms of cohesive behaviour or simply the removal of decomposing remains. The variety of Neanderthal burial activity (Pettitt, 2011) would suggest that the latter option can be discarded and that Neanderthal burial represents another aspect of social cohesion. If true, this would create a distinction between Neanderthal and modern human burials. The latter, with their grave goods, allow for the interpretation of spiritual expressions whilst the former may simply be a cohesive act intended for the group rather than the deceased, a basic form of emotional nurturing.

Alternatively, the methodological explanation rests on the use of the material proxies employed to infer the presence of spiritual behaviour. The Neanderthal record lacks material artefacts which can be attributed to spiritual expression when compared to the archaeological record of modern humans in the Upper Palaeolithic. This would suggest that the use of proxies was either too narrow and may need to be broadened which is unlikely considering that such proxies held up well in all previous analyses, or that Neanderthal spiritual behaviour was sufficiently different from modern humans that analogical proxies based on contemporary ethnographic records cannot be used to identify them.

Regardless, this analysis indicates that spiritualism may not have played a significant part in Neanderthal behavioural expression. The implications of this with regards to Neanderthal behavioural 'modernity' are discussed in more detail in Chapter 9.

7.5 SUMMARY

The Middle Palaeolithic analysis described in this chapter centred on four behavioural predictions based on ethnographic modelling. The conformity of the Neanderthal archaeological record to these predictions allows one to interpret not only the usefulness of employing ethnographic modelling to determine Neanderthal behaviour, but also highlights differences between the social behaviours of Neanderthals and modern humans.

Of the four behavioural predictions outlined in this chapter (see above), statistical analysis upheld two of the predictions (Food Resource Acquisition and Social Cohesion), supported the interpretation of a third (the relationship between Kinship and Material Culture) and refuted a fourth (Social Control/Spiritual expression). The results of the analysis broadly favour the use of ethnographic analogy in relation to Neanderthal behaviour, with the caveat that the appropriate analogue is employed (i.e. sub-arctic/arctic hunter-gatherers), but also highlights several social differences between Neanderthals and modern humans that will be discussed in Chapter 8: the lack of spiritual and social control behaviour, the different role material artefacts may have played in Neanderthal foraging societies, and the use of alternative foraging strategies employed by Neanderthal groups occupying different landscapes. These behavioural differences suggest Neanderthals may have employed a less adaptive social economy compared to that of modern humans, one that was heavily influenced by demography, population density, and physiology.

8. DISCUSSION

8.1 INTRODUCTION

The series of social behavioural analyses conducted throughout this thesis have attempted to determine the suitability of ethnographic analogy as a tool for inferring non-material social and symbolic behaviour from the archaeological record. The aim of this approach was to highlight any behavioural differences/similarities between Neanderthals and anatomically modern humans (AMH) which are not interpreted in conventional analyses of archaeological assemblages. Results show (Chapters 5, 6 and 7) that social behavioural modelling can be an appropriate tool in inferring prehistoric social behaviours if certain criteria are met.

This chapter will build on discussions already highlighted in Chapters 4 to 7 on the role social behaviours played in Middle and Upper Palaeolithic foraging societies, and the unique social expressions that separate Neanderthals and AMHs.

8.2 THE SUITABILITY OF ETHNOGRAPHIC ANALOGY IN INTERPRETING PREHISTORIC SOCIAL BEHAVIOUR

A discussion of the overall methodology and development of the ethnographic model and analogical process in warranted here as the interpretations of the results of the various analyses rely on an understanding of both the benefits and limitations of the process. The reader needs to be aware of these to understand not only the methodology of this thesis overall but also how interpretations were conducted and conclusions were arrived at. Ethnographic analogy has become a standard tool for archaeologists to infer behavioural trends in prehistoric populations. Models have naturally focused on behaviours which provide distinct material proxies within the archaeological record rather than focus on behaviours that may not leave material traces. Analogies have therefore focused on interpreting prehistoric foraging strategies (Oswalt, 1976; Winterhalder, 1981; Yesner, 1981; Binford, 1986, 2001; Foley, 1992; Kaplan and Hill, 1992; Cosgrove and Pike-Tay, 2004; Collard et al, 2005), determining which food sources were exploited (Roscoe, 2004, 2006; Liebenberg, 2006; Dorsk and Wright, 2010; Cohard et al. 2012; Knight, 2012) and determining potential rates of fission-fusion in prehistoric societies using behaviours which can be corroborated by a range of archaeological, ethnographic and primatological evidence (Conkey, 1980; Grove, 2009; Morgan, 2008; Grove et al, 2012; Burke, 2012).

Interpreting prehistoric social behaviour has not been approached with the same methodological consistency, given that many social expressions have few discrete material proxies. The only way researchers can interpret prehistoric social behaviour is to adopt a narrow approach that can be reconciled with the archaeological record such as focusing on symbolic artefacts, the transport of raw materials and faunal exploitation (Gamble, 1998).

The main failing of this approach is self evident: only a selected range of social behaviours can be interpreted. When one considers the importance of behavioural modernity in questions related to Neanderthal extinction and the resulting dominance of AMH in the Upper Palaeolithic, focusing on a narrow behavioural range only serves to limit our understanding of human behaviour during the Middle-Upper Palaeolithic transition. Further, the majority of these models have adopted an environmental approach to hunter-gatherer behavioural expression (Oswalt, 1976; Binford, 1986; Fitzhugh, 2001; Roscoe, 2004, 2006; Lehmann et al, 2007; Grove, 2009; Dorsk and Wright, 2010) with only a handful of behavioural models identifying other variables which may affect human social behavioural expressions (Wiessner, 1986, 2002; White, 1982; Minnis, 1985; Foley, 1992).

The ethnographic model described in Chapter 3 and the subsequent statistical results show that existing models can be adapted to identify and predict a large range of social behavioural expressions in both contemporary and prehistoric hunter-gatherer societies. Several factors make this possible: (1) an existing behavioural framework, (2) an expansive dataset composed of behavioural variables from representative hunter-gatherer societies of all ecological zones that includes both material and non-material variables, (3) the recognition that individuals 'imprint' specific associations onto artefacts not related to their utilitarian function, and (4) a representative range of archaeological sites/assemblages of a given cultural period which can be used as archaeological analogies. The importance of each of these factors in the construction of a social behavioural model is discussed below.

8.2.1 Employing and expanding on existing behavioural frameworks

Models that predict past human social responses to environmental variability need to be comparable with existing behavioural models for methodological reasons. Compatibility serves two purposes: the model employs recognised variables for measuring environmental variability, and the results of any statistical analysis can be directly compared with those of previous behavioural models.

By incorporating aspects of Binford's *Routed Foraging Hypothesis* (1986), Oswalt's (1976) model of technological complexity and Roscoe's (2004) latitudinal model on hunter-gatherer food resource composition, the model described in this thesis is methodologically capable of determining hunter-gatherer responses to resource variability (Binford, 1986) using a latitudinal proxy for environmental productivity (Oswalt, 1976; Roscoe, 2004). By expanding and incorporating aspects of these early models, initial latitudinal results are comparable with them. Any significant deviations from these models would suggest that the construction and analysis of the dataset was inappropriate for the type of analysis that was being undertaken. As each of the models address different issues relating to hunter-gatherer behaviour the initial model could be evaluated against three variables: tool complexity, food resource acquisition and migration. The results (Chapter 3, Section) regarding food resource acquisition and tool complexity conform to the models proposed by Binford (1986), Roscoe (2004) and Oswalt (1976) respectively. Only migration could not be identified in the initial analyses due the nature of this variable and its representation in the archaeological record. The conformity of the results here to existing behavioural models suggests that the approach undertaken is appropriate for interpreting past hunter-gatherer social behavioural expressions. This approach is inherently conservative but necessary to address behaviours which are potentially influenced by a variety of factors and display multiple links to material artefacts.

The inclusion of material variables in the model is important if one is to apply it to the archaeological record, but their inclusion also serves to highlight other potential influences on social and symbolic expression other than environmental variability. The results in Chapter 3 clearly show an environmental influence on several social behavioural expressions (Chapter 3, Section 3.4.3), but they also highlight the influence that both food resource acquisition (Chapter 3, Section 3.4.3) and tool use (Chapter 3, Section 3.4.2) have on material and non-material social behaviours.

The analysis has therefore highlighted interplay between environmental variability and food resource acquisition influencing the expression of social behaviours in hunter-gatherer societies. The recognition of this interplay in the Middle Palaeolithic suggests that the analysis has recognised a core behavioural facet of hunter-gatherer societies, and the factor could be employed when other variables are lacking.

8.2.2 A large and variable ethnographic dataset

To identify those variables which influence the expression of hunter-gatherer social behaviour, and the relationships which exist between these variables, an adequate ethnographic dataset is required. Such a dataset needs to reflect the full range of hunter-gatherer behaviour and must represent all ecological zones.

Past ethnographic models have tended to employ datasets compiled from the contemporary record and though they represent the major ecological zones the sample sizes tend to be small; for example Oswalt employed 21 societies in his 1976 analysis (Oswalt, 1976). Any social behavioural analysis employing ethnographic data must ensure that datasets represent the full range of hunter-gatherer environments and this can only be accomplished if multiple societies from each environmental zone are used. This ensures that each landscape within a given region (plains, coastal, forest etc) is represented and that behavioural associations linked to these landscapes are recorded. The analysis here incorporates 55 hunter-gatherer societies from a range of environments and landscapes representing a greater anthropological range and variability than previously attempted.

The information required to create these datasets is already available in the literature, and in some instances has already been gathered together online: quantitative data can be found in Murdoch (1967) and Binford (2001), whilst qualitative information is available through the *Human Relations Area Files (HRAF)* and ethnographic reports (such as Balikci, 1970; Damas, 1984; Barnard, 1992). Several researchers already employ some of these resources, but to understand the full range of hunter-gatherer behaviour one must incorporate all this data into an appropriate analytical framework as suggested above. This model and analysis show that these resources (Murdoch, 1967; Binford, 2001 and HRAF in particular) need to be employed with greater frequency to help progress social behavioural modelling and its application to the archaeological record.

8.2.3 'Imprinting' behavioural associations onto artefacts

Unlike foraging models, social behavioural models cannot rely on discrete material proxies to identify behavioural expressions. The ethnographic record shows that cultures embed social expressions onto a range of materials and artefacts, including tools and symbolic artefacts (Wiessner, 1986; Winterhalder, 1992; Henshilwood and Marean, 2003). Recognising and employing these associations forms the very core of social behavioural modelling. Some associations between materials and their social meaning are well known, such as the *hxaro* gifts used by the Ju/'hoansi and the exchange of food between hunters in Inuit societies. The materials employed in these exchanges all have other primary utilitarian purposes, but their social function is to mitigate risk in times of stress.

Exchange networks are just one example of social associations between materials and artefacts, but others can be found in the decoration of tools to reflect kin associations (Conaty and Beierle, 1997), the precedence given to certain hunting tools when foraging (Oswalt, 1976;Gell, 1991; Fitzhugh, 2001) and of course the multitude of spiritual associations given to living organisms and artefacts (Balikci, 1970; Lowe, 1998; Aldhouse-Green, 2001; Layton, 2001; d'Errico and Vanhaeren, 2007; Dunbar, 2007; Culotta, 2009; Lewis-Williams and Challis, 2011; Pettitt, 2011). It is important for any behavioural analysis to understand that one material artefact can play host to several social associations. The variety of these behavioural associations needs to be recognised so that (a) the full range of behavioural expressions/associations are included in any compiled dataset, and more importantly (b) so that a variety of proxies are available to use in the interpretation of social behaviours from the archaeological record. It is critical to record the context of these associations and also recognise both primary and secondary associations. By identifying context, one can ensure that multiple proxies are available for use when applying the model to the archaeological record.

8.2.4 Representative range of archaeological sites/assemblages

The creation of an ethnographic dataset for inferring social behaviours in prehistory will only be as good as the archaeological assemblages and materials selected as potential proxies for such behaviours. It has already been discussed that individuals associate behaviours to certain materials and artefacts and there are two issues in translating these associations to the archaeological record: first, archaeological assemblages only represent a fraction of the material variability used by prehistoric foragers; second, archaeological sites only represent a fraction of the occupational events of prehistoric groups.

The first issue can be resolved by recognising that several social behaviours can be associated with a single artefact. By categorising ethnographic artefacts into discrete categories based on the associations given to them by contemporary hunter-gatherers, one can then find comparable material analogues within the archaeological record which can be used for social inferences.

To address the issue of the number sites being unrepresentative of the number of occupational events, the full range and types of sites and their assemblages were included in the analysis. For periods whose archaeological record is especially sparse the maximum number of available sites need to be included to ensure a fuller representation of a culture. This approach exports the focus of analyses to a continental scale, though periods with an abundance of sites may be capable of supporting more focused regional analyses, for example in the Gravettian. Restricting analysis to certain cultural periods has the advantage that periods can be compared. Finally, when applying a behavioural model to the archaeological record it is important to maintain the focus of any analysis on one culture and species. This model has conducted independent analyses on both AMH and Neanderthals but has not incorporated a combined analysis featuring both species even when incorporating all EUP/UP AMH cultures. It would be possible to adapt an analysis of this type to include multiple cultures or multiple species, for example comparing social behaviours between the Palaeolithic, and the Neo- and Mesolithic may be of interest to some, but such a model may not be able to determine fine grained behavioural differences and could potentially only provide the broadest of conclusions.

8.2.5 Social Behavioural Modelling and the Archaeological Record

The various analyses conducted throughout this thesis show that ethnographic analogy can be used to infer the presence of social behaviours in past hunter-gatherer populations. Due to the non-material nature of some social behaviours certain considerations need to be addressed prior to the application of any analogical conclusions. Regardless, the development of social behavioural models in the future will provide a valuable analytical tool for researchers wishing to understand the influence of environmental productivity and on the expression of prehistoric social and symbolic expressions. Currently one must take an inherently conservative approach in developing and interpreting these first generation social behavioural models but the ethnographic model described throughout this thesis has highlighted a series of social relationships which exist due to the influence of environmental variability in both contemporary and prehistoric hunter-gatherer societies. This model has shown the value of ethnographic analogy as a tool for archaeologists inferring prehistoric social behaviours when employing an adaptable yet conservative analytical approach.

8.3 ENVIRONMENTAL INFLUENCE ON HUMAN FORAGERS IN THE MIDDLE AND UPPER PALAEOLITHIC

A key result of the analyses conducted in this thesis has been the observation of the behavioural responses to environmental variability in both contemporary and prehistoric hunter-gatherer societies. The analyses have shown that foraging societies deal with environmental variability by adopting optimal regional foraging strategies best suited to the landscapes they reside in. Further, behavioural responses that are employed to reduce the amount of risk when acquiring food are not only found among contemporary ethnographic populations, but also among Upper and Middle Palaeolithic foragers. The identification of this behavioural constant in both modern human and Neanderthal foragers suggests that cognitive differences between the two species were negligible and that the use and understanding of the term 'behavioural modernity' needs to be re-evaluated. The conformity of the results suggests that there is a core behavioural principle in human foraging societies: food is the essential resource – which is obvious – but all other resources/behaviours either support the acquisition of food or else becoming secondary to it. Thus any differences in Neanderthal food resource acquisition behaviour could provide potential insights into Neanderthal cultural behaviours rather than cognitive limitations.

8.3.1 Regional Specialisation of Neanderthal Food Resource Acquisition Behaviour

Where once Neanderthal foragers were viewed as simple scavengers we now know them to be apex predators whose choice of prey centred on medium and large game species such as horse, ibex, reindeer and mammoth and as a result employed a range of strategies to successfully exploit each of these resources. The archaeological record of Neanderthal diet and food resource acquisition is by no means complete, and new finds of small game, fish and plant exploitation continuously alter our understanding of Neanderthal diet and foraging strategies (Cochard et al, 2012; el Zaatari et al, 2011;Hardy, 2010; Hockett, 2012).

The archaeological record suggests a regional distribution of large game species restricted to northern and eastern regions whilst the open grassland landscapes of southern Europe were the preferred habitat of medium sized herd animals. The distinction in Neanderthal food resource acquisition highlighted by the statistical analysis could therefore represent the adoption of regional foraging strategies by Neanderthal groups as a result of the varying levels of environmental productivity between northern and southern Europe. Alternatively these results could support the interpretation of Neanderthal seasonal exploitation of food resources[11].

The ethnographic record provides a series of analogues that one can use to distinguish between the seasonal and annual exploitation of certain species and resources. A seasonal change in resource dependency from summer to winter typically involves a shift to high yield species which can provide a range of resources including food and domestic materials and also involves the exploitation of a range of secondary resources or the use of previously cached food stores. Seasonal exploitation also involves migration to reconnect with other groups, though the nature and size of such aggregations are dependent on total food resource availability (Heffley, 1982; Lehmann, et al, 2007; Grove, 2009; Grove et al, 2012; Morgan, 2009; Roscoe, 2006).

The evidence to support the interpretation that Neanderthal foragers pursued large game as part of a seasonal foraging strategy during the winter months is present but ambiguous: the majority of faunal remains attributed to large game species such as mammoth are found in sites and contexts which were occupied in winter (Golovanova et al, 1999; Patou-Mathis, 2004; Steele, 2004; Burke, 2006; Pettitt, 2011) and large game tend to dominate faunal assemblages but they also include a range of other species conforming to ethnographic analogues of high latitude foragers (Hardy, 2010; Delagnes and Rendu, 2011; Cochard, 2012), and with large game predominantly located in northern and eastern regions

[11] In this context: a 'regional forager' represents an individual or group who remains within a specific region/landscape/foraging radius all year round and exploits a distinct 'primary' resource; whilst the 'seasonal forager' migrates between two distinct regions as resources permit and as a result may have multiple primary resources depending on the environment. Such migrations may be small or large depending on the environment. An example of a seasonal forager would be the Inuit who exploit fish and terrestrial game in the summer, and seal in the winter; whilst the Dogrib Indians are an example of a regional forager who remain focused on the acquisition of caribou within their hunting grounds all year long.

hunter-gatherers would have likely had to migrate to exploit them (Fiore et al, 2004; Delangnes and Rendu, 2011; Burke, 2012).

It has to be noted, however, that the data can support other interpretations. Many of the sites occupied during the winter downturn are caves and rock-shelters and the primary function of the site was to provide shelter. Sites could represent occupations by either regional or seasonal foragers as both would have needed shelter from the elements in equal measure. Indeed, regional foragers are likely to have known the landscape far better than seasonal foragers and would therefore have had primary knowledge of the best shelters and exploited them accordingly. Similarly, if concentrations of large game could be found in northern regions throughout the year then Neanderthal foragers could have survived without having to adopt any significant seasonal foraging behaviour. With these contexts under consideration winter occupation sites could represent the activities of either seasonal or regional foragers,

Recent interpretations of the Mousterian tool kit and Neanderthal population structure and migration patterns lend support the regional foraging strategy model. Ruebens (2012) notes that the Mousterian displays elements of regional variation between north-west and central-eastern Europe: the Mousterian of Acheulean Tradition (MTA) in the west, the Micoquian in central Europe. Various ethnographic analyses (Oswalt, 1976; Binford, 1986, 2001; Winterhalder, 1987; Smith, 1991; Torrence, 2001; Collard et al, 2005), including this thesis, have highlighted the link between tool form and function and regional changes in the Neanderthal tool kit suggests that Neanderthal foragers in these different regions were exploiting different resource types. The faunal record shows that Neanderthals, no matter their regional habit, still exploited a range of food resources and would have needed a multi-purpose tool kit; but the exploitation of different primary resources would have required the adaptation of tool kits so as to more efficiently acquire and kill specific game. The stylistic differences between the MTA and Micoquian could represent these adaptations, with the bulkier Micoquian of central Europe possibly the facies of choice for the exploitation of large game.

Our understanding of Neanderthal demography and migration patterns also suggests that Neanderthal foragers, all things being equal, would have benefited from a regional foraging strategy rather than a seasonal one. Both Gamble (1999) and Mellars (1996) have noted that Neanderthals exploited smaller home ranges than modern human foragers, and isotopic and energetic evidence suggests that Neanderthal foragers may have had a minimum foraging radius of 20km[12] (Burke, 2006; Richards et al, 2008) thus Neanderthals were restricted to a small foraging zone. In regions below 45°N, resources would have included a range of medium sized herd animals but in the north large game may have been the only suitable primary resource available. Such ranges would have affected northern Neanderthals foragers in two respects: first, Neanderthal group sizes would have been constrained as the landscapes would not have been able to support large aggregations of Neanderthal individuals (Grove et al, 2012); and secondly, Neanderthal foraging groups could have only survived by constructing strong social cohesive bonds between individuals (discussed below). Employing regional foraging strategies in such contexts would have been beneficial for Neanderthal hunter-gatherers as smaller foraging groups would have become better acquainted with their home ranges and smaller population densities of Neanderthal foragers would have been unlikely to have over exploited resources.

The support for the adoption of Neanderthal regional foraging strategies is likely the result of the continental scale of the Middle Palaeolithic, and it is likely that Neanderthal foraging groups employed seasonal adaptive strategies when resources where under stress. The analysis serves to highlight the different foraging strategies employed by Neanderthals

[12] Giving a potential total home range of 1,257km^2 or 781 square miles though these estimates must be considered as representing the minimum potential range.

throughout their European range. Such behaviours are comparable in contemporary foraging groups, who over a distance of 1,500km[13] (comparable to the Neanderthal European range) adopt regional strategies in conjunction with seasonal activities. This serves to show that hunter-gatherer societies can be (broadly) regionally defined by the animals they exploit and the food resource acquisition behaviours and technologies they employ[14].

This thesis posits that Neanderthal foragers adopted a regional foraging strategy centred on the acquisition of one primary resource supported by a range of secondary acquisitions. This would have involved the recognition of specific animal species that would have been able to provide a range of resources for hunter-gatherer groups. In the south, Neanderthal foragers would have focused on the acquisition of medium sized game whilst in the north large game such as mammoth were pursued due to the range of materials they could provide in an environment where overall resources were limited. This is not to say that northern Neanderthals focused on one resource at the expense of others, merely that certain species were more highly valued than others and pursued accordingly. Thus Neanderthal foragers in the north would have exploited secondary resources to pre-empt any failure in the acquisition of large game resources (as the faunal record of the Middle Palaeolithic suggests they did). A migratory lifestyle would have been a feature of these regional foraging strategies, more so for northern foragers who may have had to travel further for potential resources. The social consequences of this divide on Neanderthal foragers are discussed below.

In effect, statistical analysis and ethnographic analogy suggest that Neanderthals were practising optimal foraging strategies designed for the environments and resources of Europe during OIS-3.

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[13] Based on the differences in primary resources of the Dogbrib Indians and Copper Inuit.

[14] The Miwok and Yuki are examples of hunter-gatherer societies that employ local regional foraging strategies, where each society has diverged to exploit separate resources. For the Yuki, this involves the primary exploitation of fish by Yuki Lake foragers, and terrestrial resources by the Yuki Proper.

8.3.2 Modern Human Food Resource Acquisition Behaviour

The adoption of regional foraging strategies by Neanderthals contrasts to the foraging behaviours of AMH during the Pioneer and Developed Aurignacian. The faunal record of the EUP would seem to suggest that though AMH foragers predominantly exploited resources such as reindeer and horse there was no regional specialisation of either species with hunter-gatherers instead opting to exploit a range of species. It is only in the Gravettian that we see the regional specialisation of hunting between east and west. The archaeological record of the Early Upper Palaeolithic (EUP) suggests that AMH foragers limited their food resource acquisition behaviours to environments which they had experience in exploiting, typically grassland and lower latitude evergreen environments which were similar to those of the Near and Middle East from where they emigrated. For Pioneer Aurignacian foragers the environment served as an anchor for migration into other regions, and it would have aided their travel across Europe as they would have experienced similar conditions prior to their arrival into Europe. The archaeological record shows that by c.35 kya Developed Aurignacian groups had begun to venture into higher latitudes for extended periods of time, but it is only in the Gravettian that we see AMH distributed throughout the majority of ecological zones of Europe.

The exploitation of a variable food base would have reduced the risk of starvation only if adequate tool technologies were created which could be utilised on a variety of game. The new blade typologies of the Aurignacian can be viewed in the same light as the variation observed within the Mousterian: a technological response aimed at reducing the risk of failure during the exploitation of a range of food resources (Banks et al, 2009; Djindjian, 2012; Straus, 2012). Neanderthals would have had little need to develop such typologies as the Mousterian was already adapted to reflect the regional specialisation of their game exploitation strategies. The creation of new tool typologies and the exploitation of a specific type of terrestrial game (medium versus large) suggest that AMH foragers during the Pioneer and Developed Aurignacian exploited those resources which presented the most optimal mix. Though the rapid migration throughout Europe during the Pioneer phase suggests that AMH foragers may have undertaken an opportunistic foraging strategy, it is likely that groups focused on the exploitation resources which they were familiar with and for which they had already developed suitable foraging strategies. An accurate understanding of EUP foraging strategies is complicated by the fact that (1) the ethnographic record has no examples of foraging societies migrating into completely new environments and so there are no analogues which can offer specific examples of hunter-gatherer behavioural responses to this context, (2) many sites in the EUP archaeological record only the winter activities of AMH hunter-gatherers and therefore only represent distinct strategies during a given moment, and (3) statistical analysis of the EUP archaeological record does not provide any distinctions or insights in AMH foraging behaviour for this period other then highlighting the preference for medium sized game species.

What the archaeological record and statistical analysis suggest, however, is that AMH adopted different foraging strategies than their Neanderthal contemporaries. Indeed, until 35 kya it is likely that Neanderthals remained the optimal human foragers in Europe due to their exploitation of regional resources, defined foraging ranges and established knowledge of the landscape and seasonal variations. Conversely, modern human foragers exploited a standard range of resources and show little evidence of regional specialisation and had to experience the seasonal variations of Europe first hand without prior knowledge and experience.

Only when AMH population size increased, and Developed Aurignacian groups became more widespread in the landscape, would Neanderthal foragers have found their regional foraging resources under threat. Southern Neanderthal foragers would have seen their primary food resource diminish due to increased competition whilst in the north exploitation of medium sized game by AMH would have reduced the availability of this secondary resource for Neanderthal foragers. The implications of this competition are threefold:

- As resources diminished in the south, Neanderthal group size would have been reduced as the environment would no longer have been able to support large aggregations and population density may have been reduced to similar sizes as those observed in the north;
- The removal of the secondary resource base as a result of AMH exploitation of medium sized game would have meant that northern Neanderthal foragers experienced a higher-risk foraging environment. It is likely that as a result several Neanderthal foraging groups would have starved, therefore leaving large regions of the north unoccupied and ready for later AMH exploitation;
- Finally, foragers in both regions would have found it necessary to migrate to areas where AMH population density was limited such as in south-western Europe. The migration of northern foragers into new regions with new resources would have presented a distinct cultural challenge for these Neanderthal foragers.

The development of 'mixed assemblages' (Ruebens, 2009, 2012), the aggregation of Neanderthal populations into certain regions free from AMH influence, and a broadening of the Neanderthal diet base suggest that Neanderthals were capable of adapting to the problems caused by increased competition with AMH foragers. However, the majority of these behavioural changes occurred when Neanderthals displayed larger population densities and were limited to specific regions, allowing quicker cultural transmission of new behavioural and material adaptations. Low Neanderthal population density throughout Europe prior to c35 kya may have impacted the Neanderthals cultural ability to sufficiently adapt to encroaching AMH competition.

The lack of Neanderthal demographic hegemony is not an *a priori* reason to assume that once AMH population densities reached a tipping point in the Developed Aurignacian that they became the dominant human predator in Europe. Only in the Gravettian do we see the regional specialisation in the hunting of game, the occupation of the majority of European landscapes and a fuller material expression of modern human social behaviours. The entire EUP was a period of adaptation for modern human foragers and that only with the extinction of the Neanderthals, the onset of the Gravettian and an understanding of the intricacies of European resource variability, did AMH become the dominant human predator of Europe and the 'Golden Age' of human occupation began (Roebroeks et al, 2000).

Until c. 35kya, Neanderthals could still be considered the apex predator of Europe due to their local knowledge but as AMH populations increased Neanderthals would have become increasing pushed to the fringes of their ranges: those who retreated to the west and east would have maintained their Mousterian traditions but those who attempted to compete with increasingly efficient AMH foragers would have had to develop new strategies to reduce the risk of resource failure.

Could the Chatelperronian and Ulluzzian industries, which first made their appearance around this time, represent the final behavioural adaptation of the Neanderthals to maintain their hunting dominance of a continent which was once theirs? It is feasible that they recognised the risk AMH posed to their food resources and adapted their tool kits accordingly. Indeed, greater Neanderthal population densities in the refuge areas and greater contact with AMH groups could have promoted a cultural transfer of ideas that could have resulted in the development of these industries. Whether Neanderthals copied the tools from AMH or made them themselves, their ultimate purpose would have been to reduce the risk of failure and would therefore have been invaluable for Neanderthal foragers who were facing increased competition of increasingly limited animal responses.

8.3.3 Social Expressions: Neanderthal perspectives

The analyses and interpretation here of the Middle Palaeolithic and EUP archaeological records suggests that Neanderthal and AMH hunter-gatherers responded to food resource stress in similar ways in terms of their social cohesive/cooperative behaviours. Only in the expression of higher tier social control and spiritual behaviours does a difference emerge, with AMH groups adopting such behaviours fairly rarely, and the Neanderthals never. This goes against the ethnographic model and its predictions for high-latitude hunter-gatherer societies who are expected to employ such behaviours to ensure that the over exploitation of resources was limited, and in some instances help to reflect kin affiliations via material associations (Turnbull, 1982; Moore, 1987; Rossano, 2010). Though we see material expressions in the Aurignacian which can be interpreted to represent spiritual behaviours, notably the Höhle Fel and Höhlenstein-Stadel figurines (Conard, 2003; 2009), these behaviours were rare. Cohesive and cooperative behaviours were likely favoured over control and spiritual ones.

It is only in the Gravettian that behavioural expressions conform to the ethnographic predictions, supporting the interpretation that this period represents the collective dominance of AMH in Europe. Though the archaeological record of social behavioural interpretation is subjective in its interpretation, frequencies of these behaviours do increase after c. 35 kya suggesting that this may be the tipping point between Neanderthal and AMH dominance in Europe during OIS-3 (White, 1982; Zilhao and d'Errico, 1999; Djindjian, 2012). This difference suggests that for 10 kya AMH foragers developed their social and symbolic behaviours alongside Neanderthals instead of migrating into Europe carrying a full repertoire of symbolic behaviours (McBrearty and Brooks, 2000; McBrearty, 2007).

Such behaviours would have been essential for the successful acquisition of game by both Neanderthal and AMH foragers, and for the successful migration of AMH throughout the EUP. Though both societies may have employed similar behavioural responses to food resource availability and acquisition, the unique nature of Neanderthal and AMH societies with regard to physiology, food resource acquisition, demography and environmental context ensured that these expressions are likely to have been unique between the two hominid species.

As social behavioural expression is related to methods of food resource acquisition one would expect that Neanderthals, by participating in unique regional foraging strategies, would have displayed a range of social behaviours that would have allowed them to adapt to their variable environments. Identifying these behaviours in the archaeological record is problematic considering that the majority are non-material and leave little physical trace. Further complicating matters is that the interpretation of the presence of these behaviours in the archaeological record is entirely subjective. This thesis has advocated the use of ethnographic analogy to help clarify the context of social behavioural expressions and how they relate to material artefacts. By understanding and taking into account how contemporary hunter-gatherers relate to, and use, material artefacts archaeologists can more accurately understand the context of their use by prehistoric foragers and identify relationships between non-material and material expressions. Further, such analogies not only provide a primary behavioural inference but they also highlight secondary associations between material artefacts and non-material behaviours which may not have been previously considered by researchers. These primary and secondary associations highlighted by ethnographic analogy serve to clarify existing methodological subjectivity in terms of social inferences whilst also providing more substantial relationships between artefacts and social behaviours not previously taken into account. Appendix 4 notes how ethnographic analogy and archaeological artefacts can be used to infer the presence of certain behavioural expressions through acts such as burial (spiritualism, social cohesion, territoriality), the presence of unique shaped items (kin associations, social cohesive behaviour, rites of passage), the hunting of certain types of game species and the transport of raw materials which often involve individuals working together to complete tasks successfully (social network development, social cooperation, social control); where possible, Neanderthal behavioural inferences were made from multiple artefacts.

The Middle Palaeolithic statistical analysis shows that the dominant social expressions within Neanderthal societies centre on a range of behaviours that can be collectively referred to as socially cohesive. These include cooperative hunting, kin affiliations, rites of passage events, prestige affiliations and food sharing which principally involve Neanderthal individuals working together to successfully complete a task, typically one related to the acquisition of food as per the expectations of the ethnographic analysis. As noted above and in Chapter 7, and evidenced within the archaeological record, Neanderthal social expressions seemingly do not extend to social control and spiritual expression. The lack of these behaviours has two important implications: the first is that Neanderthal groups were primarily focused on the acquisition of food resources and adopted behavioural expressions which helped foragers reduce risk in the acquisition of food; and second, that they had no need for behaviours that aim to control and/or limit the behaviours of individuals. The absence of these forms of social control may reflect a lack of cognitive ability (Theory of Mind) to be aware of the need and ability to adopt these social responses, or Neanderthal demography suggests that group sizes were too small to require such control behaviours. Each of these points will be discussed below, but it has already been noted that due to environmental and foraging constraints Neanderthal foraging group sizes would have been smaller than those of modern humans (Grove et al, 2012) and it is feasible that social cohesive behaviours were more efficient at keeping individuals in line than harsher control mechanisms.

Social cohesive behaviours would have benefited Neanderthal foragers as they would have allowed them to coordinate their actions in the pursuit of game. Whilst cohesive behaviours such as rites of passage activities would aid knowledge transfer from generation to generation the lack of Neanderthal material culture suggests that such acts may have been accomplished via oral tradition. It is notable that such oral traditions are frequent amongst the sub-arctic hunter-gatherers of North America whose environmental context is most analogous to that of the Neanderthals, including the Blackfoot, Dogrib and Mistassini Cree (Conarty and Beierle, 1997; Brown and Beierle, 1997). An oral approach to knowledge transfer would have resulted in proficient hunters and elderly individuals occupying a place of prominence in Neanderthal societies as these individuals would have been able to pass along details of herd migrations, seasonal changes, the best sites to occupy etc due to their own experiences. Such positions of prestige have been interpreted to have existed in Mesolithic societies (Spikins, 2008) and it is possible that influential individuals also played a significant part in Neanderthal societies and could explain why Neanderthals invested significant amounts of time to look after certain individuals (Trinkaus, 1983; Trinkaus and Zimmerman, 1982). However, the reliance on one or two individuals in this manner would have put Neanderthal foraging groups at significant risk if anything were to happen to these individuals. Such behaviours may have had their negative attributes, but the prominence of individuals in a foraging group/society based on their knowledge and hunting skills does have ethnographic precedent.

Neanderthal groups would have benefitted by adopting these behaviours, and there are distinctions between northern and southern Neanderthal behaviours. In the north, social cohesive behaviours, specifically cooperative hunting, would have been more prominent than in the south as smaller group sizes and lower population densities would have meant that there were fewer individuals available in the acquisition of game. As Neanderthal groups in the north focused their food acquisition behaviours on the exploitation of large game, cooperative hunting would have been important if a small group of foragers were to successfully acquire food. As with all cooperative hunting, trust and communication between individuals would have been essential but the high-risk high-yield exploitation of mammoth and the potential risk of starvation if failure occurred would have imbued these behavioural traits more strongly in Neanderthal foragers of the north and as such are likely to have been subjected to systems of prestige that reflected the contributions and influence of specific individuals. Such behaviours are common in small foraging groups that hunt large game species, with Inuit whale hunters occupying a distinct place in their communities above other hunters (Antropova and Kuznetsova, 1964; Damas, 1984; Smith et al, 2010). The exploitation of mammoth would have been a sufficiently large, dangerous and resource rich animal to grant hunters certain amounts of prestige and influence within their group.

This is not to say that foragers in the south did not participate in cooperative foraging merely that the bonds between individuals which help facilitate such hunting would have been stronger in northern groups due to the inherent risk of the environment. Ethnographic analogy suggests that foragers only place such high levels of trust in individuals who are kin related (Lee, 1982) and it is likely that Neanderthal groups in the north compromised individuals who were either directly kin related or related via marriage. Determining kin associations via the archaeological record is particularly difficult and the lack of such material artefacts in the Neanderthal record further complicates matters. If assessments on northern Neanderthal group size and population constraints are accurate ,then they conform to ethnographic expectations of groups which would have comprised 10 – 15 kin related individuals, dispersed throughout the landscape with infrequent contact with other groups, and highly migratory (Grove, 2009; Grove et al, 2012). Hunting and travelling with kin would have provided strong *in situ* bonds of trust and cooperation between individuals that would have been of benefit in the acquisition of game. The diffusion of individuals to different kin groups would strengthen social cohesive links between non-kin groups but such bonds would be weaker than those between blood relatives as they rely on factors including prestige, hunting ability and other measurable elements of fitness which can be subject to degradation or loss. As long as such bonds are maintained, however, they could potentially provide a range of social resources to share food, exchange knowledge, and reproduce.

Therefore in the north, smaller Neanderthal communities and foraging groups were bound by stronger kinship ties that allowed them to exploit high-risk resources in a variable resource environment. Such groups would have been highly migratory, cooperative and would have left little impact on the landscape. In the south, larger Neanderthal group sizes and population densities (though still lower than those of modern humans) allowed for the creation of social networks between foraging groups that would have allowed foraging groups to hunt cooperatively, share resources and exchange knowledge. The presence of a social safety net in southern Neanderthal communities, no matter how limited, would have reduced the need for migrations within their foraging radii as they may have been able to rely on contributions from other groups in the landscape. It is unlikely that such social networks were the equivalent of those established by AMH foragers as there seems to be little evidence for the transfer of materials other than those which can be used to create tools (Hayden, 1993; Mussi. 2001); merely forms of mutual aid between forager groups the equivalent to resource distribution behaviours observed within many contemporary hunter-gatherer societies during resource downturns (Wiessner, 1987, 2007; Moore, 1982; Knight, 2012).

These behavioural differences would have served to create a divide within Neanderthal societies, notably between north and south. The catalyst for this division, the different methods of food resource acquisition, would have led to behavioural expressions which likely reinforced these divisions based on contemporary hunter-gatherer data. The Neanderthal expression of social cohesive behaviour mirroring those of AMH in the EUP (see below) suggests that both species displayed a cognitive parity when developing optimal behavioural mechanisms for their respective environments. Indeed, the Middle Palaeolithic analysis shows that Neanderthals conformed to ethnographic predictions in all aspects except for the expression of social control, spiritualism and material symbolic behaviour. The possible reasons for this discrepancy are noted below, but for the purpose of this section it has to be noted that by showing some parity with modern humans, Neanderthals were not the cognitively naive cousin that some would have us think (Klein, 1999; Gargett, 1999; Mellars, 1999). These analyses have shown that they were quite variable apex predators who dominated Europe throughout the majority of OIS-3.

8.3.4. Social Expressions: AMH Perspectives

The social behavioural analysis of the EUP archaeological record suggests that AMH hunter-gatherer societies that migrated into and throughout Europe during OIS-3 expressed similar social behaviours that conform to ethnographic expectations. The similarity of these social cohesive expressions to those seen in the Middle Palaeolithic suggests that both human species responded to the environmental conditions of Europe in broadly similar ways. Though the analysis suggests that both Neanderthals and AMH foragers adopted social cohesive behaviours to survive, it also highlights that they did so in specific ways: where the

Neanderthal analysis suggests they adopted a broad range of social cohesive behaviours, the EUP analysis suggests that AMH focused more specifically on the creation and maintenance of social networks between groups. Such networks not only allowed AMH to successfully migrate into Europe but also distinguish themselves from the incumbent Neanderthals.

The creation and maintenance of social networks between AMH forager groups would have provided a range of cohesive behaviours beneficial during the initial Pioneer incursions into Europe and the establishment of larger Developed bands. The ethnographic record shows that the establishment of social networks allows for the exchange of information, reciprocal sharing of food and material resources, and provides opportunities for reproduction between foraging groups. Typically social networks conforming to this pattern are initiated and reinforced by the transfer of symbolic and raw materials between individuals and groups, and it is within the archaeological record of the EUP that we see the emergence of the regional use of beads and long distance transport of raw materials suggesting the creation of different ethno-linguist cultures (Vanhaeren and d'Errico, 2006). Gamble (1989, 1999) has also posited that raw material transport reflects social networking by AMH.

The existence of social networks between AMH foragers has been discussed for some time and the implications of their benefits are well known and their association with modern humans is not seriously contested, but the mechanics of *how* these networks were established needs to be discussed. Ethnographic precedent suggests that reciprocal bonds are created between individuals who hunt and share resources (Weissner, 1987; Rossano, 2010; Knight, 2012), and it is likely that within the EUP a similar mechanism was used. Foraging groups may have come into contact with one another and through the interactions of their hunters formed the basic social ties of the foundation for future social networks. Spikins (2008) has already discussed how individuals who hold prestige status within a group cultivate social relationships with non-kin equivalent skill. Such relationships would have been beneficial for

Pioneer groups who migrated into new regions, and could have been renewed via a number a mechanisms, including heredity or marriage and could have potentially lasted for generations.

The analysis of EUP behaviour suggests, however, that social networks were of less importance during the Developed Aurignacian than they were in the Pioneer (Chapter 5, Section 5.3.2) which would seem to indicate that social networks of the EUP could only be sustained for certain amounts of time or were subject to demographic constraints. Aiello and Dunbar (1993) have noted that modern human social networks can accommodate 150 known associates. It is unlikely that this number would have been reached during the initial Pioneer migrations unless these groups employed a system of seasonal aggregation between related groups with exchange networks bonding groups and individuals together over long distances in the interim. This explains the dominance of the social networks highlighted in the EUP analysis and conforms to existing ethnographic precedent (Wiessner, 1986; 2002). The onset of the Developed Aurignacian (beginning c. 40 kya, but markedly noticeable after c. 35kya) marks the beginning of a notable increase in modern human populations, especially in south west and central Europe, and as a result individuals are likely to have breached Dunbar's number more regularly. Using Davies' (2001) definition of Developed Aurignacian groups as progenitors of further Pioneer groups it is possible that the establishment and maintenance of social networks were prioritised to reflect the origin of such groups. Thus, after c. 35 kya Pioneer groups may have prioritised social links between Developed groups whilst neglecting prior relationships to groups further afield. This would have furthered the expression of regional territoriality as groups would have favoured primary networks in their immediate region. In sum, the original creation of social networks provide the initial wave of Pioneer settlers with a loose safety net in an unfamiliar environment. The number of such networks between each group is likely to have been small and based on a relationship established between prominent individuals from different kin groups. As demography increased throughout the duration of the EUP, knowledge of the landscape and its resources would have increased significantly and limitations on social network size would have prioritised primary regional affiliations over distant ones.

Why then did AMH foragers during the Aurignacian adopt this specific form of social cohesion when the Neanderthals seemingly applied a much broader range of cohesive behaviours that seemingly did not involve the use of social networks? First, prior to 45 kya modern humans had no presence and experience of the European theatre and its environment. Establishing networks between foraging groups that allowed for the exchange of resources, materials and knowledge would have allowed modern humans to adapt to conditions more quickly. Neanderthals, having evolved in Europe, could not only draw upon their biological adaptations to the climate and environments (Chapter 2), but also had generations of knowledge and experience that would have allowed them to survive in Europe without the need to form extensive social links between groups and bands. Second, Neanderthals may have found it difficult to overcome regional differences that may have prevented the establishment of such networks. The nature of Neanderthal demography would also have made the establishment of social networks difficult, especially in the north where groups are likely to have been small and widely dispersed. Third, social networks would have opened up a wider range of reproductive possibilities than by simply relying on chance meetings in the landscape. Indeed, the exchange of kin is likely to have helped establish and maintain such networks. Neanderthals of course needed to reproduce, but the structure of Neanderthal population distributions may not have established strong enough permanent links between groups and bands.

Finally, this analysis shows that the expression of social control behaviours, such as taboo rules and spiritual expression, had a negative influence on the establishment of social networks between AMH hunter-gatherers of the EUP. This finding goes against the ethnographic model's predictions and shows that the expression of these higher tier social behaviours were not as important in the EUP as they were to become in the later Upper Palaeolithic (the Gravettian analysis conforms to expectations). There was little need for social control during the EUP and those individuals or groups who displayed such behaviours may have either been ignored or actively shunned. This is not surprising when one considers that the aims of such behaviours are to keep freeloaders in line. Pioneer groups would have been too focused on the acquisition of food and survival for individuals to attempt to gain an advantage over others. Group sizes are likely to have been small enough that social cohesive behaviours would have kept individuals bound together. Though Developed bands would have been comprised of a larger number of individuals that may have necessitated such behaviours, it seems they too disapproved of them. It is possible that Developed groups of any considerable size only met infrequently and therefore, as with Pioneer groups, social cohesive behaviours may have been sufficient. This is not to say that such behaviours were not present, the Höhle Fels 'Lion Man' statuette suggests that spiritual elements may have been present in certain EUP groups, but merely that they hindered the development of social networks. It is possible that such behaviours were only conducted in the presence of direct kin or expressed in a limited material capacity.

Only in the Gravettian do we see the full suite of 'modern human behaviour' on a continental scale in the form of regional specialisation of food resource acquisition, spiritual expression, and the variability of symbolic artefacts because only then was there a need for such items and behaviours.

8.3.5. Summary

This analysis has shown that both Neanderthals and modern humans employed similar behavioural responses to the variable environments they inhabited, supporting the conclusion that both were cognitively able to adapt to the variable environments of Europe during OIS-3 in their own ways: the development of social networks for modern humans compared to the use of a broad range of social cohesive behaviours by Neanderthals. Whilst these differences suggest that each species were capable of responding to their own situations individually, the similarities of the mechanisms behind these responses suggest that modern humans and Neanderthals displayed some parity in their cognitive processes in the development of optimal foraging behaviours. Of particular note is that the dominance of modern humans in Europe was only assured c.35 kya due to increased population density. The adoption of optimal foraging strategies, use of social cohesion behaviours, and adjustment of the Mousterian techno-complex to represent regional needs suggests that Neanderthals were the masters of their domain experiencing a 'Silver Age' before modern human resource competition took its toll.

8.4. CONSTRAINTS ON NEANDERTHAL SOCIAL AND SYMBOLIC BEHAVIOUR

Ethnographic analogy shows that Neanderthal and Modern Human hunter-gatherer societies developed similar behavioural mechanisms that allowed them to adapt to the variable environmental conditions of Europe during OIS-3, notably by expanding their foraging base and adopting a range of social cohesive expressions. Though the expression of these behaviours was unique to the conditions experienced by each species, the adoption of similar mechanisms suggest that (i) Neanderthals and modern humans displayed both a cognitive and behavioural parity and (ii) that the social mechanisms involved in dealing with resource variability have been a feature of human hunter-gatherer societies for at least 60 kya.

Neanderthals, seemingly, did not display a tendency to adopt social control behaviours or create symbolic artefacts. This does not mean that Neanderthal societies were not structured using symbols, merely that they did not express their symbolic associations in material forms. At its most basic, what we understand as ‘symbolism’ is merely the communication of information between individuals and groups in abstract forms. Symbolic artefacts can therefore be recognised as communication through the material sphere (as ‘External Symbolic Storage’ (Henshilwood and Marean, 2003). Language is often considered the height of symbolic expression due to its abstract nature (d’Errico et al, 1999; Bickerton, 2007b; Dunbar, 2007) whilst dance and storytelling are also considered symbolic despite not leaving material traces. The material emphasis of the archaeological database means we often overlook the importance of these non-material symbolic behaviours, but this analysis has shown that Neanderthals are likely to have employed them. What, then, prevented the Neanderthals from producing similar artefacts such as those of the Upper Palaeolithic archaeological record? Methodological, cognitive, physiological and demographic factors are discussed below in turn.

8.4.1. Fault with the Methodological Approach

Ultimately, the social behavioural interpretations of the Neanderthal archaeological record have been based on analogy with contemporary hunter-gatherers, and though every effort has been used to address any potential issues which may make such comparisons untenable (Chapter 3) there remains a possibility that ethnographic analogy is not suitable for the interpretation of human behaviour across such broad chronological and phylogenetic barriers. These criticisms have been addressed in the Methodology section of Chapter 3, but a brief discussion is required here.

The overall aim of this analysis was to use ethnographic analogy to determine the behavioural differences and similarities of Neanderthal hunter-gatherers in comparison with modern human foragers. By employing a large dataset of contemporary hunter-gatherer behavioural information, the analysis aimed to identify the core behavioural and material expressions that forager societies employ in responses to reductions in environmental productivity. To address the issue of behavioural change over time, the ethnographic models original behavioural interpretations were tested and accordingly amended by applying similar analyses to the archaeological records of the Upper, and Early Upper, Palaeolithic (Chapters 4 & 5). These analyses, which centred on behaviourally modern human foragers of similar cognitive capacity to contemporary individuals, conformed to the majority of expectations outlined by the original ethnographic model. Indeed, the only prominent methodological issue related to sample size and distributions rather than to behavioural expressions and interpretations.

If Neanderthal behaviour was fundamentally different to that of contemporary and AMH foragers then it would have been recognised either by the failure of the analysis overall or by highlighting behavioural associations that went against ethnographic predictions. The latter occurred in the analysis of Neanderthal social control behaviour, spiritual expression and material artefact production which suggests that Neanderthals may have had a fundamentally different approach to these expressions compared with modern humans. However, the similarity of Neanderthal social cohesive and food resource acquisition behaviours to the ethnographic model shows that they adopted core forager behaviours. This shows that the methodological approach employed in this thesis was able to recognise the unique expressions of Neanderthal hunter-gatherers in OIS-3. Ethnographic analogy as used in this context will never be free from questions concerning its appropriateness, but it has to be noted that few tools are available to the palaeoanthropologist when interpreting social behaviours from the archaeological record. Until further approaches are developed, ethnographic analogy will remain a key analytical tool, and its limitations will have to be addressed and considered when it is used. This thesis has attempted to address as many of these issues as possible, with the result that the resulting patterns are considered representations of Neanderthal behaviours.

8.4.2. Cognitive Restrictions in Neanderthal Individuals

Though several researchers have argued that Neanderthals displayed less cognitive adaptability than modern humans (Montes, 1991; Gargett, 1999; Angelucci, 2002; Klein, 2008; Mellars, 1989, 2005), the behavioural model supports the interpretation that Neanderthal cognition was on a par with that of modern humans. There are two issues relevant here: the cognitive ability to create symbolic materials and the cognitive ability to imbue those materials with abstract associations. When considering the latter, we need to have an understanding of not only the neural capacity of the Neanderthal neocortex but also the levels of intentionality (Theory of Mind) as these would have influenced the Neanderthal capacity to not only create abstract symbolic associations but also their ability to understand such concepts.

The archaeological record of tool creation, cooperative hunting, burial of the deceased and a capacity for language indicates that Neanderthals were capable of communicative intents, i.e. third level intentionality that allows for the communication of intentions, beliefs and desires i.e. capable of deception and capable of basic symbolic expression (Dunbar, 2003). The recognition that Neanderthal societies employed a broad range of social cohesive behaviours, interpreted to include rites of passage and storytelling events suggests Neanderthals were capable of more than a third level of intentionality. The interpretation that Neanderthals relied on oral traditions to maintain group cohesion suggests they were capable of fourth order intentionality though one limited to the transmission of personal experiences rather than the creation of fictional accounts. It is unlikely that Neanderthals were capable of behaviours such as spiritual expression which require a capacity for fifth order intentionality as the archaeological record does not provide any material proxies for the expression of such behaviours. The variety of Neanderthal interment, from caching to burial, suggests these activities represent a range of social behaviours likely to have been used to reinforce social bonds rather than represent any distinct spiritual behaviour. As the identification of fifth level behaviours requires material evidence, the lack of these artefacts in the Neanderthal archaeological record can be viewed in one of two ways: either Neanderthals did not create such artefacts because they were *incapable* of the expressions associated with them, or they did not create such artefacts because they *had no need* for them. In the absence of evidence both conclusions are possible. The similarities, however, between Neanderthal and modern human foragers suggest that Neanderthals could have been capable of such behaviours but did not express them due to other constraints; after all, it is only within the Gravettian that we see the sustained and materially elaborate use of spiritual expressions yet the majority consensus is that AMH were capable of such expressions at 40 kya (Klein, 1999, 2008; Mellars, 1989, 2005; Stringer and Andrews, 2005). Cognitively therefore the Neanderthals were capable of the social behavioural expressions already attributed to them in this thesis (cooperative hunting, social cohesive behaviours, rites of passage behaviours, storytelling and dance ceremonies, prestige hierarchies and the care for the elderly) and they were potentially capable of further expressions. Until conclusive evidence emerges to counter this interpretation it should be the standard interpretation of Neanderthal cognitive ability.

Though Neanderthals may have been cognitively capable of expressing and understanding symbolic concepts they could still have experienced limitations on the effectiveness and potential range of such behaviours. Pearce et al (in press) have presented an analysis which suggests that Neanderthals had a smaller neocortex ratio compared to modern humans, and thus a reduced cognitive capacity in the ability to plan, reason, and understand behaviours and actions from other individuals. They conclude that reductions in neocortex size would have limited the active size of Neanderthal social networks, meaning that Neanderthals potentially maintained social links with fewer individuals compared with modern humans. The analysis by Pearce et al. is not entirely convincing, resting as it does on cranial markers that are subject to morphological variations depending on sex and the specific environments an individual resides in, and a failure to take into account other factors which could have accounted for larger orbits in the Neanderthal cranium such as an adaptation for the retention of heat by creating larger sinus cavities. The argument that Neanderthals required larger optic processing centres to compensate for low light intensities in northern latitudes and does not take into account factors such as snow, present for 6 months of the year in many northern environments (van Andel and Davies, 2003a), the reflection of light from which could have provided enough visibility for Neanderthal foragers. Such considerations place doubt on the conclusions drawn by Pearce et al., and even if one accepts their conclusions the implication of a reduced Neanderthal social circle does not discount the possibility that they were capable of higher tier social functions; though the spiritual expressions are likely to have been limited in such instances.

Finally, the Neanderthal use of the Levallois technique in tool production, the inferred use of different materials to create hafted tools (Ambrose, 2010; Belfer-Cohen and Hovers, 2010), the use of iron oxide pigments (Zilhao, 2007), and the use of plant resources for purposes other than food (Weiner et al, 2000; Merlin, 2003; Hardy et al, 2012) show that Neanderthals not only understood the properties of a range of materials but also had the necessary experience and planning to utilise these materials in a range of contexts. The creation of figurines, beads and the use of pigments to colour the skin are all within the capable range of Neanderthal creation.

It is therefore likely that Neanderthals had the cognitive skills to plan and create symbolic artefacts as well as imbuing them with abstract symbolic associations. Though expressions may have been restricted to a smaller social network then modern humans, the level of behavioural expression matches that of AMH in the EUP. Cognitive ability, it seems, is not likely to have been a factor in the ultimate expression of Neanderthal social and symbolic expressions though such a conclusion will likely have to be modified with future discoveries.

8.4.3. Physiological Constraints

The robust nature of Neanderthal skeletal and muscular morphology noted in Chapter 2 would have limited Neanderthal behaviours and actions in distinct ways. They would have impacted Neanderthal food resource acquisition behaviour and hunting strategies, as well as possibly creating subtle differences in the behaviour between males and females. Indeed, the creation of a range of stone tool types with regional variants and the adoption of close quarter hunting strategies suggest that physiological hindrances were minor, and behaviours adapted accordingly. The increase in muscle mass, however, would have presented Neanderthals with an issue that would have directly influenced their ability to create symbolic artefacts: increased energy budgets.

The energetic requirements for modern human individuals typically require the consumption of up to 2,500 calories per day per individual. Such an amount, sufficiently resourced from the environment in the form of meat and edible vegetation, would have provided enough energy to sustain all metabolic processes. Any increase in muscle mass, such as that observed within Neanderthals, would have led to corresponding increases in the amount of energy required to sustain basic metabolic processes. Sorenson and Leonard (2001), Verpoorte (2006) and Snodgrass and Leonard (2009) have calculated that the minimum energetic expenditure of an average Neanderthal was in the range of 4,000 calories per day per individual or just under double that of modern humans, whilst high intensity behaviours such as the exploitation of large game species could potentially have cost Neanderthals 6,000 calories per activity (Table 8.1). In contrast, high intensity activities within modern humans are likely to have resulted in energy expenditures costing less than 4,000 calories[15].

	BMR (kcal/d)	Winter (kcal/d)	PAL	TEF (kcal/d)	TEE (kcal/d)
Females					
Summer – Low	1465	-	1.82	267	2933
Summer – High	1465	-	2.50	366	4029
Winter – Low	1465	293	1.82	640	3840
Winter – High	1465	293	2.50	879	5274
Males					
Summer – Low	1876	-	1.98	371	4085
Summer – High	1876	-	2.50	469	5159
Winter – Low	1876	375	1.98	891	5348
Winter - High	1876	375	2.50	1126	6754

Table 8.1. Estimated Total Energy Expenditure (TEE) (kcal/day) for Neanderthals. Table shows seasonal differences in the mean energetic outputs of Neanderthals as a result of increased metabolic activity due to the robust nature of Neanderthal morphology. Table adapted from Snodgrass and Leonard (2009).

Any increase in energy requirements means that Neanderthals would have had to exploit more resources from the environment to sustain basic metabolic processes. The implications this has on Neanderthal behaviour are extensive. First, Neanderthals would not have been able to focus on one particular type of food resource as one resource alone would not have been able to provide all of the Neanderthal energy requirements. As a result, Neanderthal foragers would have had to exploit a range of animal and vegetable resources. Southern European environments would have presented a range of food resource that Neanderthals could have exploited including various USOs, fruits, terrestrial mammals, fish, and plants (Hardy, 2010; Hockett, 2012) but in the north such resources were either limited or unavailable. Neanderthal exploitation of large game species such as mammoth would have provided them with large amounts of meat and marrow resources that could have sustained them over several days, though they would have unlikely been able to support large bands of

[15] As a reference point, marathon runners typically use 4,000 calories in the standard 26.2 mile endeavour.

Neanderthal foragers for any length of time. This greater energetic need lends support to the position of Hockett (2012) who states that Neanderthals would have required a variable resource base for survival. By looking at the metabolic costs it is clear that to maintain a basic forager lifestyle Neanderthals would have had to exploit the full range of food resources available in Europe during OIS-3, including fish. The rarity of such behaviours in the archaeological record highlights not only a major gap in our knowledge and understanding of Neanderthal behaviour, but also the limitations of archaeology when interpretations rely solely on the material evidence.

Second, higher energetic costs would have impacted Neanderthal demographic and migratory behaviour. It has already been noted that larger Neanderthal metabolic requirements would have resulted in the exploitation of more resources within a defined foraging territory. As environments only contain a finite amount of exploitable resources and Neanderthals exploited a large proportion of those available, group sizes are likely to haven been smaller to reduce the potential over exploitation of those food resources available. This would have been more pronounced in northern environments where limited resources would have only been able to support smaller groups of foragers, though group sizes in the south would also have been constrained. These energetic constraints would have likely worked in tandem with environmental restrictions to keep Neanderthal group sizes within a sustainable range. Further, the restriction of Neanderthal foraging radii to approximately 20km (Richards et al, 2008) can be explained not only in terms of energetic limitations but also as an unwillingness to move away from those resources which could sustain them. In essence the higher energetic expenditure of Neanderthal individuals would have required them to remain within specific areas for fear that they may run out of suitable resources. The anchoring of Neanderthals to their environment due to physiological constraints explains the division in food resource acquisition behaviour observed in the Middle Palaeolithic analysis: though environmentally more productive, southern environments may not have been able to support the Neanderthal population as a whole, and as a result foraging groups would have needed to migrate into regions that potentially had a greater amount of available resource. The exploitation of large game by small, regionally distinct Neanderthal groups in the north would have provided enough food and material resources for survival in high latitude environments whilst ensuring that southern foraging groups could still hunt without the risk of over exploitation.

Third, higher energy requirements for Neanderthal foragers mean that they would have been at a distinct disadvantage when in direct competition with AMH foragers. AMHs would have had the advantage as their lower energetic requirements would have meant the exploitation of fewer resources, saving both time and energy. Conversely, the greater need for energy in Neanderthals would have required longer foraging times which would have reduced the total amount of food resources available. Neanderthal options would have been limited: stay and compete, increase their foraging radius, or migrate to another region. The latter two choices would have resulted in increased energetic expenditures meaning that Neanderthals would have had to exploit *more* resources in the short term. In any case, these behaviours would have only postponed competition with modern humans in the long term. The higher rate of modern human reproduction and incoming migration would have only increased this pressure, and may have lead to regional extinctions of Neanderthal groups throughout Europe when direct competition occurred. Hublin and Roebroeks (2009) posit a similar scenario for Neanderthal regional extinctions, though they concentrate on the influence of environmental shifts rather than Neanderthal energetics though the mechanisms would have been similar: environmental downturns would have reduced the availability of food resources in a similar manner as modern human competition. This would suggest that two factors contributed to Neanderthal extinction: environmental downturns of resource availability and modern human competition. Neanderthals could have adapted to the former via migration into new regions followed by population expansion during subsequent upturns; yet the presence of AMH would have been a constant competitive factor and from c. 35kya they would have been present in the majority of European landscapes. There would have been no subsequent 'upturn' and food resource availability would have continued to become severely restricted as AMH dominated the continental landscape. Once large concentrations of Neanderthals were restricted to patches of south-west and eastern Europe their extinction was inevitable as these refuge environments would not have been able to support the overall energetic needs of the Neanderthals.

Finally, with increased energetic expenditure Neanderthals are likely to have evaluated any action in terms of its energetic cost and reward. Neanderthals would therefore have led a utilitarian lifestyle with behavioural expressions significantly shifted towards the acquisition of food: the creation of tools to effectively hunt and butcher game, the use of social cohesive behaviours to maximise the potential of cooperative hunting, the care of the injured and elderly so as to retain prior knowledge, and the exploitation of a range of terrestrial resources are behaviours all geared to acquire the maximum amount of food whilst using as little energy as possible. The lack of social control behaviour and spiritual expressions in the Middle Palaeolithic analysis can therefore be attributed to the fact that they provided no immediate gains for the investment they required and as such would not have been necessary in Neanderthal societies. This also explains the lack of material symbolic artefacts in the Neanderthal archaeological record. The time and energy involved in creating a bead necklace or figurine could be the equivalent of making a stone tool or much higher[16] with the no guarantee that these objects would increase the chances of food resource acquisition in the

[16] The creation of a beaded necklace or decoration of some kind would not only involve the physical act of piercing the material in question (bead/shell etc) but also the act of finding materials of the appropriate size, colour and number. To complete the entire *chaine opertoire* of creating a beaded necklace could potentially last for weeks rather than hours (Bednarik, 2007)

near future. Faced with a constant need to acquire food, Neanderthals would have likely favoured tool production over that of a symbolic artefact due to the simple fact that the former could potentially recoup the energy used to create it (possibly several times over). The lack of material symbolic artefacts likely represents a conscious decision by Neanderthal individuals to focus on the production of artefacts that would have benefitted their immediate survival rather than invest in abstract concepts whose long term benefits may not have been experienced.

This is not to suggest that Neanderthal society was organised along purely utilitarian lines as the Neanderthal behavioural record shows that they could adapt their physical behaviours to accommodate their physiological restrictions. Levallois methods of tool production, for example, show the efficient use of raw materials in the production of tools which would have reduced the frequency of raw material acquisition. Neanderthal burials also highlight the efficient use of raw materials suggesting that Neanderthals and AMH had different perspectives when it came to the disposal of their dead. This difference is highlighted by modern humans preferring complete burials whilst Neanderthals tended to cache their dead (Pettitt, 2012). Caching represents the removal and transportation of skeletal elements from a primary burial to a secondary location, and so cannot be explained as a purely utilitarian behaviour. Such behaviours likely represent distinct social activities but the presence of multiple skeletal elements from sites such as La Quina (France), Le Moustier (France), Roc de Marsal (France), Fumane (Italy), Grotta del Principe (Italy) and Hohlenstein (Germany) (Valladas et al, 1986; Cesnola, 1996; Madre-Dupouy, 1983, 1989, 1992; Debentath and Jelinek, 1998; Peresani, 1998; Beck, 1999; Alhaique et al, 2005; Pettitt, 2011) suggests that the individual was not the focus of burial. The restriction of Neanderthal foragers to distinct territories due to their energetic and food acquisition behaviours may have resulted in the development of strong territorial associations between Neanderthals and their landscape.

Cached burials could therefore represent the symbolic return of the deceased to their core home range within or serve as territorial markers to ward off other groups who may be active in the region. The latter would have reduced Neanderthal inter-group competition and ensured that regional resources were not over exploited. A social explanation is therefore favoured for these types of burials rather than a purely functional one. Though socially cohesive overall, caching does not seem to represent a distinctly spiritual behaviour. This does not mean that such activities were not symbolic but that they represent the need for Neanderthals to maintain control of their foraging regions whilst limiting energetic expenditure.

Yet, Neanderthal burial practices were varied, and though caching is predominant examples of complete Neanderthal burials can also be observed notably at Shanidar (Iraq), La Ferrassie (France), and Spy (Belgium) (Peyrony, 1934; Semal et al, 2008; Trinkaus, 1983). One could again argue that these burials represent the functional disposal of the dead, but the deliberate arrangement of individuals and the occasional presence of grave inclusions such as tools, animal remains and pigment place these burials closer to those of AMH though spiritual associations are unlikely to have been a feature. From the dedication of both time and energy, and the relationship of Neanderthal behavioural expression to food resource acquisition, we can infer that the burial of these individuals reflects a distinct loss to the Neanderthal group. In this context, the death of a particularly proficient hunter or elderly individual with a lifetime of regional knowledge would represent a loss in terms of the successful acquisition of food resources. The act of burial would have provided an opportunity for the group to adapt to the loss a hunter. The lack of symbolic artefacts in these burials can be explained by (i) the Neanderthal refusal to create such artefacts in light of energetic constraints and (ii) the need to retain all materials they have in their possession to acquire food and other resources.

Energetic constraints would have had fundamental implications for the behavioural expressions of Neanderthal societies in terms of food resource acquisition, demographic composition, migratory behaviour and the creation of material artefacts. Given these limitations, Neanderthal society is likely to have been more utilitarian than that of AMH, with actions assessed according to their potential energetic returns rather than abstract symbolic concepts. As a result Neanderthal social and symbolic behaviour would have been largely non-material. This is not to say that Neanderthals were not symbolic, merely that they were not *materially* symbolic. Cached burials, cooperative hunting, and an inferred reliance on oral traditions all rely on the same abstract communication of concepts (territorial markers, hunting strategies and storytelling respectively) as material symbols. This difference in symbolic expression is therefore not the result of discrepancies in Neanderthal cognition, but a behavioural adaptation to environmental and physiological factors. Energetic constraints do not, however, explain the lack of spiritual expression in Neanderthal societies and though the burial of the deceased could be interpreted as representing a belief in an afterlife the variation of these burials suggest other social explanations are more appropriate. The reasons for this perceived lack of spiritual expression are discussed below.

8.4.4. Demographic Restrictions in Neanderthal Society

Though Neanderthal energetic constraints explain the lack of symbolic material expressions, they do not explain the lack of Neanderthal spiritual expression or social control behaviour. Though behaviours such as taboo rules, animalistic worship and ritual violence are inherently non-material or otherwise hidden from the archaeological record the lack of other significant proxies for these behaviours suggest that their expression in Neanderthal society was limited or non-existent. Even the burial of the dead, typically a reliable proxy for representing spiritual behaviour, can be better explained as acts of social cohesion.

The function of social control behaviours and spiritual expressions are to restrict the action of freeloaders from exploiting resources to which they are not entitled (Dunbar, 2007). Typically the need for these behaviours arises when group size and population densities increase and the cohesive aspects of social cooperative behaviour cannot maintain group hegemony. These behavioural expressions are also beneficial when resources are scarce and there is a greater need to maintain resources at sufficient levels for survival. The variable environment of Europe during OIS-3 and the energetic constraints experienced by Neanderthals ensured food acquisition would have been a premium concern which would have warranted the use of these behaviours. The apparent lack of social control expression regardless of a need, and a cognitive ability, to do so suggests that Neanderthals may not have needed these behaviours.

Grove et al (2012) have shown that as latitude increases rates of group fission increase and that Neanderthal rates of fission were higher than those of modern humans. This would suggest that in comparison, Neanderthal group sizes would have been smaller than those of modern human foragers. The interpretations of Neanderthal population density as being lower than that of modern humans mean that throughout OIS-3 there were fewer Neanderthals inhabiting the landscape in fewer group concentrations. Though the reduction in group sizes are likely responses to environmental restrictions, a side effect of this reduction would have been that groups could have been efficiently maintained through the use of social cohesive behaviours and kinship ties.

For the majority of the Middle Palaeolithic, therefore, Neanderthals would have had no need for social control and spiritual expressions but the increasing dominance of the AMH presence in Europe during the MP/UP transition and the subsequent confinement of Neanderthal communities to the south-west and eastern Europe would have increased population densities in these areas. With an increased Neanderthal presence there would have been a subsequent need to ensure resources were not over exploited and the likelihood of social control and spiritual expressions being employed would have increased. The emergence of the Chatelperronian in south-west Europe, which likely experienced the highest concentration of Neanderthals, and its associated symbolic artefacts, could therefore represent material responses to increased Neanderthal population densities. Though this process mirrors that observed in AMH foragers during the Developed Aurignacian it is unclear whether these behaviours were adopted by Neanderthals independently of AMH, or if they were influenced by them (Mellars, 2005). The similarity of Neanderthal social cohesive expression to those of AMH (Chapter 7) would seem to indicate that Neanderthals could potentially have developed and created symbolic materials. This evidence is entirely speculative and therefore the only definitive conclusion one can make on this issue is that the similarity of Neanderthal and AMH social behavioural responses, coupled with the demographic factors, allow for the possibility that Neanderthals could have created the Chatelperronian independently of AMH involvement other than indirectly through population pressure.

8.5 NEANDERTHALS – THE HIDDEN SYMBOLIC SPECIES

Minnis (1985) lists eight behavioural responses that contemporary hunter-gatherers use to respond to resource stress: economic diversification, food storage, adoption of low preference foods, surplus conversion, social-economic interactions, fission, intensification of resource activates, and intensification of social control interactions (Minnis, 1985). The analysis and interpretation presented in this thesis suggests that Neanderthals displayed four of these behavioural responses (economic diversification, adoption of low preference foods, intensification of resource activities and fission), and may have displayed a fifth (social-economic interactions) whilst the use of food storage and surplus conversion cannot be determined from the archaeological record the lack of social control activities can be attributed to Neanderthal demographic and physiological constraints which may have hindered the expression of these behaviours. Neanderthal responses to environmental variation largely conform to ethnographic predictions, though individual behavioural responses were tailored to their own circumstances. The implications of this conclusion are clear: it places both Neanderthals and AMHs on a behavioural and cognitive parity, except for spiritual and material artefact expressions. This difference is accounted for by physiological and demographic constraints which limited the use of certain social and symbolic expressions and suggests that Neanderthal social and symbolic behaviours were predominantly non-material.

Neanderthals were therefore a symbolic species, but their symbolic expressions were inherently different than that of modern humans. Due to the nature of the archaeological record and its reliance on material evidence, these behaviours have often been overlooked and Neanderthals have become the 'hidden symbolic species' due to the lack of recognition for the variability of their social expressions. Further work combining ethnographic analysis with archaeological interpretation will no doubt reveal the greater intricacies of Neanderthal symbolic behaviour and may fundamentally alter our current perceptions of our closest extinct ancestor.

9. CONCLUSION

The fundamental aim of this thesis was to identify Neanderthal behavioural responses to variations in environmental productivity, and to compare these behavioural expressions to those of modern human foragers of the Upper Palaeolithic. The results of the analyses conducted within this thesis have highlighted three important aspects of human behavioural expression in OIS-3 that alter our potential understanding of Neanderthal and modern human social and symbolic behavioural expression. The first is that Neanderthals and modern humans displayed relative parity in their social behavioural expressions with regard to social cohesive behaviours, though behavioural expressions ensured both species expressed these differently with Neanderthals preferring to adopt a broad range of cohesive expressions which would have helped with the acquisition of food resources whilst modern humans focused on the development of social networks that would have likely reduced the risk of migration into an entirely new landscape. Second, analysis suggests that Neanderthals were constrained in their behavioural and material expressions by demographic and physiological constraints. Specifically, Neanderthal group sizes likely never reached the critical point where social control behaviours were needed to keep freeloaders in line, whilst these factors may also have limited the effectiveness of material exchanges to reinforce social bond. Further, physiological constraints would have resulted in Neanderthals favouring the production of artefacts that could have provided a return on their investment rather than investing in abstract material concepts. Finally, analysis suggests that the occurrence of behavioural modernity emerged slowly rather than as a predetermined package of traits; with the Early Upper Palaeolithic (EUP) representing a period of behavioural adaptation for modern human foragers with the full suite of behavioural traits associated with so-called 'modernity' solidifying within the Gravettian.

The implications of these finds for the development of human behavioural expression are important, particularly in relation to the Neanderthals. First, the conformity of the results throughout all the analyses conducted in this thesis suggests that human behavioural responses to variations in environmental productivity have remained relatively consistent for at least 60 kya and did not uniquely appear with the emergence of modern humans into Europe. Indeed, the interpretation of the EUP as a period of behavioural adaption for modern humans as well as the recognition that aspects of Neanderthal social behaviours were in some way utilitarian lends support to a gradualist interpretation of social behavioural development; with certain expressions being adopted when needed and cast away when no longer useful.

Second, it suggests that Neanderthals were capable of a range of social and symbolic behavioural expressions that are typically ignored in traditional analyses of the archaeological record. Though the development of these behaviours would have been limited by demographic and physiological constraints, this in no way reflects the cognitive capacity of the Neanderthals to express higher tier social and symbolic expressions. Indeed, if a gradualist mechanism underlies behavioural expression then one can posit that under the right set of conditions Neanderthals could have overcome their demographic and physiological limitations to produce material artefacts. The production of pierced and beaded artefacts towards the end of the Neanderthal presence in Europe (Zilhao et al, 2010) could represent such an event.

Finally, this thesis has highlighted several areas of analysis which can be expanded upon in the future. This thesis has shown the potential of using ethnographic modelling in conjunction with the archaeological record and with further refinements it is possible that future applications could undertake more specific methodologies rather than the broad scope described here. Notably, the model described in this thesis has shown its usefulness in highlighting human behavioural differences in so-called ‘transitional periods’, in this instance that of the Middle to Upper Palaeolithic, and with methodological adaptations its inferences can also be applied to other transitional periods: sufficient inclusion of pastoralist/agricultural data as well as primate behaviour alongside existing hunter-gatherer information would allow for the model to be applied to later prehistoric periods such as the adoption of agriculture in the early Neolithic or allow for the inference of early *Homo* behaviour at the very beginning of human evolution respectively. Though the models methodological approach suites broad scale applications, with sufficient archaeological and environmental data regional analyses can be attempted to understand behavioural questions related to modern human dispersals. As our archaeological and environmental understanding improves the model can be applied to resolving outstanding issues in the migration of modern humans from Africa into the Near East, into Australasia and into the New World. The application of this behavioural model to different archaeological periods and regions will no doubt provide research opportunities in the future, but the implications and conclusions highlighted by this thesis also provide interesting future research possibilities: a fuller understanding of Neanderthal demography and physiology, and the constraints they impose on Neanderthal communities, will provide interesting insights into the nature of Neanderthal extinction; whilst the development of social networks and social cooperation during the Aurignacian suggests a complex process of modern human adaptation to European conditions during OIS-3 that took millennia to perfect and research on this aspect of social behavioural evolution needs to be researched further.

Ultimately this thesis has highlighted that Neanderthals and modern humans were behaviourally comparable throughout the Middle/Upper Palaeolithic Transition and that both species developed a range of social expressions that, though not as prominent as those of the succeeding Gravettian, represent a distinct behavioural adaptation to the European landscape. Without these adaptations it is unlikely that Neanderthals would have dominated the continent for over 200 kya or that modern humans would have been able to successfully migrate into this habitat. Behaviourally, therefore, the period 60 – 30 kya represents a Silver Age for human hunter-gatherer societies in Europe.

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APPENDIX ONE: ETHNOGRAPHIC BEHAVIOURAL DEFINITIONS

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Ornamental Stones: Precious stones, such as amber or obsidian, used as ornaments and trading items. Typically they yield some value to the individual.

Engravings: Personalised engravings upon hunting implements and tools to indicate ownership to a particular family band, tribe, or individual.

Spiritual Amulets: Organic or non-organic items adapted to fit onto clothing as a means of spiritual protection.

Colour Use: The use of colour pigments in either a domestic or symbolic form.

Labrets: A form of body piercing, typical below or on the lower lip.

Decoration: The engraving or addition of materials to domestic or hunting artefacts.

Beads: Perforated materials, typically marine shells, which can be brought together to form a necklace-type artefact.

Personal Ornamentation: Artefacts made or organic materials used for personal adornment; such as ear rings, finger rings and necklaces.

Body Art: The application of colour pigment to the skin to create decorative patterns.

Rock Art: The application of colour pigment to rock surfaces to create decorative patterns.

Toy Artefacts: Small scale replicas of hunting equipment or small, playful and amusing artefacts with which to pass the time. Typically artefacts will be smaller than the norm, and may include figurines, animal sculptures and counting devices.

Musical Instruments: Artefacts created and used for the sole purpose of creating music, either via percussion, shaking or through the passage of air.

Perforated Animal Teeth: Teeth belonging to a species not designated as *Homo sapiens* which contain a perforation so as to form a linking chain, in the same manner as *Beads* (see above).

Bone Ornamentation: Bone samples, either animal or human, which have been worked so as to create a decorative pattern or object.

Tool Complexity: The total tool assemblage of a society earns a high techno-unit (Tu) value as offered by the criteria proposed by Oswalt (1976).

Social Hierarchy Indicators: Artefacts of a distinct and unique nature used to symbolise a position of status within the society in question. Such items may be engraved stones, marine shells, or rare objects.

Sculpture: The skilled working of a material source to fashion a replica of animal and human figurines. Such material sources could include stone, wood and bone.

Ceremonial Artefacts: Artefacts of various types used only during ceremonies, typically associated with the fate and destiny of the society in question.

Ceremonial Clothing: Clothing different to that normally worn by individuals within a society. Such garments are to only be worn during group ceremonies, seasonal gatherings or initiation rites,

Embroidery Patterns: Specific patterns of design upon clothing and basketry.

Materials – Storage: Materials chiefly used in the storage of food.

Materials – Tools: Materials chiefly used in the tool assemblage of a society.

Materials – Processing: Materials used in the processing of food resources, including terrestrial and aquatic game and plant and vegetable sources.

Materials – Household: Materials employed in the creation and maintenance of the domestic home.

Materials - Individual: Materials used for clothing and adornment.

Food Storage: Food is actively cached away in specific locations for later use in time of food scarcity.

Social Taboos: Societal rules restricting certain behaviours which are implemented and followed to conform to spiritual needs.

Tension Relief Ceremonies: Occasions which involve no physical altercation, but instead rely upon verbal expression to end specific grievances.

Conduct Seasonal Gatherings: Tribes come together to share food resources, or to perform specific rituals and initiations. Such gatherings are typically regular and occur when seasons change, or when specialised food resources are available.

Warfare Code of Honour: Warfare rules must be followed when in conflict with another tribal society so as not to inflict dishonour upon ones own people.

Infanticide: The killing of babies and infants, typically to reduce population and resource pressures.

Ritual Violence: The killing of the elderly, the maiming of individuals or the act of self harm which aims to serve the society or the individual in some manner, possibly to relieve population pressure or to bring about good luck.

Disassociation of the Elderly: The abandonment of the aged during mobile phases, or leaving the elderly in a specific location so as the fend for themselves when they have become a possible burden to the society.

Strong Same-Sex Kinship: Relationships are more strongly expressed and reinforced between individuals of the same sex.

Division of Labour – Men: Males do the hunting within a society.

Division of Labour – Women: Women carry out the domestic tasks of a society, typically the gathering of local resources and rearing of young children. Such women would typically maintain and manufacture their own tools.

Male-Male Intra-Kinship Bonds: Male to Male kinship found within a society.

Female-Female Intra-Kinship Bonds: Female to Female kinship found within a society.

Female-Male Intra-Kinship Bonds: Female to Male kinship found within a society, where females can influence the decisions of males in some manner.

Male-Female Intra-Kinship Bonds: Male to Female kinship found within a society, where the male opinion is a dominant force.

Male-Male Inter-Kinship Bonds: Males can influence the decisions of other males from other tribes or societies.

Female-Female Inter-Kinship Bonds: Females can influence the decisions of other females from other tribes or societies.

Female-Male Inter-Kinship Bonds: Females can influence the decisions of other males from other tribes or societies.

Male-Female Inter-Kinship Bonds: Males can influence the decisions of other males from other tribes or societies.

Dance Ceremonies: Celebratory ceremonies and rituals involving dancing and music.

Storytelling Ceremonies: Celebratory ceremonies and rituals involving an individual telling a story.

Social Niches of Influence – Attained: Social influence is attained through activities such as hunting, yielding children, and warfare where bravery and skill are evident.

Social Niches of Influence – Ascribed: Social influence is inherited through familial blood lines.

Social Niches of Influence – Achieved: An influential role is recommended from one individual to another.

Spiritualism – Animism: The placement of spiritual meaning into non-living items such as land, the sea or rock, as well into loving items such as tress and flowers.

Spiritualism – Totemism: The placement of spiritual meaning into living sources such as animals, fish, bird and insects.

Corpse Modification: The changing of the deceased in some manner, namely altering their physical appearance. Such alterations may include cutting of the skin, scalping or appendage removal.

Grace Offerings: Offerings to spiritual representatives in the form of food offering, or through self harm and ritual violence.

Funeral Ceremonies – Cremation: Disposing of a deceased individual by way of burning the body.

Funeral Ceremonies – Burial: Disposing of a deceased individual interning the body underground.

Funeral Ceremonies – Entombment: Disposing of a deceased individual by placing the body inside an enclosure of some sort.

Funeral Ceremonies – None: No ceremony is conducted when an individual dies.

Rites of Passage – First Hunt: The first hunt/kill is viewed as a special occasion, notably for males where it may symbolise the transition into manhood.

Rites of Passage – First Menstruation: The first menstruation symbolises the beginning of womanhood, typically celebrated or mentioned within a society. The first menstruation may also bring about specific social taboos which are now applicable to the woman.

Rites of Passage – Marriage: The joining of two individuals and in a wider context the joining of two families or tribal units. Such a ceremony may involve the presentation of gifts and the possible moving of residence for one of the individuals.

Rites of Passage – Circumcision: For both male and females. May typically occur after birth, or later when the individual has grown and is believed to be entering adulthood.

Rites of Passage – Birth: The birth of an infant, typically conforming to specific social taboos, practices and company.

Rites of Passage – Death: The death and disposal of an individual following specific guidelines (see above).

Rites of Passage – Other: Other forms of ceremony, both large- and small-scale which symbolise the maturity of an individual.

Seasonal Ceremonies – Spring: Spring is the main season of the year when ceremonies occur.

Seasonal Ceremonies – Summer: Summer is the main season of the year when ceremonies occur.

Seasonal Ceremonies – Fall: Fall is the main season of the year when ceremonies occur.

Seasonal Ceremonies – Winter: Winter is the main season of the year when ceremonies occur.

Spiritual Reincarnation: The belief that the spirits of individuals and animals are reincarnated through the birth of individuals and animals.

Shamanism/Medicine Diviners: Spiritual and religious affairs are presided over by individuals believed to yield spiritual control which can influence the luck and history of the band or tribe.

Spiritual Ceremonies: Ceremonies, differing from seasonal ceremonies, which celebrate the spiritual beliefs of a society and are not reliant upon the sharing of food resources.

Group Hunting/Foraging: Hunting or Foraging is conducted in groups containing a minimum of two individuals.

Individual Hunting/Foraging: Hunting and Foraging is conducted by a single individual.

Food – Mammal (Large): Typically warm blooded faunal species. Hunted species may be terrestrial or aquatic, and feature whales and buffalo.

Food – Mammal (Medium): Typically warm blooded faunal species. Hunted species may be terrestrial or aquatic, and feature seals and caribou.

Food – Mammal (Small): Typically warm blooded faunal species. Hunted species may be terrestrial or aquatic, and feature small seal species and sheep etc.

Food – Fish: Fish species located in rivers, streams or oceans which require to be caught or trapped by specialist technology.

Food – Birds: Species capable of flight or considered part the bird faunal assemblage, including eagles and penguins.

Food – Vegetable: Food sources from the ground, not actively cultivated and not containing seeds.

Food – Fruit: Food resources grown from the ground or from plants of some kind, not actively cultivated and containing seeds.

Food – Other: Food sources not conforming to the above criteria.

Food Distribution Rules: Specific social rules as to the distribution of food resources to individuals within a society. Typically such rules feature the greatest share of the food source going to the hunter who killed the animal.

Food Butchering Rules: Only specific parts of the killed animal are used as food, with other parts being employed as building materials, or even grace offerings.

Time – Hunting : Time spent by an individual/group actively hunting for food resources.

Time – Social: Time spent by an individual/group taking part in social activities such as dancing, art creation and symbolic artefact creation.

Time – Tool Creation: Time spent by an individual/group actively creating tools.

Time – Maintenance: Time spent by an individual/group maintaining domestic and hunting materials.

Political Centre – Elders: Elders decide upon the location of camp movements and hunting strategies, and can exert influence over the society due to their experience.

Political Centre – Shamans: Shamans decide upon the location of camp movements and hunting strategies, and can exert influence upon the society as a whole.

Migratory: The specific society in question is mobile and does not remain settled permanently.

Settled: The specific society in question remains settled, and is not mobile on a seasonal basis.

Season Patterns – Aggregation: Group aggregations follow seasonal patterns, either due to weather or animal influences.

Season Patterns – Dispersal: Larger groups disperse into smaller, more mobile groups depending on either season or the availability of food resources.

Prey Influenced Migration: Migration is dominated by following the primary hunted resources, or similarly by pre-empting the arrival of prey at specific locales.

Prey Influenced Division of Hunters: Hunters are divided depending on the type of prey they excel at catching, for example whale hunters or buffalo hunters, and experience specific kudos with regards to their specific hunting niche.

Return to Same Locations – Sites: Specific sites are returned to on a seasonal basis.

Return to Same Locations – Area: General areas are returned to by a society, most likely due to the frequency of prey migration and reliability of prey.

Specific Site Locations Chosen: Sites need to fulfil specific requirements before a society will settle there. Such requirements may include close proximity to prey, water sources, and tool resource.

Spatial Use – Domestic: Specific space use for the domestic household.

Spatial Use – Butchering: Specific space used for the butchering of game.

Spatial Use – Tools: Specific spaces within camp for the creation of tools.

Spatial Use – Spiritual: Space reserved for ceremonial and spiritual activities.

Spatial Use – Birth: The birth of babies is conducting in a distinct area.

Spatial Use – Death: Funeral ceremonies are conducted in a distinct area, either away or within a camp.

APPENDIX TWO: ARCHAEOLOGICAL BEHAVIOURAL DEFINITIONS

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Tool Complexity: Inferred from archaeological materials such as bone and lithics which show evidence of working by human individuals. Morphological analyses have been employed to determine if the overall typology of individual tools to determine whether they are single implements or part of a larger multi-component tool.

Cave Site: Archaeological site is located entirely or partially within a cave enclosure or rockshelter.

Open Site: Archaeological site is located entirely within an open landscape and is not enclosed by any natural covering.

Organic Tools: Inferred use of wood and other organic materials based on ethnographic analogy and archaeological evidence of the use of wood as tool forms since 500kya.

Bone Tools: Inferred use of bone as a raw material for the creation of tools by the analysis of morphology and whether they have been deliberately modified by human interaction.

Composite Tools: Inferred from the morphology of lithic and bone materials which suggest that individual tool elements compromised a part of a multi-component tool form.

Engraving: Inferred from the presence of linear or repeated markings on tool forms and other objects made by human action.

Pigment – Body: The inferred use of pigment for body decoration through ethnographic analogy and/or the variety of pigment presence within the archaeological record

Pigment – General: The use of iron oxide pigments for a variety of non-specific purposes that could include domestic and symbolic actions. Inferred from the ethnographic record and/or the amount of pigment present in the archaeological record.

Rites of Passage: Inferred from the ethnographic record using material proxies from the archaeological record including the burial of individuals, the hunting of game, the organisation of hearths and the presence of pigment and other symbolic materials within the archaeological record.

Ceremonies: Inferred from the ethnographic record using material proxies from the archaeological record including the burial of individuals, a large amount of hunted game, the organisation of hearths and the presence of pigment and other symbolic materials within the archaeological record.

Taboos: Inferred from the archaeological record using the faunal record and the preferred use of certain animal parts, the arrangement of community hearths and the non-violent pathology which could be used to infer the presence of ritual violence.

Hearth Arrangements: The arrangement and use of hearths for specific tasks, whether tool creation or other activities.

Social Networks: Inferred from the archaeological via the trade of raw materials and artefacts between different regions and the hunting of game species which may require the use of several bands/individuals working cooperatively.

Social Control: Inferred from the presence of archaeologically visible non-violent pathologies that may indicate ritual violence, the varied presence of reliable game species within the faunal record suggesting reduced optimal foraging conditions and the use of storage technology to preserve food stores.

Plant Resources: The gathering of plant and vegetable resources as a food source as evidenced from archaeological finds including plant remains.

Small Game: The hunting of small game species for use as a food resource as evidenced from the faunal record.

Medium Game: The hunting of medium game species, such as horse or deer, for use as a food source as evidenced from the faunal record.

Large Game: The hunting of large game species, including mammoth, for the use as a food source as evidenced from the faunal record.

Single Species: The hunting of game species who live and migrate alone in the environment.

Herd Species: The hunting of game species which live and migrate in herds.

Migration (Long): The inferred migratory distance of hunter-gatherers over large distances (> than 50km) from the hunting of migratory animal species from the faunal record and the transport of raw and symbolic materials over similar distances into new regions.

Migration (Small): The inferred migratory distance of hunter-gatherers over small distances (< than 50km) from the faunal record and the transport of artefacts and raw materials over similar distances.

Time – Hunting: Inferred from a combination of tool typology and total faunal record to determine the time it would take to food resources.

Time – Butchering: Inferred from a combination of tool typology and total faunal record to determine the time it would take to food resources.

Time – Social: Inferred from a combination of hearth arrangement and the number and type of symbolic and non-utilitarian materials within the archaeological assemblages.

Time – Tool: Inferred from the amount of tool debitage and the particular typologies present within the archaeological assemblage.

Time – Spiritual: Inferred from the amount and type of symbolic artefacts and activities, including burial, present within the archaeological assemblage.

Burial: The full burial of an individual(s) of adult individuals. Complex spiritual behaviour inferred from the inclusion of grave goods and other symbolic artefacts.
Caching Burial: Burial of human elements separated from the full skeleton; typically representative of secondary burials.

Burial – Children: The full burial of children. Complex spiritual behaviour inferred from the inclusion of grave goods and other symbolic artefacts.

APPENDIX THREE:
Inferred Phylogenetic relationships of the 55 ethnographic societies which compromise the ethnographic dataset.