A Semiotic Approach to the Evolution of Symboling Capacities

During the Late Pleistocene with Implications for Claims of 'Modernity'

in Early Human Groups

by

Elisabeth Vasser Culley

A Dissertation Presented in Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

Approved July 2016 by the
Graduate Supervisory Committee:

Geoffrey A. Clark, Co-Chair
C. Michael Barton, Co-Chair
Curtis W. Marean
Iain Davidson

ARIZONA STATE UNIVERSITY

August 2016

ABSTRACT

This research uses Peircean Semiotics to model the evolution of symbolic behavior in the human lineage and the potential material correlates of this evolutionary process in the archaeological record. The semiotic model states the capacity for symbolic behavior developed in two distinct stages. Emergent capacities are characterized by the sporadic use of non-symbolic and symbolic material culture that affects information exchange between individuals. Symbolic exchange will be rare. Mobilized capacities are defined by the constant use of non-symbolic and symbolic objects that affect both interpersonal and group-level information exchange. Symbolic behavior will be obligatory and widespread. The model was tested against the published archaeological record dating from ~200,000 years ago to the Pleistocene/Holocene boundary in three sub-regions of Africa and Eurasia. A number of Exploratory and Confirmatory Data Analysis techniques were used to identify patterning in artifacts through time consistent with model predictions. The results indicate Emergent symboling capacities were expressed as early as ~100,000 years ago in Southern Africa and the Levant. However, capacities do not appear fully Mobilized in these regions until ~17,000 years ago. Emergent symboling is not evident in the European record until ~42,000 years ago, but develops rapidly. The results also indicate both Anatomically Modern Humans and Neanderthals had the capacity for symbolic behavior, but expressed those capacities differently. Moreover, interactions between the two populations did not select for symbolic expression, nor did periodic aggregation within groups. The analysis ultimately situates the capacity for symbolic behavior in increased engagement with materiality and the ability to recognize material objects can be made meaningful– an ability that must have been shared with Anatomically Modern Humans' and Neanderthals' most recent common ancestor. Consequently, the results have significant implications for notions of 'modernity' and human uniqueness that drive human origins research. This work pioneers deductive approaches to cognitive evolution, and both strengths and weaknesses are discussed. In offering notable results and best practices, it effectively operationalizes the semiotic model as a viable analytical method for human origins research.

To Mel and Marty and for all the others.

To my family and extended families for seeing me through.

ACKNOWLEDGMENTS

I would like to acknowledge the support of my committee members, Geoff Clark, Michael Barton, Curtis Marean, and Iain Davidson. Each has brought to bear a specific expertise in the development and execution of this project. It is only the better for it. Each must also be thanked for shouldering burdens well above and beyond the call of duty in order it see it to completion. I am especially thankful for Michael's tolerance and patience at the very end.

I am also particularly indebted to Kim Ryan, and can only hope to be such a good friend. Two peas in a pod; two foxes in the hen house! I would also like to acknowledge my family who have supported me in many different ways. The last flurry of props was key! I could not have done this without Sarah Striker Collins, John Langan, Dan Garcia, Natasa Garic-Humphrey, Anna Novotny, Erin Thompson, Jocelyn Bernatchez, Al Dart, the Rock Family, and– of course– Jean Clottes. There are many more. Your generosity has known no bounds; your confidence in me has never waivered. I am incredibly grateful.

This research has further benefited from University Graduate Fellowships and from financial and other support through the Directorate of the School of Human Evolution and Social Change at Arizona State University.

TABLE OF CONTENTS

Page

LIST OF TABLES ix

LIST OF FIGURES xi

CHAPTER

1. THE SEMIOTIC MODEL IN CONTEXT 1

1.1 Project Background 1

1.2 Document Structure 5

2. THE SEMIOTIC PARADIGM 7

2.1 On Semiology: The Limits and Legacy of Ferdinand de Saussure 7

2.2 On Peircean Semiotics: The Sign Relation 10

2.3 Peirce's Sign Typology 13

2.4 The Evolution of Human Signification 20

2.4 Style as Social Consequence: Material Correlates of Emergent and Fully Mobilized Symboling Capacities 24

2.5 Chapter Summary 31

3. ANALYTICAL PARAMETERS 33

3.1 The Spatial Units of Analysis 34

3.2 The Temporal Units of Analysis 39

3.3 Selection Criteria 40

3.4 Analytical Variables 45

4. DATA SUMMARY 53

4.1 The African Data Set 54

CHAPTER Page

4. DATA SUMMARY 53

4.1 The African Data Set 54

4.2 The Levantine Data Set...59

4.3 The European Data Set 64

5. ANALYTICAL PROCEDURES 71

5.1 Data Collection and Classification..71

5.2 Regional Data Analysis and Profile Building.....................................75

5.3 Multiregional Analysis..81

5.4 Chapter Summary 81

6. ANALYTICAL RESULTS 83

6.1 Information Exchange in Pleistocene Africa 83

6.2 Information Exchange in Pleistocene Levant 94

6.3 Information Exchange in Pleistocene Europe...................................102

6.4 Information Exchange in the Human Lineage 111

7. SYNTHESIS AND CONCLUDING DISCUSSION 115

7.1 A Synthesis of Results and Their Implications.................................115

7.2 Model as Method: Operationalizing the Semiotic Paradigm.............118

END NOTES 121

REFERENCES 124

APPENDIX

A. AFRICAN ASSEMBLAGES BY CODE 153

APPENDIX Page

B. CLASS FREQUENCIES IN THE AFRICAN DATASET BY TIME PERIOD 154

C. CLASS MEMBER FREQUENCIES IN THE AFRICAN DATASET BY TIME PERIOD: ASSERTIVE ARTIFACTS 155

D. CLASS MEMBER FREQUENCIES IN THE AFRICAN DATASET BY TIME PERIOD: EXTRA ASSERTIVE ARTIFACTS 156

E. LEVANTINE ASSEMBLAGES BY CODE 157

F. CLASS FREQUENCIES IN THE LEVANTINE DATASET BY TIME PERIOD 158

G. CLASS MEMBER FREQUENCIES IN THE LEVANTINE DATASET BY TIME PERIOD: ASSERTIVE ARTIFACTS 159

H. CLASS MEMBER FREQUENCIES IN THE LEVANTINE DATASET BY TIME PERIOD: EXTRA ASSERTIVE ARTIFACTS 160

I. CLASS MEMBER FREQUENCIES IN THE LEVANTINE DATASET BY TIME PERIOD: EMBLEMIC ARTIFACTS 161

J. EUROPEAN ASSEMBLAGES BY CODE 162

K. CLASS FREQUENCIES IN THE EUROPEAN DATASET BY TIME PERIOD 163

L. CLASS MEMBER FREQUENCIES IN THE EUROPEAN DATASET BY TIME PERIOD: ASSERTIVE ARTIFACTS 164

APPENDIX Page

M. CLASS MEMBER FREQUENCIES IN THE EUROPEAN DATASET BY TIME PERIOD: EXTRA ASSERTIVE ARTIFACTS......165

N. CLASS MEMBER FREQUENCIES IN THE EUROPEAN DATASET BY TIME PERIOD: EMBLEMIC ARTIFACTS......166

LIST OF TABLES

Table Page

2.1 Style Types Used as Material Correlates for Advanced Symboling Capacities..........28

2.2 Behavioral Entailments and Potential Material Correlates of Emergent Symboling Capacities 29

2.3 Behavioral Entailments and Potential Material Correlated of Fully Mobilized Advanced Symboling Capacities 30

2.4 Expected Archaeological Patterns for The Emergent and Mobilized Stages of Advanced Symboling 31

3.1 Temporal Divisions for Model Testing 39

3.2 Raw Material Types Used for Model Testing 52

4.1 Sample Sizes by Time Period 54

4.2 African Assemblages under Analysis 55

4.3 Levantine Assemblages under Analysis 60

4.4 European Assemblages under Analysis 65

6.1 Relative Frequencies of Assemblages in the African Study Area with Assertive, Extra-Assertive, Emblemic, or Extra-Emblemic Materials..........84

6.2 Results for Chi Squared Tests to Determine Randomness of Trends in the Prevalence of Styles of Information Exchange Over Time..........86

6.3 Mean Number of Classes of Information Exchange Strategies in the African Bin Sample Assemblages..........86

6.4 Mean Inverse Simpson Diversity Estimates for Information Exchange Strategies in the African Dataset..........88

Table Page

6.5 Semiotic Profiles for the African Bin Samples.....93

6.6 Relative Frequencies of Assemblages in the Levantine Study Area with Assertive, Extra-Assertive, Emblemic, or Extra-Emblemic Materials.....94

6.7 Mean Number of Classes of Information Exchange Strategies in the Levantine Dataset.....95

6.8 Mean Inverse Simpson Diversity Estimates for Information Exchange Strategies in the Levantine Dataset.....96

6.9 Semiotic Profiles for the Levantine Bin Samples.....101

6.10 Relative Frequencies of Assemblages in the European Study Area with Assertive, Extra-Assertive, Emblemic, or Extra-Emblemic Materials.....103

6.11 Mean Number of Classes of Information Exchange Strategies in the European Dataset.....105

6.12 Mean Inverse Simpson Diversity Estimates for Information Exchange Strategies in the European Dataset.....105

6.13 Semiotic Profiles for European Bin Samples.....110

6.14 Semiotic Profiles for All Regions.....112

LIST OF FIGURES

Figure Page

2.1 Peirce's Triadic Sign Relation 11

2.2 Peirce's Sign Types 14

2.3 Iconic Signs for Gendered Restrooms Re-Appropriated as a Symbol 16

3.1 African Study Area 35

3.2 Levantine Study Area 37

3.3 European Study Area 38

4.1 African Study Area Showing The Location Of Assemblages Under Analysis 57

4.2 Levantine Study Area Showing The Location Of Assemblages Under Analysis 62

4.3 European Study Area Showing The Location Of Assemblages Under Analysis 67

6.1 Line Graphs Showing Increases and Decreases in the Prevalence of Different Styles of Information Exchange Over Time in Each Study Area....................................82

6.2 Distribution Plots of Diversity Estimates for Styles of Information Exchange in the African Study Area During Each Analytical Time Period...................................90

6.3 Distribution Plots of Diversity Estimates for Styles of Information Exchange in the Levantine Study Area During Each Analytical Time Period...............................98

6.4 Distribution Plots of Diversity Estimates for Styles of Information Exchange in the European Study Area During Each Analytical Time Period..............................107

6.5 Line Graphs Showing Increases and Decreases in the Prevalence of Different Styles of Information Exchange Over Time in the Combined Dataset.........................113

CHAPTER 1: THE SEMIOTIC MODEL IN CONTEXT

Project Background

Defining the nature and origin of modern human cognition is one of the most important and seemingly intractable problems in contemporary anthropology. Molecular research has placed the emergence of Anatomically Modern Humans in Africa approximately 200,000 years ago (e.g., Cann et al. 1994; Harpending et al. 1998; Harpending and Rogers 2000; Ingman et al. 2000) and revealed at least some admixture with Archaic hominins during colonization of the Old World (e.g., Green et al. 2010; Reich et al. 2010; Meyer et al. 2012; Prüfer et al. 2014; Seguin-Orlando et al. 2014; Fu et al. 2014). Yet, while genetic evidence clearly shows our biological origins are the outcome of a relatively complex Eurasian population structure, with molecular introgression as recent as ~54,000 years ago (Seguin-Orlando et al. 2014; Sankararaman et al. 2012; Higham et al. 2014; but see Eriksson and Manica 2012, 2014), questions about our cognitive origins persist.

Researchers have traditionally cited an "explosion" in tool standardization, blade and microblade production, antler and bone working, compound weaponry, personal ornamentation, and representational art only ~40,000 years ago in Western Europe as the earliest indicators of advanced or fully modern cognition. Cognitive modernity was, in turn, implicated in our migrations out of Africa, global dominance, and sole survivorship (e.g., Mellars and Stringer, eds. 1989; Gamble 1999; Klein 2000, 2009[1989]; Bar-Yosef 2002; Mellars 2005). However, an increasing number of "precocious" (Butzer 1982) materials have prompted workers to reconsider the evolutionary trajectory of complex human behaviors and the cognitive capacities that support them. Heat-treated lithic materials (Brown et al. 2009; Brown et al. 2012), bone tool industries (d'Errico and Henshilwood 2007; Backwell et al. 2008), beadwork (d'Errico et al. 2005; Henshilwood 2009), engraved ochre and shell (Henshilwood et al. 2002; Texier et al. 2010), paint palettes (Henshilwood et al. 2011), and other artifacts from the African Middle Stone Age suggest advanced cognition may have emerged quickly in the human career and possibly with anatomical modernity as a single speciation event. Similar materials associated with Neanderthals and other Archaic hominins, including wood and bone implements (Carbonell and Castro-Curel 1992; Castro-Curel and Carbonell 1995; Thieme 1997), eagle talon jewelry (Radovčić et al. 2015), and engraved and painted shells (Joordens et al. 2015; Peresani et al. 2013) (see also: d'Errico et al. 1998; Riel-Salvatore and Clark 2001; Langley et al. 2008; Brumm et al. 2012; Finlayson et al. 2012), suggest advanced capacities could have arisen even earlier in the human lineage.

The result is a plethora of models that argue modern cognition arose abruptly ~50,000 years ago (e.g., Ambrose and Lorenz 1990; Gamble 1999; Klein 2000, 2009[1989]; Shea 2003; Coolidge and Wynn 2009), or that it emerged more sporadically, beginning *at least* 80,000 years ago, with attribution to Archaic hominins disputed (e.g., Gibson 1996; Foley and Lahr 1997; McBrearty and Brooks 2000; d'Errico 2003; Mellars 2006; Hovers 2009; d'Errico and Stringer 2011). The models are highly variable in terms of the nature, causes, and point of origin claimed for modern reasoning (see Stringer 2002, Henshilwood and Marean 2003, and Shea 2011a for thorough reviews). Recent efforts have focused on identifying the cognitive entailments of specific behaviors to justify their use as indicators of advanced cognition and thus strengthen a favored origins model. Flexible and shared attention, planning depth, advanced theory of mind, advanced symboling, and/or executive functions are consistently cited as integral components of fully modern cognition (e.g., Mithen 1996; Deacon 1997; Donald 1997; Coolidge and Wynn 2009; Henshilwood and Debreuil 2011; Barrett 2012), leading to analyses of their role in the production and use of various stone and bone tool industries and other artifacts (e.g. Coolidge and Wynn 2009; Ambrose 2010; Wynn and Coolidge 2010; Goren-Inbar 2011; Henshilwood and Debreuil 2011; Brown et al. 2012; see also d'Errico et al. 2003 and Wadley 2013). However, the nature of these cognitive processes and their relationship to complex behaviors in general and to the archaeological record in particular are under-theorized. There is little consensus regarding which capacities are necessary for advanced reasoning or which are represented by a particular artifact, leaving researchers to differentially prioritize archaeological remains as key indicators of cognitive modernity. The resulting interpretations of when, where, and why advanced cognition arose are then necessarily unsubstantiated (Deacon 1997; Henshilwood and Marean 2003; Culley and Clark 2010).

The lack of resolution arguably lies in a failure to define what 'modern' cognition actually is and what it might look like in the archaeological record (Stringer 2002; Chase 2003; Henshilwood and Marean 2003; Culley and Clark 2010; Comments in Henshilwood and Debreuil 2011). Instead, cognitive and anatomical modernity are historically and semantically linked in a teleological framework that nearly requires modern human cognition and indicators thereof to be defined as (and fluctuate relative to) that which is *not* associated with Archaic remains. The paradigm reduces evolutionary process to a static point in time in which we appear unique and from which our evolutionary successes and cultural achievements are guaranteed. It cannot address non-linear evolutionary trends, whether cognitive or anatomical, nor why or how cognitive capacities and their behavioral manifestations might vary beyond species affiliation (Shea 2011a, 2011b; Ames et al. 2013; see also Conard 2010; Nowell 2010; Davidson 2010). Indeed, a number of researchers (e.g. Chase 2003; Gamble 2003; Barham 2007; Langley et al. 2008; Nowell 2010; Shea 2011a, 2011b; Ames et al. 2013; Speth 2014) have called for the discipline to move away from cognitive modernity as an analytical framework in favor of theoretically-grounded deductive approaches that can more rigorously define the evolutionary trajectory of human cognition and better explain its material consequences. The following research on the evolution of symboling capacities responds to that call.

This project uses Peircean Semiotics to model the evolution of symboling capacities in the human lineage and their potential material correlates in the Late Pleistocene archaeological record. The model constitutes a series of interrelated hypotheses: symboling capacities will manifest in two distinct stages, primarily defined by the presence or absence and relative percentages of specific styles of symbolic and non-symbolic material culture. Indicators of emergent capacities will occur sporadically across space and time, whereas fully developed and mobilized capacities will be evident in the consistent present of symbolic material culture as an information exchange technology.

The semiotic model was tested against the published record dating from ~200,000 years ago to the Pleistocene/Holocene boundary in three sub-regions of Africa and Eurasia. Results are discussed in terms of the model's ability to identify changes in symboling capacities and are compared to leading models of cognitive evolution.

Implications for notions of 'modernity' and human uniqueness are emphasized. Although some results are ambiguous, the work provides a crucial foundation for deductive approaches to cognitive evolution and can effectively guide future origins research. The significance of the research lies as much in its methodological contributions as in its outcomes.

Document Structure

Chapter Two will provide a brief history of semiotic inquiry and define the basic terminology and principles of modern semiotic theory. Zoosemiotic research is reviewed in order to place human signification within the larger context of primate cognition and sign use and to model the evolution of symboling in the human lineage specifically. The model defines two evolutionary stages, each associated with distinct styles of material expression. Chapter Two will therefore include a discussion of style theory, the types of signification that stylistic variations can support, and consequences for the archaeological record. The discussion introduces the stylistic indicators that are used to identify the evolutionary trajectory of symboling behaviors in the archaeological record and thereby test the viability of the model itself.

Chapter Three describes the parameters of the research project, including the regions and time periods under consideration and general criteria for including or excluding assemblages from analysis. The chapter also provides detailed justifications of the specific artifact classes that were used to identify each stage in the evolution of symbolic behavior and to assign semiotic profiles to assemblages and regions. Chapter Four summarizes the sample data under analysis.

Analytical protocols are detailed in Chapter Five, including statistical techniques used for identifying patterning in the various styles of information exchange. Methods used for cataloging assemblages and for determining the number of instances of and any increases in the material indicators of symboling capacities are also detailed.

Chapters Six and Seven provide extensive discussions of the analytical results, the impact methodological parameters may have had on them, and 'best practices' for future research. Results are considered at the site, regional, and multiregional level and, where possible, relative to watershed events such as climate change, migrations, and known demographic shifts. The potential roles of biological/cognitive change, the social landscape, and non-symbolic expression in the emergence of symbolic behavior are discussed and in conjunction with comparisons between the semiotic model and traditional paradigms. Concluding discussions point to semiotic theory as a point of articulation for and means of integrating relevant theory while building a shared vocabulary and conceptual framework for robust cognitive analyses in a range of contexts.

CHAPTER 2: THE SEMIOTIC PARADIGM

Semiotics explains the construction, transmission, and perception of information in terms of sign types and patterns of signification. Signs are vehicles of meaning, such as words, objects, and gestures. Signification is their use and manipulation in language, art, and other forms of expression (Nöth 1990; Preucel 2006; Sebeok 1991). Semiotic inquiry can be traced back to Plato and Aristotle, who contemplated the nature of signs and signification, and to the Stoics, who distinguished between things that signify (*semeion*) and what is signified (*semeionomenon*). Philosophers from the Middle Ages were the first to propose an independent science of signs and drew on semiotic concepts to frame ontological treatise on categories, relations, and universals (Nöth 1990; Preucel 2006; Meier-Oeser 2011). It was in 1690 that John Locke (1993[1690]: 414-415) coined the English term "semiotics" and firmly established the 'doctrine of signs' (also known as 'logic') as one of three formal branches of Science.

On Semiology: The Limits and Legacy of Ferdinand de Saussure

Modern semiotics emerged in the 19th century as two distinct intellectual traditions: "linguistic" semiotics as developed by Ferdinand de Saussure and the more broadly conceived semiotics of Charles Sanders Peirce. Saussure defined 'semiology' as a general science of communication and "the life of signs in society" (1916, 1966[1959]:16)[1]. He proposed a field of study that would identify the rules and principles structuring language, writing, military codes, symbolic rites, and other sign systems that express socially meaningful ideas. Saussure nevertheless considered language the most important of these, and and his own work focused almost exclusively on the internal structures of linguistic communication as a model for understanding other types of signification.

For Saussure, the linguistic sign is a dyadic relation, or "two-sided psychological entity" (1966[1959]:66), in which a sound pattern (the signifier) and a concept (the signified) are symmetrically linked and mutually constitutive. Linguistic signs are also arbitrary, or "unmotivated": sound patterns have no intrinsic qualities that motivate or guide conceptualization toward the ideas they represent. Both, in fact, are mental constructs independent of external phenomena, such that multiple sound patterns in the same or different languages can be linked to the same idea (e.g., "notion," "concept," "concepto," "idée").

Language is constituted in linear series of discrete but ambiguous units that are structured by phonological, syntactical, and semantic rules. Meaning is situated in the consequent matrix of syntactic and associative relationships– including the relative position of and the phonological similarities and differences between units– that limit ambiguity and effectively motivate sign relations. Thus, in the Saussurian model, it is the simultaneous coexistence and resulting binary oppositions between "lot" and "pot" and "cat" and "hat" that determine each word's meaning and makes intelligible: "'I like it a lot!' Said the Cat in the Hat to the fish in the pot" (Seuss 1957). From this perspective, language and other sign systems are cognitive methodologies for differentiating signs within a bank of tacit knowledge to decode information and re-represent inner thought (Merleau-Ponty [1969] in Flynn 2011).

Saussure's work has had a significant influence on anthropology and archaeology as the foundation of structuralist (e.g. Leroi-Gourhan 1965; Lévi-Strauss 1969; Turner

1995[1969]; Lewis-Williams 1972), post-structuralist (e.g. Foucault 1973[1969]; Stoler 1989), post-processual (e.g. Hodder 1986; Tilley 1991), and cognitive perspectives (e.g. Glassie 1975; Renfrew 1994). With his semiology critical in the development of analytical approaches to symbolic culture, meaning-making, and the human mind, Saussure is credited with a transformation of the social sciences (Conkey 2001; Preucel 2006; see Whitley 1993 and Conkey 2001 for extended reviews of Saussure's impact on archaeological research and pertaining to Pleistocene art, specifically).

Despite this legacy, semiology is now widely rejected as a model for non-linguistic sign systems. Material culture violates Saussure's central claim that sign relations are arbitrary and thus only decoded through structured oppositions that delimit meaning. Instead, the physical properties, values, functions, and use histories of objects impinge on, motivate, and direct perception as materiality engages agents and elicits individual interpretation. Unlike language, but often in service to it, material culture is ambiguous, polysemous, multivalent, and durable (Sperber 1975; Mertz and Parmentier 1985; Shanks and Tilley 1987; Hodder, ed. 1989), allowing it to transgress the limits of individual speech acts and the boundaries of linguistic communities (Sperber 1975; Culley 2006). Material culture is necessarily more than the hyper-redundant means of reiterating linguistic content that is defined by Saussure's model of code substitution (Sperber 1975).

Indeed, the implication is that all sign systems– linguistic and non– constitute a matrix of arbitrary and motivated sign relations, through which agents actively engage in the construction, transmission, and accumulation of knowledge (Sperber 1975; Mertz and Parmentier 1985; Parmentier 1997; Conkey 2001; Preucel 2006). Analytical models of symboling and the evolution of symbolic behavior must then identify all sign types, how each supports arbitrary sign relations in symbolic expression, and the implication of these dynamics for the evolution of symbolic behavior and its archaeological footprint.

On Peircean Semiotics: The Sign Relation

Although Peirce's semiotic is unfamiliar to most archaeologists, he is well-known outside the discipline as the father of Pragmatism and as one of America's greatest thinkers (Russell 1959:276; Popper 1972:212; Nagel 1982:303; Eco 1989:x-xi; see also Preucel 2006 and Atkin 2013). Certainly the scope of Peirce's contributions, ranging from analytical philosophy to mathematics, cartography, astronomy, and physics (e.g., Peirce 1878a, 1878b, 1879, 1905, 1960[1931]; see also Nagel 1982; Preucel 2006; Atkin 2013), reveals a 'Renaissance man' and hints at the synthetic, integrative nature and broad relevance of his ideas.[2]

Peirce embraced Locke's definition of semiotics as the study of logic and perception and a formal branch of science. He considered signification a shared property of the natural world and strove to understand all forms– whether vocal, gestural, material, chemical, etc. (Peirce 1878a, 1960[1931]; Nöth 1990; Preucel 2006; Atkin 2013; Burch 2014). Peirce argued signification is constituted in an irreducible, triadic relationship between a sign, its *Object*, and its *Interpretant*[3]– or the sign relation. A sign is "anything which is so determined by something else, called its Object, and so determines an effect upon a person, which effect [is the] *Interpretant*, that the latter is thereby mediately determined by the former" (PEP 1998:478; Peirce 1991:141-143; 1960[1931]; Nöth 1990; Preucel 2006; Atkin 2013) (Figure 2.1).

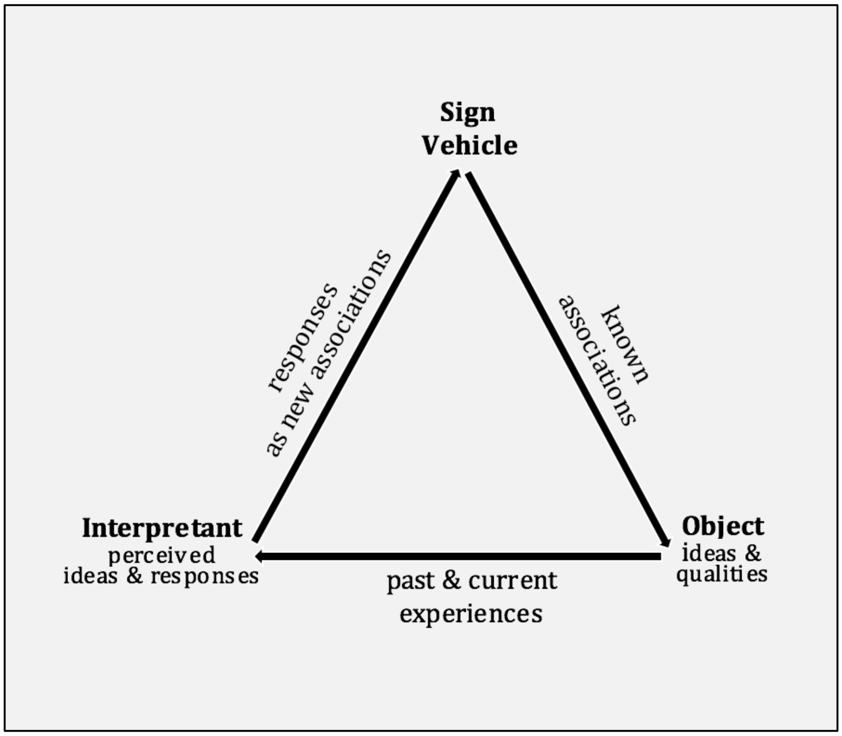

Figure 2.1. Peirce's triadic sign relation.

More simply, a sign is a vehicle of meaning, or a signifier, and its *Object* is what it represents. The *Interpretant* is an individual's recognition of and physical, emotional, and intellectual responses to the sign and its *Object*. Meaning is not situated in a dyadic relationship between a sign and its *Object*. Instead, a sign signifies– becomes meaningful– only when it is recognized as a sign and interpreted from within a specific use context (Peirce 1991; PEP 1984:49-58; Hoopes 1991:7; Atkins 2013). For example, a portrait is a sign, and the actual individual who sat for the painting is its Object. The portrait's *Interpretant* is necessarily manifest through and mediated by a number of variables, including the viewer's recognition of and past experiences with the individual represented in the painting, as well as ideas about portraiture, the physical and aesthetic properties of the painting itself, the context in which it is viewed, and others' responses to it. Peirce's *Interpretant* is as much the highly contextualized and constrained perceptual process through which meaning is made manifest as it is the outcome of that process.

In fact, Peirce (1960[1931]: 4.536, 5.475-476, 8.184, 8.314-15, 8.343) identified three kinds of *Interpretants* that are best understood as degrees of clarity within single instances of signification (Atkin 2013:np). The *Immediate Interpretant* is simply the recognition that a sign is a sign, or the recognition of meaningfulness. The *Dynamic Interpretant* captures all possible responses that could occur with the recognition and perception of that sign, given the conceptual constraints of its *Object* (Peirce 1960[1931]: 4.536, 5.475-476, 8.184, 8.314-15, 8.343; Atkin 2013; Corrington 1993:158-164). The *Dynamic Interpretant* also includes, and is most typically associated with, the "actual effect which the sign, as a sign, really determines," or brings forth in an individual's mind (Peirce 1960[1931]: 4.536, 8.343). It is what a sign means to a specific individual and precedes an understanding of a sign's intended meaning– "what *you* mean" (Atkin 2013:np; emphasis added). Peirce's definition of this *Final Interpretant* is the intellectual, emotional, and/or physical attitude and general habits of conduct that would reasonably arise in a semiotic community, given repeated interactions with and consideration of a sign relation (Peirce 1960[1931]: 4.536, 6.481; Atkin 2013; Corrington 1993:158-164).

If the portrait example is teased-out a bit further with the *Object* of the sign vehicle (the painting) defined as George Washington, its *Immediate Interpretant* is the degree of clarity one might have after seeing it quickly, out of the corner of the eye, and wondering, "is that a painting?" The *Dynamic Interpretant* includes the recognition of the painting as a painting and the possibilities it represents George Washington as a stepfather, a general, or a president– or someone who just looks like him. The *Dynamic*

Interpretant manifests as an individual's determination that it represents President Washington. The interpretation is based on various clues (signs) within the image, from past experience, and the viewing context. The *Final Interpretant* allows room for the integration of new information (signs) and the correction of individuals' perceptions in maintaining community consensus.

As a result of its tripartite structure, a sign necessarily and simultaneously directs attention 'backward' to the *Object* that constrains and brings forth a universe of potential meanings and 'forward' to the *Interpretant(s)* that emerge. Moreover, *Final Interpretants* become the *Objects* of new sign relations in a theoretically endless but coherent chain of signs, taken-up and negotiated by a semiotic community (Peirce 1960[1931]:2.92, 2.303, 3.66-68; 5.284; Hoopes 1991:141; Preucel 2006:55-56; Atkins 2013). The process is 'interrupted' by habit of thought emerging from the *Dynamical Interpretant* and ultimately reified or re-directed through community interaction (Peirce 1960[1931]:5.284; Atkins 2013; Preucel 2006). Signification, then, is generative, expansive, recursive; meaning is fluid, coherent, and constrained. Most importantly for Peirce, meaning is not located in the perception of individuals, but in the habituated responses to, and thus consequences of, a sign's use (Preucel 2006:50-51).

Peirce's Sign Typology

Peirce's discussion of the triadic sign relation includes a complex typology that accounts for the diversity and interdependencies of relationships that can pertain between each component of the triad. He classified signs based on the different ways in which a sign vehicle can relate to itself, to its *Object*, and to its *Interpretant* in order for a sign relation to demand attention and effectively guide interpretation toward a specific habit of

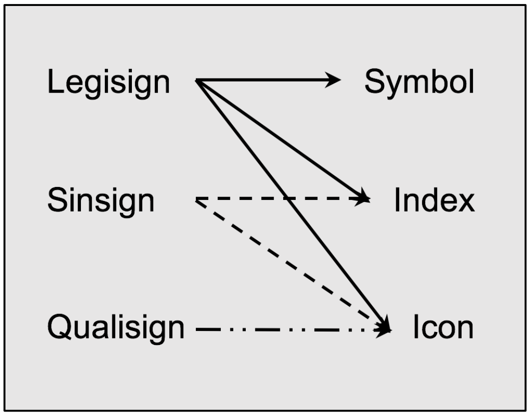

Figure 2.2. The list of sign types on the left characterize the different relationships signs can have with themselves. These sign-sign relations determine the type of relationship signs can have with their *Objects*. The three possible sign-Object relations are listed on the right. The lines indicate the hierarchical nature of sign types: sign-sign relations can only support sign-Object relations of an equal or lesser degree of abstraction. As a consequence, higher order sign types embed and build on lower order types.

mind (Deacon 2012; Atkin 2013; Preucel 2006; Burch 2014). The formal classification of any given sign, then, reflects a combination of traits that collectively determine how that sign relation makes itself meaningful. Only the types that characterize the relationships between a sign vehicle and itself and its *Object* are discussed here (Figure 2.2).[4] The following type descriptions are taken from Peirce (1960[1931]), Deacon (2012), Preucel (2006), Atkin (2013), and Nöth (1990) unless otherwise noted.

Sign types that capture the relationships that a sign can have with itself describe the properties of sign vehicles, *independent of any reference those properties may or may not make*. Those types are *qualisigns*, *sinsigns*, and *legisigns*. *Qualisigns* are sign vehicles with a distinct quality– perhaps an unusual sheen, depth of color, or beauty– that demands attention. *Qualisigns* have a potentiality. *Sinsigns* are unique occurrences; singular forms taken as sign vehicles. Portraits are a good example. Although there may be many portraits of the same individual, each one is unique in the age, dress, social roles, status, and other attributes that it represents. As such, each portrait is a singularly occurring form taken as a sign, or a *sinsign*. *Legisigns* are one of multiple instances of a sign vehicle that is defined by convention, law, or rule of design. For example, the quarter's (25¢) arbitrary but standardized form, including the depiction of George Washington, is a sign vehicle because of a socially determined rule of design that must be replicated with minimal variance for each instance of the sign to function as currency. *Legisigns* are tokens, or replicas of themselves.

The three sign types that characterize the potential relationships between a sign vehicle and its Object of reference are the most widely known of Peirce's typology and are frequently appropriated in anthropology. These types are *icons*, *indexes*, and *symbols*. If a *quali*-, *sin*-, or *legisign* shares properties with its *Object*, it is an *icon*. A portrait is thus an *iconic sinsign* because its properties bring to mind a specific individual by virtue of looking like that individual, but in a singular way. A sign vehicle that has a proximal and/or causal relationship with its *Object* is an *index*. For example, smoke is an *indexical sinsign* that references fire because it is proximal to and caused by fire, while yet unique in color, smell, density, etc. A sign vehicle that has an arbitrary relationship with its *Object* is a *symbol*. The properties of a symbolic sign vehicle do not determine its *Object*. Instead, the relationship between the sign vehicle and its intended reference must be socially determined and maintained through time.

A particularly interesting example of a symbolic relationship between a sign vehicle and its *Object* is found in the re-appropriation of standardized stick figures that we use to designate gendered restrooms (Figure 2.3). These *legisigns* coopt familiar clothing styles to reference each gender iconically; however, when used to mark facilities, there is no iconic relationship between the *legisigns* and the *Object*, "bathroom." The additional reference is indexical, hinging first on recognizing the *iconic legisigns* as signs for gender and then on repeatedly experiencing their association with

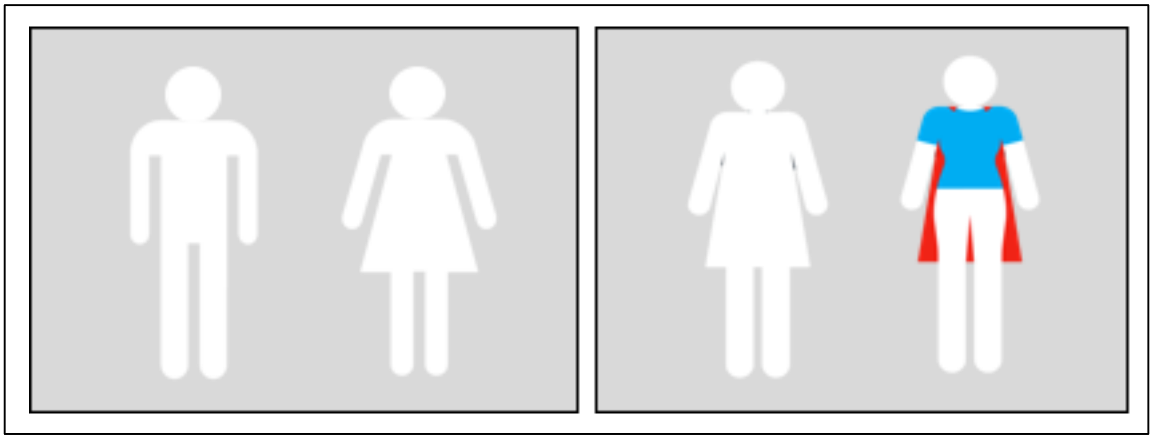

Figure 2.3. The conventionalized stick figures on the left that designate gendered restrooms are legisigns. The arbitrary rules of design use clothing styles to reference each gender iconically. Their repeated association with gender-specific bathrooms has created and maintains an indexical relationship between the designs and bathroom facilities. An artist has recently changed the rule of design for representing women, simultaneously referencing and juxtaposing the traditional conceptualization of women (1) and Superwoman (r) to symbolize our gender assumptions and the movement to re-define them (https://itwasneveradress.com).

facilities until the link is habituated (Deacon 2012). However, an artist has now redefined the Object of the initial iconic relationship (https://itwasneveradress.com). By simply re-coloring the image, she disrupts our habit of thought and brings Superwoman to mind. The juxtaposition of the expected and actual *Objects* of the sign vehicle prompts us to reconsider our perceptions of and assumptions about women. With the juxtapositioning itself the new *Object,* the sign now *symbolizes* those assumptions and perceptions without iconic or indexical relationships with them.

The female stick figure as icon, index, and symbol illustrates the three types of relationships that a sign vehicle can have with an *Object*, as well as the potential for multiple *Objects* that must be negotiated and prioritized with each expression. Yet despite the fluid and polysemous nature of signification, Peirce's taxonomy reveals a hierarchical dependency among sign types that limits their referential use. Ultimately, the properties that define a given sign vehicle as a *quali-*, *sin-*, or *legisign* determine the kinds of relationships it can have with its *Object*. *Qualisigns* can only have iconic relationships with *Objects*, while *sinsigns* can reference iconically and indexically. *Legisigns* such as the gendered stick figures can be *icons, indexes*, and *symbols* (Deacon 2012; Atkin 2013) (Figure 2.2).

Examining the semiotic potential of the 'redness' of ochre (hematite) that is frequently recovered from archaeological contexts provides a useful example. The quality of 'redness' necessarily references other instances of redness through its similarity with them. In Peircean terms, it is an *iconic qualisign* that signifies a distinct attribute with only the potential for meaningfulness. For redness to refer to something other than its defining property, it must do so through indexical or symbolic relationships with additional *Objects*– relationships that are not inherent to redness, nor to any *qualisign*. An indexical relationship requires many singular instances of ochre 'redness' be taken as signs in association with a potential referent, such as blood, for 'redness' and red ochre to habitually guide perception to that *Object*. In Ndembu practices that have been documented in Zambia (Turner 1967), for example, an indexical relationship has been established between red ochre and menstruating women, as well as male warriors, through the recurring use of ochre in healing rites associated with menstrual disorders and through the ritualized body painting of tumbanji (war chiefs). In these cases, red ochre is recognized as a sign through its iconic relationship with blood and made meaningful through its proximal associations with women and warriors. The sign's semiotic potential is not realized through the properties of ochre, per se, but through the multiple occurrences of them in bounded contexts. The potential is situated in the sign's relationship to itself that is characteristic of *sinsigns*.

For red ochre to have a symbolic relationship with an *Object* and signify more abstract conceptualizations, both the relationships between a sign and itself and between a sign and its *Object* must be conventionalized. Variability among recurrent instances must be standardized as a rule of design that can bring forth and draw on iconic and indexical concepts, while elevating symbolic meaning as the intended *Object*. Hypothetically, among the Ndembu then, red ochre would have to be marked, shaped, and/or used in a specific way to unequivocally distinguish it from the *indexical sinsigns* at play and to consistently guide perception from blood, to women's blood, menstrual blood, and finally to 'fertility' as the arbitrarily negotiated *Final Interpretant* of the semiotic community.

The standardization that distinguishes *legisigns* from *sinsigns* and its role in enabling symbolic sign-object relationships is also evident in the prescribed display of presidential portraits in federal buildings. In these displays, each portrait constitutes an array of iconic and indexical references to specific individuals, social roles, historic periods, etc. Yet, through highly regulated use and standardized placements, the collection as a whole engages additional *Objects* that are independent of the referential limits of each depiction: the office of the presidency, the history of, and social values therein. Significantly, it is the standardized elements that are recognized across space and time as a sign vehicle, even as the iconic and indexical sign-object relations (the portraits), the semiotic community (the viewers), and the use-context (the federal buildings) change.

This discussion emphasizes several core tenets of Peircean semiotics with significant implications for the identification of symboling and its evolutionary trajectory in the archaeological record. As a consequence of the hierarchical and interdependent nature of the relationships that sign vehicles have with themselves and with their *Objects*, signs are polysemous. Meaning is fluid and situated, with the most appropriate *Object* and a *Final Intepretant* defined by and emergent from each use context. In almost all cases, it is not possible to claim with certainty that a given artifact functioned as a symbol at the place and time of discard. This dynamic has limited previous attempts at operationalizing Peircean semiotics as an archaeological research method and generated some skepticism toward such efforts (Conkey 2009; Preucel 2006; Bouissac 2000:340).

However, a sign's semiotic potential is situated in its relationship with itself, with symbolic expression demanding a rule of design or of use that draws on, yet re-directs perception from iconic and indexical *Objects* toward socially negotiated meanings. It is only through abstraction, conventionalization, and standardization that meaning can persist beyond the limited use contexts in which iconic and indexical relationships grounded in similarity and proximity are salient. Therefore, it is possible to identify the properties of *legisigns* in the archaeological record and thus an artifact's potential for symbolic expression. The use of stylistic attributes to help identify legisigns is discussed below.

Symbolic expression is emphasized as a primary mechanism in the transmission and accumulation of knowledge that is the hallmark of our species. Symbolic meaning is also typically described as arbitrarily linked to a sign and so cognitively demanding to manifest and maintain.[5] Yet the previous examples show how meaning unfolds as lower order sign relations scaffold perception and ultimately engender higher order sign vehicles and increasingly derived relationships between signs and their *Objects*. In conjunction with understandings of non-human signification, the perspective effectively models the evolution of symbolic expression from extant iconic and indexical relationships.

The Evolution of Human Signification

This section reviews current understandings of non-human semiotic capacities as the foundation from which human symboling behaviors necessarily emerged before turning to stylistic variables that further delimit expectations of archaeological symbols and provide specific proxies for analysis.

Zoosemiotic research (e.g., J. von Uexküll 1982; T. von Uexküll 1987; Sebeok 1977, 1991) has evaluated the semiotic behaviors of a broad range of species and demonstrates that non-human, pro-social and social species use a number of sign types to transmit information about their environment and maintain cooperative hierarchies. Great ape vocalizations and gestures are well documented (Cheney and Seyfarth 1985, 1990; Seyfarth and Cheney 1990; Preuschoft and Preuschoft 1994; Savage-Rumbaugh and Roger Lewin 1994; Fetzer 1998; Jolly 1999; Arnold and Zuberbühler 2006; Greenfield et al. 2008), and comparable sign systems are found in insects (Nöth 1990), birds (Sebeok 1979b), canids (Beckoff 1995), and other mammals (Janik et al. 2006; Nöth 1990). The use of material objects as signs to establish identities and mediate relationships is also documented (Bouissac 1994; Sebeok 1979:18-19; Madden 2003, 2008). For example, male bowerbirds use discarded objects to decorate their bowers and attract females during extended mating rituals. The males preferentially choose and arrange shells, flowers, and other curios that are shown to be good predictors of each bird's mating success. The females first visit the bowers when the males are absent and return based on the displays. (Madden 2003, 2008; Bouissac 1994: Plate 1).

In all of these examples, perception is directed by an indexical sign-object relation that, in turn, hinges on variation in sign forms to point to a specific proximal or causal agent. They are indexical *sinsigns*. Even with bowerbirds' use of curios, where the fundamental relationship between a material thing and what it represents is conventional, each curio is no more than a *qualisign*, perhaps chosen for its resemblance to previously used objects. Through collection, assemblage, display, and response, the curios and baubles come into association with and necessarily reference a specific bird and his viability as a partner. The process of mutual engagement transforms the curios into bowers and the iconic *qualisigns* into indexical *sinsigns*, but with meaning and its consequences still inextricably linked to a bounded spatiotemporal context (Bouissac 1993, 1994; Deely 1991, 2002; Eco 1979; Nöth 1990; Sebeok 1979; J. von Uexküll 1982; T. von Uexküll 1987).

Modern human signification is supported by capacities for metarepresentation and theory of mind, and thus entails an awareness that sounds, bodies, material objects, etc. can be made meaningful (Eco 1979; Deely 1991, 2002; Bouissac 1993, 1994; Nöth 1990; Sperber 1994; Tomasello 2000; Wilson 2000; Lehrer 1990; see also Dennett 2000). 'Sign recognition' allows groups to conventionalize the relationships that signs have with themselves and their *Objects* and to stipulate meaning that is independent of proximate individuals and specific use contexts (Eco 1979:273-274; Deely 1991, 2002; Bouissac 1993, 1994; Sebeok 1991; J. von Uexküll 1982; T. von Uexküll 1987).

Semiotic theory delineates the evolutionary trajectory of modern human symbolic behaviors as emergent from the capacities for signification we share with other primates and manifest through 'sign recognition' and the gradual mobilization of stipulated meanings. Sign recognition and stipulation would have emerged from sustained, shared attention to publicly visible indexical signs and their consequences (Eco 1979; Deely 1991, 2002; Bouissac 1993, 1994; Sebeok 1991; J. von Uexküll 1982; T. von Uexküll 1987; see also Moriarty 1996). For example, all animals make marks on the landscape (tracks, scratch marks, nests, etc.) that are unintended *indexes* of those animals and their specific behaviors. Hominins leave additional traces– knapping debris, remains of butchering sites– that are indicators of past travels or other groups and possibly discarded resources (Davidson 2013). The repeated co-occurrence of material phenomenon, individuals, groups, places, and activities inevitably results in a plethora of unintended indexical signs. Sustained shared attention to those signs, variations in them, and the responses they elicit creates a social space in which actors are motivated to bring forth and manipulate specific objects and their consequences. The recognition that material objects have semiotic potential and their meaning can be stipulated and negotiated is then ultimately situated in repeated social action.

Davidson and Noble (Davidson 2013; Davidson and Noble 1989; Noble and Davidson 1996; see also Noble and Davidson 1993 and Davidson and McGrew 2005) have extended this argument to the origins of picture-making and language. They posit social engagement with and responses to the co-occurrence of indexical marks and objects they coincidentally resemble, such as three adjacent cupule marks that resemble and co-occur with human faces, provides a context through which similarity would be pointed to, valued, and enhanced through additional marks or action. The process would lead to an understanding of 'resemblance' and 'depiction' and to picture-making, without need for stipulated icons to co-occur with their *Objects* to be recognized as meaningful. Moreover, depictions no longer context-dependent give rise to systems of abstracted ideas and concepts essential to the transformation of communication into language.

Although the origins of language are beyond the scope of the project, it is important to note the broad consensus regarding engagement with materiality from within hominin social structure, and specifically durable, unintended signs that persistently demand shared attention, as the context through which sign recognition can occur and lower order sign use can engender symbolic expression.

Stipulation requires selection from among many idiosyncratic expressions and their transformation into a standardized code. The process entails the constant reinforcement of new and fallible codes and the renegotiation of old ones (Eco 1979); it is cognitively and socially demanding. It is also at least somewhat costly in time and attention and potentially risky in eliciting negative responses from within a group or attention from competing groups. Stipulated object-use should therefore develop slowly and in contexts in which codified signaling confers an adaptive advantage (Eco 1979; Deely 1991, 2002; Bouissac 1993, 1994; Sebeok 1991; see also Dyson-Hudson and Smith 1978; Richerson and Boyd 2000).

It is likely stipulated object-use first emerged and re-emerged with increases in population density, when closely linked individuals and groups tend to cluster and population structure favors the transmission of complex phenomena[6] (Shennan 2001; Henrich 2004; Centola and Macy 2007; Borgatti et al. 2009; Powell et al. 2009; Centola

2010; see also Braun and Plog 1982). Increased population density would also favor mechanisms that mitigate increased social interaction and competing interests by facilitating communication. Once negotiated meanings became culturally salient and symboling "fixed" as an adaptive strategy, the full mobilization of sign recognition would affect the obligatory use of sophisticated symbol systems for information exchange (Deacon 1997; Eco 1979; Deely 1991, 2002; Bouissac 1993, 1994; see also Conkey 2009 and Richerson and Boyd 2000).

Style as Social Consequences:
Material Correlates of Emergent and Fully Mobilized Symboling Capacities

Sign recognition constitutes a shift in our relationship with materiality and entails changes in the use and production of material culture (Conkey 2009; see also Deely1991) that should be visible in the archeological record and allow for deductive evaluations of the semiotic model. For example, the initial exploration of materiality may result in increased variability in raw material types (lithic and organic), manipulated resources (heat-treated stone, mineral, and/or eggshell), "exotic" lithics, and/or aesthetically valued objects (color-selected ochres, beauty shells). Indicators of *Emergent* sign recognition should also include the sporadic appearance of idiosyncratic, indexical objects such as marked stone and bone, as well as standardized artifacts like shell ornaments, painted plaquettes, or figurines that show a degree of stipulation and codification of symbolic referents.

Fully *Mobilized* sign recognition should result in the sustained exploitation of materiality and innovative use of stipulated objects- indexical, iconic, and symbolic- in complex information exchange systems (Deacon 1997; Eco 1979; Deely 1991, 2002; Bouissac 1993, 1994). The archaeological indicators of fully *Mobilized* capacities include the material correlates of *Emergent* capacities, as well as rock alignments, clay sculpture, parietal art, aggregation sites, and other remains. Moreover, stylistic variation among stipulated objects will pattern as distinct information exchange systems.

Information Exchange Theory (IE) was first developed in the 1970s (Wobst 1977) and subsequently adopted and modified by many anthropologists (Wiessner 1983, 1985; Conkey 1978, 1980; Gamble 1982; Hodder 1986; see Hegmon 1992 and Clark et al. 1996 for a review of IE and other style theories). In general, the perspective defines some formal variation in material culture as information and argues social agents actively manipulate artifact styles to control information exchange. In mediating social knowledge and facilitating interaction, style expands access to economic and human resources and is unquestionably adaptive.

For Wiessner (1983, 1985, 1989, 1990), style is situated in the fundamental human need to define self and others through the visual comparison of identity markers. Style will vary based on the cognitive demand for and adaptive value in information about personal or group identities. Wiessner recognizes two kinds of style based on their respective referents, or the ideas they represent. Assertive style transmits information regarding individual identities through indirect and idiosyncratic signaling of states of being or various levels of affiliation. Assertive style has no distinct referent or direct symbolic relationship with individuals and is therefore associated with small objects that make reference through proximity. The style type reflects interpersonal exchange that can cross-cut group boundaries and is necessarily subject to enculturation and acculturation to maintain a communicative function. Emblemic style is formal variation in material culture that transmits information about a group's norms and values and to a defined audience. Because it has a distinct referent and is therefore under strong selective pressure to remain uniform across space and time, emblemic style is well suited for marking group boundaries (Wiessner 1983; Wobst 1977; Conkey 1980). It has been linked to parietal art and other large material remains (e.g., Barton et al. 1994; Clark et al. 1996). Wiessner (1983; see also Conkey 1980) also argues that emblemic style should emerge with non-continuous social organization, or competitive social groups, and either appear frequently or not at all.

Wiessner's definitions of assertive and emblemic style draw on semiotic theory, but can be modified to further articulate with the approach and extend its predictive value. Wiessner (1983:258) states that assertive style "has no distinct referent as it supports, but does not directly symbolize, individual identity." However, standardized assertive artifacts necessarily entail group-level negotiations to establish the ideal representational forms of membership classes and the methods to produce them. Although standardized assertive style does not have to directly symbolize individuals, it does directly symbolize group ideals and values. Peircean semiotics defines these as two different semiotic competencies and reasoning strategies that are appropriately distinguished as assertive (indexical) and extra-assertive (symbolic) information exchange. Importantly, symbolic assertion is an advanced strategy, and when recognized as an independent style type, can point to modern human reasoning capacities.

Emblemic style as it is traditionally defined similarly conflates two distinct styles of information exchange. As has been noted, emblemic style is strongly associated with the marking of group boundaries and larger and/or stationary artifacts are often taken as such markers due to their size and visibility on the landscape. However, many remains that would be classified as emblemic using Wiessner's schema would not be readily visible among non-continuous groups as they are in areas with restricted access or oriented away from travel corridors. Emblemic expression in contexts where visibility is restricted suggests the behavior is motivated by intra-group exchange. Moreover, cross-cultural research indicates that material culture that is visible, but only with controlled access, is likely to transmit information about belief systems specifically and only to other group members (Hegmon 1992). Wiessner (1983:257) cites differences in the intended referents, information content, and conditions that affect use and patterning of assertive and emblemic styles to argue for their initial distinction. Here, differences in referents, target audiences, and social consequences are used to support further distinction between assertive and extra-assertive and between emblemic and extra-emblemic and to refine expectations of the archaeological signature of advanced reasoning. Table 2.1 outlines the four styles of information exchange that will be used as material correlates for advanced symboling capacities.

It is possible, then, to specify the material consequences of advanced symboling capacities and delineate their expected patterning during the initial emergence and subsequent mobilization of sign recognition. The behavioral entailments of advanced symboling capacities include the exploration and exploitation of materiality and (indexical) assertive, extra-assertive, emblemic, and extra-emblemic object-use. Aggregation of groups as a mechanism for and outcome of the successful negotiation, re-negotiation, and maintenance of symbol systems across space and time is also likely.

Table 2.1. Style Types Used as Material Correlates for Symboling Capacities

Style Type	General Description	Type of Exchange	Use Contexts	Artifact Classes	Potential Examples
Assertive	individual motivated;constructs individual identities and states; proximal, idiosyncratic	interpersonal, indexical exchange; low risk	bodies, cave niches / interpersonal visibility	ochres personal ornaments portable art niche art	idiosyncratic notched ochres
Extra-Assertive	individual, intra-group and intra-alliance motivated; constructs individual identities and social categories; proximal, standardized	interpersonal, symbolic exchange; low risk	bodies, cave niches, graves/ restricted intra-group visibility	ochres personal ornaments portable art niche art grave goods	Blombos beads Swabian figurines Qafzeh grave goods
Emblemic	intra-group and intra-alliance motivated; constructs group identities, social values, and norms; integrative, standardized	controlled symbolic group exchange; medium risk	caves/ intra-group and intra-alliance visibility	parietal art sculpture	Lascaux, Rouffignac, Font de Gaume, aggregation sites
Extra-Emblemic	intra-group and inter-group motivated; constructs group identities, social values, norms, and boundaries; integrative and exclusionary	public symbolic group exchange; high risk	open-air sites, shelters/ intra-group & inter-group visibility	parietal art	Foz Coa

Ultimately, selective pressures, the cost of stipulated object use, and resource availability determine the material correlates and general patterning of emergence and mobilization. Archaeological evidence of *Emergent* capacities should include the first indicators of stipulated object-use motivated by individual or intra-group alliances, such as gifted raw materials (“exotic” lithics), standardized beads and pendants, and standardized motifs on carved disks, batons, and weaponry. Remains may also reflect the exploration of materiality, as with the presence of heat-treated stone, painted ostrich eggshell, or caches of particularly red ochre. Sites in coastal areas may include shell from inedible marine life, collected for aesthetic attributes. Other assemblages may simply show an increase in raw material or artifact types and irregularly marked pieces of bone or ochre. Emblemic expression will be absent. The remains of *Emergent* sign recognition and stipulated object use are expected to fluctuate as selective pressures vary until the salience and value of symbolic exchange is fixed.

Assemblages resulting from fully *Mobilized* sign recognition and the obligatory use of stipulated objects should include a range of information exchange technologies in which various styles are used to mitigate interpersonal and intra- and inter-group dynamics within different social network structures. Idiosyncratic, assertive objects should decrease in relative frequency, while extra-assertive materials like the standardized ornaments, painted plaquettes, and "niche art" should increase. Emblemic expressions such as images on cave walls, floors, and ceilings, enclosed sculptures, and "sticking stones and bones" should be common.

Table 2.2. Behavioral Entailments and Potential Material Correlates of Emergent Symboling Capacities

General Entailment	Potential Archaeological Indicators
Exploration & Manipulation of Materiality	
situated in object-awareness and resulting interest and value in material form, variability, and meaningfulness	increased variability in raw material and artifact types; increased frequencies in "exotic" materials (long-distance goods), altered materials (heat-treated stone, mineral, shell), aesthetic items (color-selected lithics & ochres, beauty shells)
Assertive Information Exchange	
proximal, interpersonal exchange; idiosyncratic, *indexical object-use* about personal attributes and individuals constructs individual identities and states	"exotic" raw materials (gifted lithic material); idiosyncratic, marked/decorated objects and ornaments (marked ochre, bone, shell, figurines, batons, pendants); grave goods
Extra-Assertive Information Exchange	
proximal, interpersonal exchange; stipulated, *symbolic object-use* intra-group and intra-alliance motivated; constructs individual identities and social categories; integrative	"exotic" raw material (gifted lithic material) standardized ornaments & decorated objects (beadwork, engraved ochre, bone, or shell, figurines, plaquettes, batons, atlatls) "niche art" (imagery in cave niches and wells)

Table 2.3. Behavioral Entailments and Potential Material Correlates of Fully Mobilized Symboling Capacities

General Entailment	Potential Archaeological Indicators
Full Exploitation of Materiality	
situated in object-awareness and resulting interest and value in material form, variability, and meaningfulness	increased/full manipulation and use of available resources (stone, mineral, bone, antler, shell, wood, heat-treated stone, mineral, shell); "exotic" raw material (traded/imported lithics); beauty shells; color-selected materials (stone, mineral, shell); craft areas or "workshops"
Assertive Information Exchange	
proximal, interpersonal exchange; idiosyncratic, *indexical object-use* about personal attributes and individuals constructs individual identities and states	"exotic" raw materials (gifted lithic material); idiosyncratic, marked/decorated objects and ornaments (marked ochre, bone, shell, figurines, batons, pendants); grave goods
Extra-Assertive Information Exchange	
proximal, interpersonal exchange; stipulated, *symbolic object-use* intra-group and intra-alliance motivated; constructs individual identities and social categories; integrative	"exotic" raw material (gifted lithic material) standardized ornaments & decorated objects (beadwork, engraved ochre, bone, or shell, figurines, plaquettes, batons, atlatls) "niche art" (imagery in cave niches and wells)
Emblemic Information Exchange	
stipulated, *symbolic object-use* & intra-group exchange intra-group and intra-alliance motivated about group and alliance norms, ideals and values constructs social values and group identities; integrative	"sticking stones and bones"; (stone, bone and antler inserted in cave walls); parietal and floor art (imagery on cave walls, floors and restricted overhangs); cave sculpture (e.g., Tuc d'Audoubert)
Extra-Emblemic Information Exchange	
symbolic, public, intra- and inter-group exchange intra-group/alliance and inter-group motivated about group and alliance norms, values and identities constructs group norms, values and boundaries integrative and exclusionary	public art (imagery at open-air sites and visible overhangs); rock cairns and alignments

Extra-emblemic rock cairns or alignments and images on stone pillars, overhangs, and boulder fields that can effectively mark boundaries among discontinuous and competitive groups are also expected, as are aggregation sites among the densest populations. Table 2.2 and Table 2.3 list the behavioral entailments and potential material correlates of *Emergent* and *Mobilized* capacities. See Table 2.4 for general descriptions of both stages of cognitive evolution, including the behavioral expectations that provide deductive protocols for testing the semiotic model. The archaeological correlates of

Table 2.4. Expected Archaeological Patterns for the Emergent and Mobilized Stages of Advanced Symboling

	Emergent	Mobilized
General Description	sporadic, patchy, mosaic distribution, but gradual increase in the exploration of materiality and in stipulated object-use; assertive and extra-assertive symboling correlate with low measures of population density, while emblemic symboling possible but unlikely; extra-emblemic object-use and aggregation sites are absent	stable and full exploitation of materiality; assertive object-use persists but decreases in relative frequency; extra-assertive object-use becomes common and dominates symboling in moderately dense populations, while emblemic object-use dominates symboling in highly dense populations; extra-emblemic symboling and aggregation are likely among the densest populations only
Material Expectations	increased variability in raw material and formal artifact types; increased frequencies in "exotic" goods, altered materials, and aesthetic objects; idiosyncratic and standardized ornaments and decorated objects; grave goods; "niche art;"	full use and creative manipulation of available raw materials; "exotic" goods; heat-treated materials; aesthetic objects; workshops; standardized ornaments and decorated objects; grave goods; "niche art;" "sticking stones and bones;" sculpture, cave art; public art; rock cairns and alignments

Emergent and fully *Mobilized* capacities are further detailed in the following chapter, including explicit justification for eliminating or adopting potential proxies relative to areas under analysis.

Chapter Summary

At this juncture, a summary review of the semiotic model and its general predictions is useful.

Model Framework and Predictions:

- Signification is universal to all living organisms and is constituted in irreducible, tripartite sign relations.
- Humans appear unique in their use of higher order sign types, specifically highly conventionalized sign vehicles (legisigns) that have equally conventionalized relationships with their referents (symbols) and that allow information to be transmitted across space and time.

- Higher order signification emerged from lower order sign relations as a consequence of sustained engagements with and shared attention to material signs in the natural environment and the recognition that signs can be stipulated.
- The evolution of higher order signification will occur in two distinct stages: *Emergent*, as characterized by the exploration of materiality and sign stipulation, and *Mobilized*, as characterized by the full exploitation of materiality and obligatory symbolic behavior.
- The response requirements of adaptive information exchange result in four styles of materials sign vehicles that redefine archaeological instances of these styles as indicators of different signification strategies and specifically *Emergent* and fully *Mobilized* symbolic exchange.

Ultimately, the stylistic classifications can be used to identify lower and higher order signs in the archaeological record, to identify changes in signification strategies through time, and to evaluate relationships between those changes and other cognitive, social, and/or environmental variables. In this research context, a strategic sampling design supports comparisons between the actual distributions of lower and higher order signification during the Pleistocene and the predicted patterning of the emergence and mobilization of symbolic behavior to better specify its origins and development among human groups. The following chapter reviews that sampling strategy and other testing parameters before turning to analytical methods and results.

CHAPTER 3: ANALYTICAL PARAMETERS

The proposed model of symbolic behavior and its emergence in the human lineage does not presuppose a relationship between cognitive and anatomical evolution. All great apes use lower order sign relations that can scaffold more advanced signification in response to and for selection in socially demanding circumstances (e.g., Preuschoft and Preuschoft 1994; Fetzer 1998). Certainly symbolic behaviors could have emerged from indexical sign use in any number of Archaic populations, with the same sporadic manifestation until or unless mobilized prior to extinction. Identifying the origin, or origins, of symbolic information exchange then necessarily requires extensive sampling that can capture patterning among different groups, and through time, for testing against model predictions.

Nevertheless, general project manageability and the need to identify model strengths and weaknesses and 'best practices' for operationalizing semiotic principles in human origins research favor a restricted program. This project evaluated only the published record from three subregions of Africa and Eurasia in six successive time periods spanning from 191,000 to approximately 11,000 years ago. Significant variation in the quantity, quality, and nature of the data both within and between these areas has largely dictated further research parameters. This chapter details those parameters, including the spatial limits of the study areas under review, the temporal framework used to group assemblages and seriate changes in each region, the criteria for including assemblages in the analysis, and the archaeological indicators of emergent and mobilized symboling that were considered.

The Spatial Units of Analysis

Areas in Southern Africa, the Levant, and Western Europe (Figures 3.1-3.3) were targeted for their centrality to human origins research, as well as for the volume, quality, and accessibility of the archaeological data associated with them. The perimeter of each locale was largely determined by site density and the sampling area needed to capture an adequate and comparable number of assemblages in all spatiotemporal units under analysis. The sparseness of the African record and consequent extent of the African study area may reflect Eurocentric biases and political unrest that have limited research there, as much or more than, actual site numbers. Effort was also made to capture a range of environments in each locale and so the information exchange strategies that may be unique to them. The analytical regions are best understood as non-randomly defined catchment areas from within which random samples were generated based on data accessibility and final selection criteria.

The African study area perimeter (Figure 3.1) extends from Cape Town, South Africa (34H 255942E 6240587N), north to Lambert's Bay (34H 245637E 6445892N), northeastward approximately 1100 km to near Standerton (35J 712835E 7028279N), due east to the Indian Ocean, and finally back along the coastline to Cape Town. The area encompasses ~634,502 square kilometers, including extensive coastal areas, the high altitude and riverine environments of the Drakensberg and Cape Fold Mountains, and much of the arid Karoo. The study area captures many of the Middle Stone Age deposits that suggest symboling and other complex behaviors emerged early in our evolutionary history (McBrearty and Brooks 2000).[7]

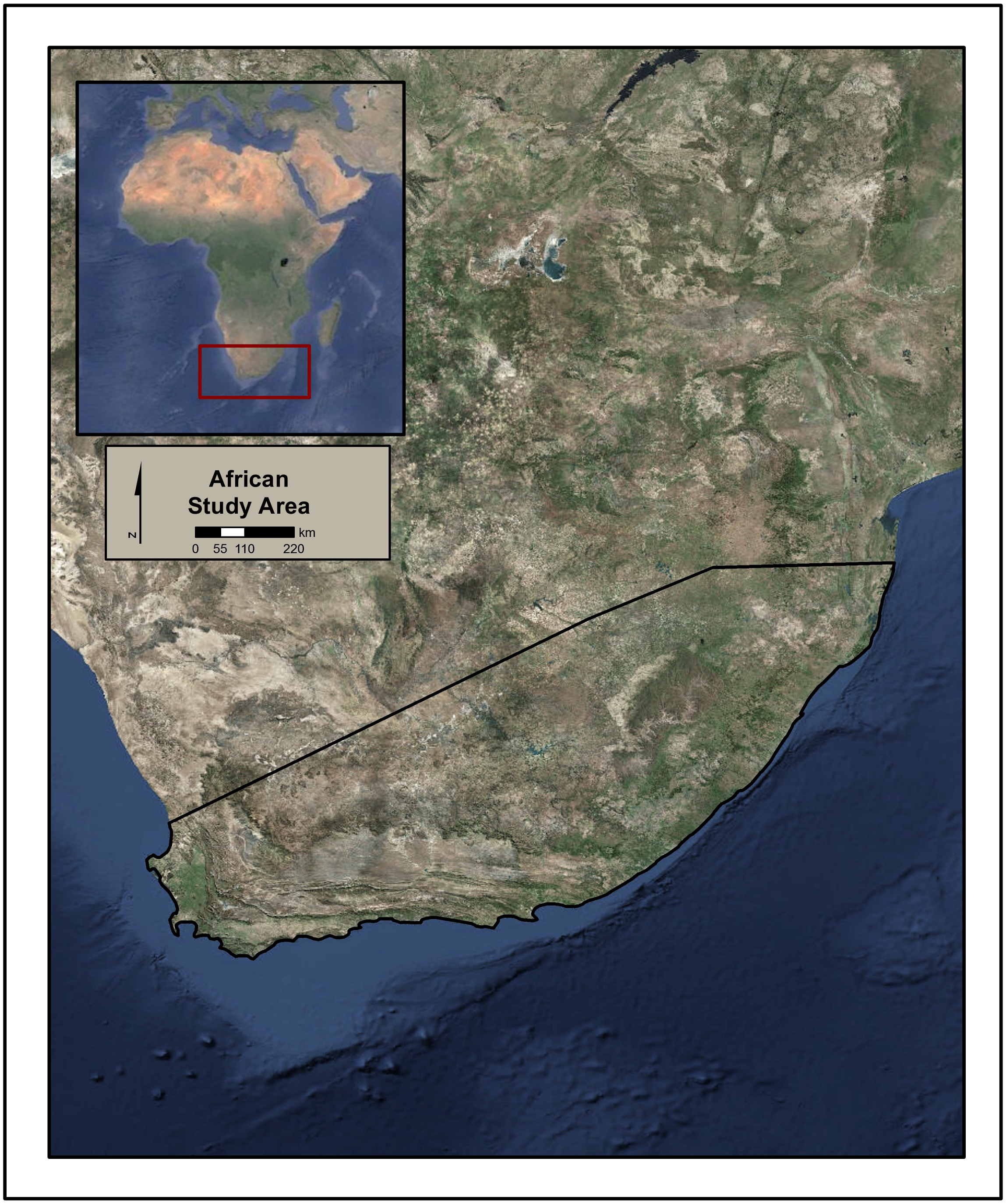

Figure 3.1. The African study area. The paucity of excavated sites in Southern Africa demanded the evaluation of a large area in order to generate sample sizes comperable to other regions under analysis. The resulting study area comprises ~634,502 square kilometers and includes extensive coastal areas, the high altitude and riverine environments of the Drakensberg and Cape Fold Mountains, and much of the arid Karoo. Map by Erin Thompson (ESRI World Imagery Service Layer 2016).

The Levantine perimeter (Figure 3.2) is traced from its northwestern extent in Dörtyol/Hatay, Turkey (37S 250201E 4074327N), south and west along the Mediterranean coastline to Port Fouad, Egypt (36R 438549E 3455627N), southeastward around the Sinai Peninsula to Eilat, Israel (36R 689571E 3270795N) and to near Yanbu, Saudi Arabia (37R 366385E 2686879N), due north to the east of Kilis, Turkey (37S 366385E 4074327), and finally back to the coastline. The study area includes ~366,118 square kilometers that capture Mediterranean coastal ranges, inland desert-steppe areas, as well as palustrine, lacustrine and riverine environments. The Levant is a probable locus of Archaic-Modern Human interactions and genetic admixture. Captured deposits include Middle Paleolithic burials, as well as early Natufian adaptations.

The European locale (Figure 3.3) is approximately 184 km east of the Atlantic coastline in the Dordogne region of southwestern France. From the village of Montignac (31T 355251E 4991741N), the perimeter extends 15 km due east (31T 370551E 4991741N), 30 km south and across the Dordogne River (31T 370551E 4961642N), 52 km due west to near Monsac (31T 318415E 4961642N), 30 km due north (31T 318415E 4991741N), and finally 37 km back east. The ~1539 square kilometer study area is characterized by an homogenous broadleaf forest cut by the Vézère and Dordogne Rivers and their many small tributaries. The lowland area lies between the Massif Central and the French Pyrenees and was likely a refugium from glacial expanse during the Late Pleistocene (Sommer and Nadachowski 2006). The Vézère Valley alone encompasses 147 Paleolithic sites, including several lithic and fossil type sites and 25 painted caves (UNESCO 2009). It is one of the densest and most thoroughly-studied archaeological records in the world.

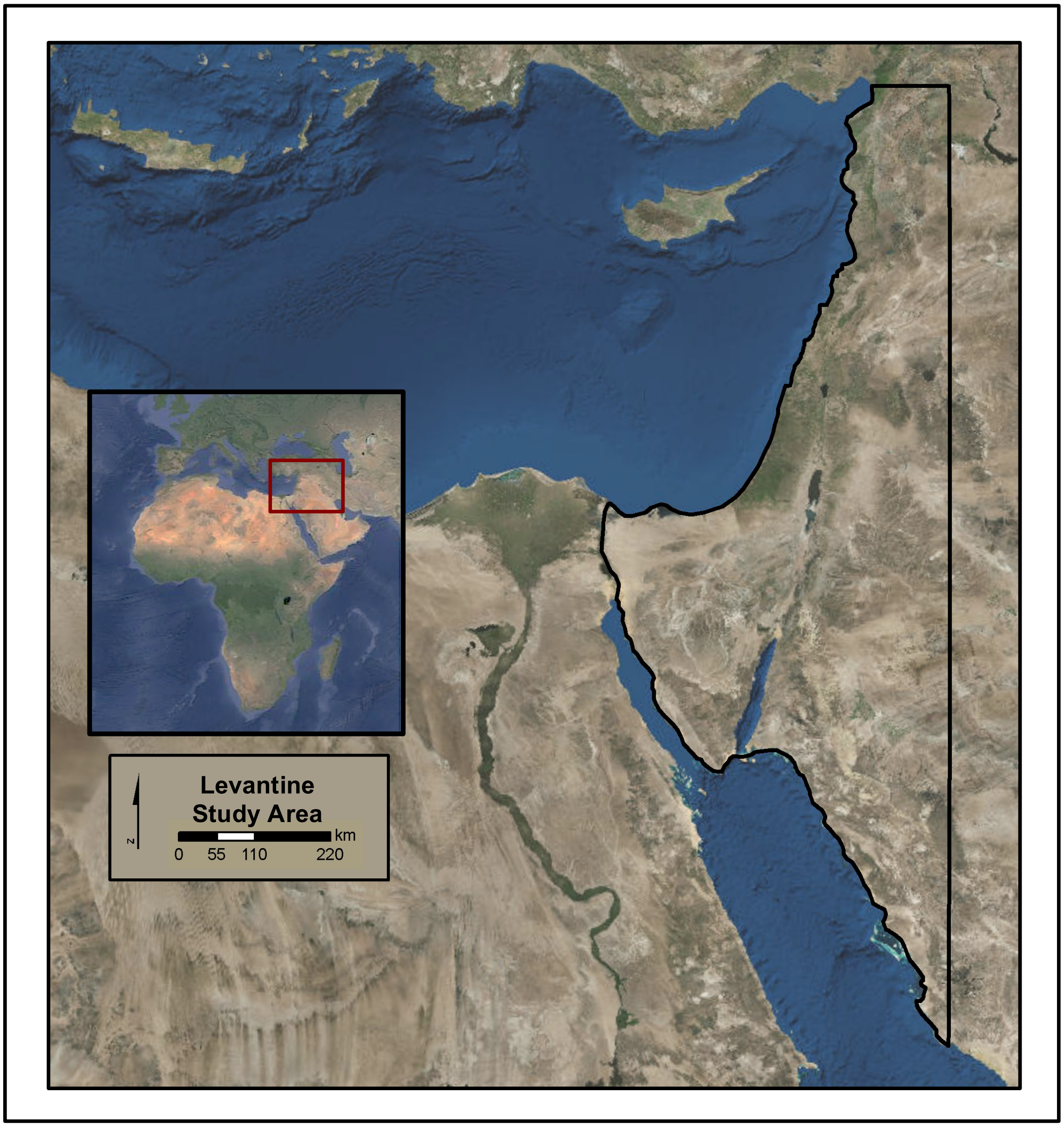

Figure 3.2. The Levantine study area. The Levantine analytical region captures ~366,118 square kilometers and includes Mediterranean coastal ranges, inland desert-steppe areas, as well as palustrine, lacustrine and riverine environments. Map by John Langan (ESRI World Imagery Service Layer 2016).

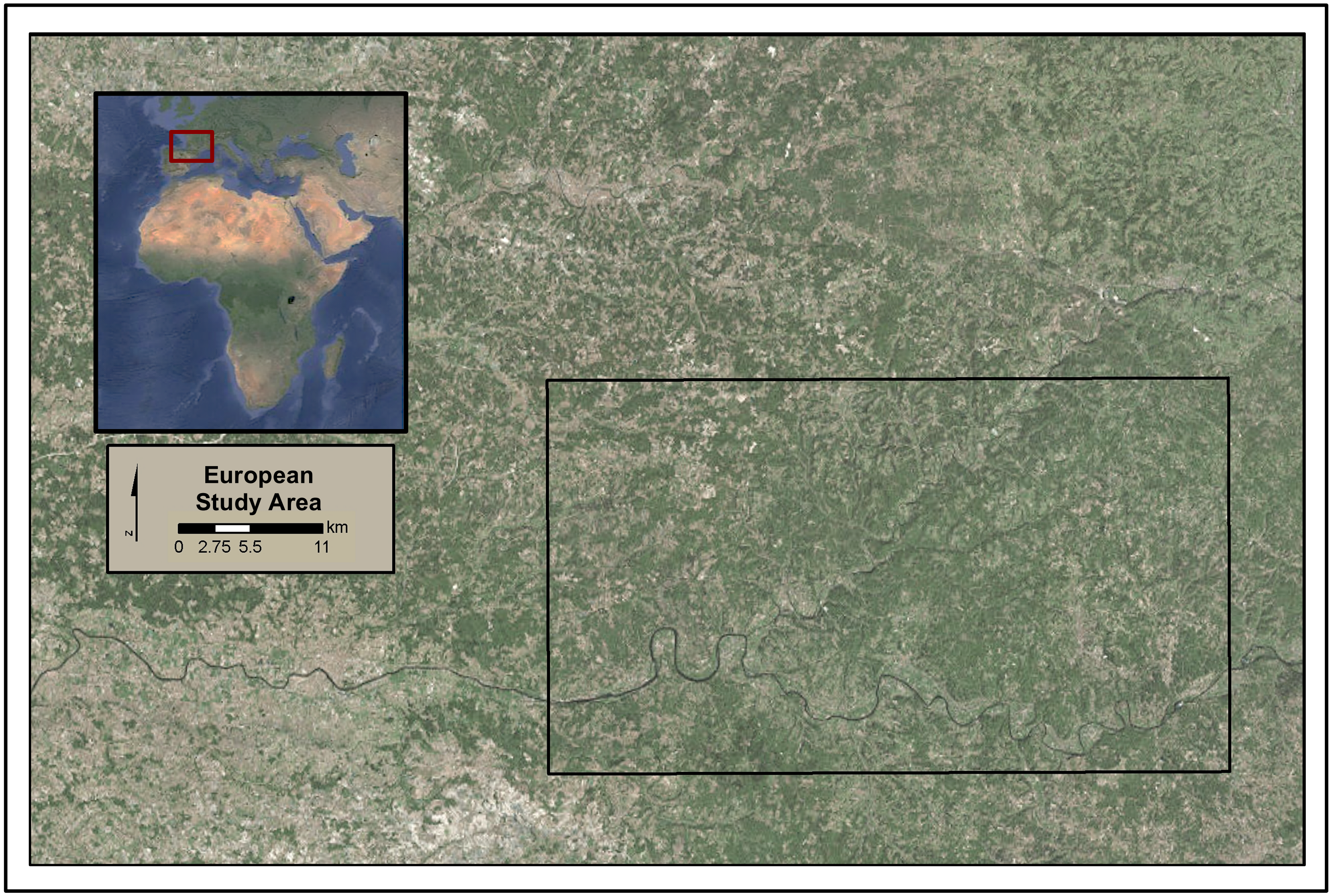

Figure 3.3. The European study area. The size of the European study area is only ~1539 square kilometers due to the unusual density of Pleistocene sites in the region. The area is characterized by an homogenous broadleaf forest cut by the Vézère and Dordogne Rivers and their many small tributaries. Map by John Langan (ESRI World Imagery Service Layer 2016).

The Temporal Units of Analysis

The ~180k year period under analysis was divided into six time "bins" (Table 3.1) for grouping assemblages from the same area into distinct chronological phases, isolating the symboling capacities characterizing each area in each phase, and identifying intra- and inter-regional patterning in those capacities through time. The divisions are intentionally "course-grained" to accommodate imprecision and variability in Pleistocene chronologies. More specifically, the temporal framework accommodates large margins of error typical of early chronometric date assignments, as well as the rough chronologies associated with industrial phases which situate undated deposits in time. The framework intentionally avoids cross-cutting chrono-industrial phases that pertain in each region and the local variations in chrono-industrial date ranges that pertain in one or several regions (e.g., Tabun D; Aurignacian). Longer bin duration also renders moot many discrepancies in site chronologies that are linked to differences in dating methods and effectively aligns regional chronologies where different methods have been favored or required. Nevertheless, both chronometric and chrono-industrial date assignments are more precise

Table 3.1. Temporal Divisions for Model Testing

MIS[a]	Time Period	Date Range	Example Industries[b]
2	**Period A**	17,000-11,000	Robberg; Early Albany; Magdalenian; Natufian
2	**Period B**	22,000-17,000	Blade Industry; Solutrean; Geometric Kebaran
2-3	**Period C**	42,000-22,000	MSA; Châtelperronian, Aurignacian; Kebaran
3-4	**Period D**	72,000-42,000	MSA, Howiesons Poort; Mousterian; Tabūn B
4-5	**Period E**	127,000-72,000	Still Bay, BBC M1-M3, MSA II; Mousterian; Levallois-Moust.
6	**Period F**	191,000-127,000	MSA I; Acheulean; Levallois-Mousterian

[a, b]Corresponding Marine Isotope Stages (MIS) and a few of the lithic industries that were captured in each analytical time period are noted as a point of reference.

for later deposits, with bin duration successively shorter as a consequence. Most time bins further correspond to distinct climatic conditions that would have differentially affected the social landscape and information exchange strategies for navigating it (following Barton et al.'s 1994 and Clark et al.'s 1996 studies of Pleistocene art).

With the temporal framework largely determined by the nature of the data spanning significant space and time, the analysis can only identify general trends in information exchange during the Pleistocene. The approach is nonetheless particularly appropriate for the cognitive research agenda. As spatially mosaic and temporally sporadic *processes*, emergent and mobilized symboling capacities are not visible in the precociousness of isolated assemblages and sites, but must be identified from larger archaeological contexts. The spatiotemporal framework used here supports the identification of general but robust trends in information exchange– within and across regions and of varying duration– through which the evolutionary trajectory of symboling and its implications can be reconstructed.

Selection Criteria

The analysis has focused exclusively on published data, and differences in the number of sites that have been documented in each sub-region must be noted. This is partially due to different research histories. Political upheaval across Africa has inhibited access to many areas since at least World War II, whereas the Levant and Europe are two of the most extensively studied and well-known archaeological regions in the world. Site preservation has also been undermined in the African and Levantine study areas where coastlines have been lost to marine transgression (Bocquet-Appel et al. 2005; Barton et al. 1994). Certainly, preservation decreases through time, with most of the earliest Anatomically Modern Human occupations undoubtedly lost.

The quality of data within each of the test regions is also highly variable. Significant advances in excavation, dating, and other analytical methods have generated a sharp contrast between the interpretive value of recently recovered materials and of older collections. The interpretive value of many deposits is also undermined by a lack of stratigraphic and/or chronological control that cannot be overcome with modern methods. Assemblages were evaluated and included or excluded from analysis based on the following interrelated criteria:

Depositional Integrity. Only subsurface stratified deposits were considered for analysis. Moreover, only assemblages from undisturbed or securely reconstructed primary depositional contexts were included in the analysis. These criteria necessarily excluded a number of open-air activity sites from the Levant that, when discovered, appeared to be recently exposed surface scatters with materials still in situ (e.g., Henry 1988), as well as some intact subsurface deposits. For example, materials recovered from the "chimney" of Tabun Cave (Jarrod and Bate 1937) that likely fell into the site from areas above it were considered intrusive and excluded.

Analytical Integrity. Sites and assemblages were also evaluated in terms of the integrity or quality of their excavation, including the scope of recovery, whether sediments were removed systematically and screened, and if artifacts were point provenienced. However, assemblages were not excluded solely on the basis of excavation methods now considered sub-standard. With all archaeologists dependent on previous discoveries and the known record to guide current work, the failure to recover or sufficiently evaluate and document items that *will become* analytically significant is inevitable, regardless of methodological improvements. The recently discovered need to re-examine all ostrich eggshell fragments recovered from Middle Stone Age sites following the publication of decorated pieces from Diepkloof Rockshelter (Texier et al. 2010) is a case in point. Archaeology must forever grapple with the reality that an absence of evidence is not evidence of absence; older excavation methods are accepted as one of many variables that result in said absence. Nonetheless, the extent to which results for each analytical unit are based on poorer excavation methods is highlighted in the discussion of those results.

Chronological Integrity. The chronological integrity of each deposit was based on a number of factors: 1) the strength of dating method(s) used, 2) the internal consistency of different date assignments, whether for the same deposit, adjacent deposits, and/or from different dating methods, 3) consistency with environmental/climatic indicators that suggest specific time periods, 4) researcher consensus.

Despite recent efforts to extract chronometric dates from a number of sites in Africa (e.g., Jacobs et al. 2008) and Eurasia (e.g., Richter et al. 2013; McPherron et al. 2013), most Pleistocene sites are still dated stylistically. Temporal assignments are based on the occurrence of chronologically delimited lithic industries or on trends in parietal and mobilier arts, such as changes in production methods or how animals are represented through time. Chrono-industrial date assignments were generally accepted unless the industrial assignment is highly contested or the date range attributed to the industry itself is contested. The chronometric dates that are available for archaeological deposits were favored over chrono-industrial assignments. Where different dating methods have been applied, OSL assignments were typically favored over TL assignments and TL over ESR. If significant discrepancies between date assignments from the same or different methods could not be reconciled, chronological integrity was considered poor and the deposits were excluded from analysis.

An important exception are the deposits from Diepkloof Rockshelter which have been repeatedly dated using both OSL and TL methodologies with results varying by 20,000 years or more still unexplained (Jacobs et al. 2008; Jacobs and Roberts 2015; Tribolo et al. 2009; Tribolo et al. 2013; Feathers 2015). The OSL chronology was accepted as both internally coherent and consistent with regional chronologies.

Date assignments for rock art sites are problematic. The first direct dates from European rock art sites that emerged in the 1990s indicated stylistic dating may have attributed too great an antiquity to much of the imagery (Barton et al. 1994; Bednarik 1995); however, many chronometric assignments have now confirmed stylistic assignments or supported even older chronologies (Valladas et al. 2001; Pettitt and Pike 2007). Chronometric dates for rock art are typically ^{14}C dates, with charcoal samples highly susceptible to contamination due to the nature of the cave environments in which Pleistocene art often occurs and the persistent use of those caves by modern peoples (Pettitt and Pike 2007). Sample sources are also variable and can include associated combustion features, “torch swipes” on cave walls, and /or the imagery itself, making it difficult to reconcile inconsistent results. Other methods have been used to date mineral deposits covering rock art and geological events that terminated site access (e.g., Quiles et al. 2016), thereby providing a minimum but imprecise age assessment. Direct dates for rock art also suffer from limited interpretive value in that they typically correspond to only one of hundreds of images from a single site and from a period in which the re-use and episodic painting or engraving of sites is well-established (Clottes 1993). Consequently, chronometric dates for rock art sites were accepted only if multiple, consistent dates were obtained and via methods that are appropriate for a given site context (i.e., cave versus open air).

Over and above the integrity or quality of date assignments, an important criterion for including assemblages in the analysis was the ability to assign a date range to a collection instead of basing time of deposition of all of the materials on a single data point. For chrono-industrial and chrono-aesthetic date assignments, the most inclusive published date range for the industry or aesthetic proxy was used, regardless of indicators that suggested a shorter occupation. Chronometric date ranges were established using direct dates, indirect dates from adjacent deposits, and chrono-industrial ranges to "bracket" assemblages in time. Ultimately, if materials could be reasonably placed within the chronological limits of a single time bin, they were included in the analysis.

It is important to note that in many cases, one or several, but not all, depositional units and associated assemblages from a site met the analytical criteria and were included. Depositional often varied between units, as did analytical integrity where multiple excavations have been conducted by different researchers. When recent work has clarified the depositional history of stratigraphic units and the provenience of artifacts that were poorly excavated or otherwise poorly understood, the data as currently interpreted was included. This was the case at Die Kelders Cave in Africa and at Pech de l'Azé IV and L'Abri Reverdit in Europe, for example.

Analytical Variables

In Peircean terms, a material object is only a sign if it is recognized as such and its properties effectively bring to mind the intended *Object* of reference by virtue of an iconic, indexical, or conventional relationship with it. The properties of the artifact then determine its relationship potential and referential consequences. It follows that the potential referential consequences of artifacts can be determined from a number of physical attributes that can be parsed as four major style types: assertive, extra-assertive, emblemic, extra-emblemic. Assertive styles that capture iconic and indexical interpersonal exchange are characterized first by their idiosyncratic nature that disallows abstraction to a symbolic referent and next by their small size and consequent limited accessibility. As styles of information exchange with the potential for symbolic *Objects* (legisigns), extra-assertive, emblemic, and extra-emblemic artifacts are identifiable in their replication of a rule of design or use as evidenced in the sampled archaeological record from the same spatiotemporal unit under analysis. Each of the three styles is distinguishable from the other relative to their interpersonal, intra-group, or inter-group accessibility (size and/or position on the landscape).

The major classes of artifacts that were retrieved from the study areas and which style type they were classified as is reviewed here. The aesthetic artifact and raw material types that were used as proxies for changing relationships with materiality that pattern with *Emergent* and *Mobilized* symboling capacities are also detailed.

Marked Objects. This class of artifacts is comprised of small pieces, fragments, chunks, or blocks of various materials, including bone, ochre, and ostrich eggshell. Markings typically fall into one of three types: deep notches or grooves along the edges of the artifacts, one or two etched lines on the surface or facet of a piece, or more complex designs comprised of multiple engraved lines on the surface or facets of artifacts. The vast percentage of these artifacts are idiosyncratic– quite similar in nature, yet unique in the number, spacing, and/or orientation of marks and of overall designs.

There are no iconic or indexical properties readily attributable to these artifacts beyond the iconic references their properties make to themselves- such as the redness of the ochre pieces or the linearity of marks on them. However, their recurrence across space and time suggests the marks elicited a response and prompted the creation and use of other marked objects- that they were taken as signs by those group members with visual access to them. Their recurrence also supports indexical relationships through repeated associations with group members or specific activities and thus evidences the semiotic potential of indexical *sinsigns*. Their idiosyncratic forms and small size do limit their potential social consequences to interpersonal signification, and they have been classified as assertive artifacts for the purposes of this analysis. Other marked objects captured in the samples exhibit a degree of standardization consistent with *legisigns* and a potential for symbolic exchange among individual group members. These artifacts were classified as extra-assertive information exchange.

A great deal of attention has been given to a suite of marked ochre blocks recovered from Blombos Cave on the coast of the African study area, with many scholars defining them as symbols (e.g., d'Errico 2003; Henshilwood et al. 2009; Texier et al. 2010). The two marked pieces that were first reported (Henshilwood et al. 2002) include markedly similar designs that were accepted as tokens of themselves, or rules of design, and classified as extra-assertive information exchange. The remaining 13 marked ochres were found distributed throughout the Middle Stone Age sequence and are visibly different from each other and from the later examples (Henshilwood et al. 2009). Moreover, an unpublished analysis (Otárola-Castillo et al. 2009) showed no statistical regularity in the patterning of marks, and there is no apparent standardization of the ochre blocks themselves. These marked ochres were therefore classified as assertive information exchange.

Similar claims of symbolic value have been made for engraved ostrich eggshell fragments recovered from a number of levels at Diepkloof Rockshelter (Texier et al. 2010), also in the African study area. The collection evidences three distinct, standardized, recurring patterns, or rules of design, with the remaining marks appearing irregular or too fragmented to interpret. It is important to note that similar designs made on ostrich eggshell containers by contemporary San in Southern Africa have no symbolic or indexical salience for group members (Polly Wiessner, personal communication 2016). Nonetheless, the patterns consistent with *legisigns* in the archaeological samples were classified as having the potential for interpersonal symbolic exchange, or as extra-assertive; the irregular examples were classified as assertive.

It is highly suggestive that the idiosyncratic ochres and eggshell fragments mostly predate or are roughly contemporaneous with their standardized counterparts. The apparent progression is consistent with an initial recognition of signs as signs, the subsequent exploration of sign stipulation and engagement with iconic and indexical signs, and the eventual scaffolding of conventionalized sign vehicles and ideas.

Decorated or Carved Objects and Figurines. This class of artifacts is distinct from marked objects in a number of ways: instances are usually larger, are often shaped, polished, carved “in the round”, and/or marked, and are frequently utilitarian in nature. They are also exclusive to the Eurasian study areas. Examples include a bone sickle handle carved into a zoomorphic shape from Kebara (Turville-Petre 1932), pierced and marked antler batons from Laugerie Haute and La Madeleine (Cleyet-Merle 1995; Laville et al. 1980; Crémades 1994; Peyrony 1926), ivory and bone plaquettes engraved with mammoth and reindeer, and antler pieces and atlatls shaped or carved into fish, horse heads, and bison, also from La Madeleine and other sites (Laville et al. 1980; Crémades 1994; Peyrony 1926; Marshack 1972). As the examples indicate, many of the objects are depictive and replicate the bestiary and other imagery found in parietal art. Such cases were easily classified as *legisigns*; however, depictive “Venus” figurines from Upper Paleolithic contexts were more difficult to assess.

The figurines are iconic representations of females, typically with voluptuous breasts, hips, and bellies and with deeply grooved vulvas. The recurrent theme and apparent interest in sexuality and fecundity has generated a number of interpretations of the figurines as symbols of fertility or similar concepts or as evidence of goddess worship (e.g., Gimbutas 2001). Nevertheless, the objects are highly individualized in terms of detailing, size, and general shape (Hodgson 2014) and, as such, cannot support relationships with symbolic *Objects*. They are best understood as iconic *sinsigns* with the potential for indexical reference.

Despite the larger size of the decorated objects and figurines and the likely increased visibility of the utilitarian examples, their semiotic potential is still limited to interpersonal exchange, with classification as assertive or extra-assertive exchange based on degrees of standardization and the replication of rules of design.

Ornaments. Ornaments are identified by evidence of having been prepared for or worn as an attachment to clothing or bodies, such as a hole for string and usewear consistent with stringing. Both idiosyncratic and standardized ornaments were sampled in all of the study areas and are ubiquitous in later periods. Examples include bone beads and pendants from Nelson Bay Cave and Boomplaas (Deacon 1984), in the African Study area, perforated animal teeth from Abri Patuad, Kebara and many other Eurasian sites (Turville-Petre 1932; Bar-Yosef et al. 1992; Reese 1991; Movius 1977; Moncel et al. 2012), and highly standardized marine shell beads from Blombos (Henshilwood et al. 2004; d'Errico et al. 2005) and Üçagizli Cave (Stiner 2003), in Africa and the Levant, respectively. As with the small marked objects, decorated objects, and figurines, the size of ornaments limits their referential potential to interpersonal exchange, and classification as assertive or extra-assertive hinged on the degree of standardization of instances recovered.

Parietal Art. Parietal art refers to images found in caves and on other rock surfaces. It is most commonly subsumed within the larger class, "rock art," that can include art mobilier (figurines and other portable objects), geoglyphs, and other "non-utilitarian" materials. In this document, "parietal art" and "rock art" are used interchangeably to mean imagery on rock surfaces only. Parietal imagery is painted, engraved, carved (bas relief), and/or even gouged into softer surfaces (finger fluting) and has been found on cave walls, ceilings, and floors, in rock shelters, and on exposed rock formations, large and small.

Rock art is perhaps the only Pleistocene material that is universally accepted as symbolic in nature, and conventionalized forms and placements consistent with *legisigns* are well-documented (e.g., Leroi-Gourhan 1967; Clottes 2010; Aujoulat 2005). Moreover, the use of caves for image production and specifically galleries deep in the ground that pose significant dangers to trespassers, is more than suggestive of a complex social ideology that necessarily required symbolic thought. For this analysis, cave imagery was classified as legisigns constituting intra-group signification, or emblemic information exchange, due to its restricted nature.

The cave imagery was used, in turn, to identify tokens of itself in other contexts, such as on rockshelter walls or on decorated objects. For example, while the symbolic *Object* of the mammoths decorating Rouffignac Cave in the European study area may not have been the intended *Object* of their representation on bone disks and other decorated materials, those representations nonetheless retain the symbolic Object as part of their *Dynamic Interpretant*. That is to say, they still manifest the semiotic potential for symbolic exchange.

For the classification of rock art outside of cave contexts, the visual accessibility of each locale was evaluated to determine if the imagery could have been used to transmit information to non-group members on the landscape. For example, as territorial markers on exposed borders. Imagery that is not visibly accessible was classified as intra-group motivated legisigns, or emblemic information exchange. Publically accessible imagery was classified as potentially inter-group motivated legisigns and so extra-emblemic exchange.

All of the rock art sites under consideration contain many images– often hundreds. Although each image actually constitutes its own sign vehicle, the collection of images was treated as a single unit for classification. The approach parallels the classification of large collections of beads from a single archaeological assemblage and is defined along with other data collection protocols in Chapter 5.

Additional materials were used as proxies for changing relationships with materiality that pattern with *Emergent* and *Mobilized* symboling capacities. Objects or 'curios' with aesthetic appeal that were not worked and had no known utilitarian function were cataloged and tallied as indicators of interests in materiality and its semiotic potential during the emergence of advanced behaviors. Examples include unworked marine shell and fossil gastropods. Altered raw materials, such as heat-treated lithics were similarly of interest and tallied. Although the semiotic model also predicts an increase in 'exotic' lithic materials as symboling behaviors are mobilized and support increasingly complex and distant social networks. However, because increases in these materials can reflect a number of unrelated factors, they were excluded from the analysis as a viable proxy.

All worked materials that were directly observed in assemblages were documented as one of 19 general raw material types (e.g., stone, bone, ochre). Additional raw materials that could be assumed to have been used based on assemblage components were also tallied. These include a hafting agent, handle, and cord when microliths and other hafted tools were present, as well as a compound applicator tool and binding agent when painted objects or parietal imagery was present. Wood and hide were assumed components of all assemblages that did not survive, but were not tallied as a "zero sum game." Consequently, in the rare instances that wood did survive, it was also not tallied.

The 19 general raw material types were defined to reflect the different knowledge required to harvest and work materials and differences on material properties that might have affected interest in them as relationships with materiality changed. For example, aquatic, terrestrial, and avian shell were distinguished to reflect the different knowledge base and efforts required to collect the materials, as well as differences in available shell sizes. Freshwater and marine shell were not differentiated as variability in the use of these materials reflects unequal access to marine environments, as much or more than behavioral choices.

Table 3.2 lists all recognized raw material types used in the analysis. The following chapter summarizes the datasets for each study area, by time period.

Table 3.2. Raw Material Types Used as Relationship Indicators

Stone
Bone
Antler
Teeth/tusk/ivory
Horn/horn core
Hafting agent
Handle
Cord
Avian shell
Aquatic shell
Terrestrial shell
Feathers
Ochre
Manganese/carbon black
Kaolin/lime white
Compound paint applicator (2)
Binding agent
Other

CHAPTER 4: DATA SUMMARY

The literature identifies well over 650 archaeological sites that fall within the study areas and date from 191,000 to approximately 11,000 years ago. Relevant data exists and was accessible for approximately half of these to be evaluated, with a total of 137 assemblages from 53 sites meeting selection criteria. Sampling was most constrained by the poor excavation methods and site reporting that characterize early archaeological endeavors in all three regions. Artifacts were not adequately provenienced, and many assemblages were dispersed among private collectors, went missing, and/or were never reported. Even when documented, 'non-utilitarian' artifact descriptions are often too skeletal to identify specific styles of information exchange. Some of the early European literature simply fails to link extensive lists of provenienced data with the descriptive information that it provides– including detailed drawings and photographs– or does so inaccurately (c.f. citation needed). Sample sizes in all regions were also limited by the need for assemblages to fall within the chronological limits of a single time bin. This is especially true of the oldest deposits that are often imprecisely dated, with both chronometric and chrono-industrial assignments frequently transgressing bin boundaries.

In general, the samples are notably small and relatively uneven, both within and across study areas (Table 4.1). Period B samples capturing responses to the Last Glacial Maximum are surprisingly problematic in Africa and Europe, and regionally-specific explanations are discussed below. Small samples *were* expected for Period F. However, it is worth noting that, in the Levantine and European study areas, there are a number of well-described archaeological deposits dating to MIS 6 and earlier that did not meet the

Table 4.1. Sample Sizes by Time Period

	African	Levantine	European
Period A 17,000-11,000	4	9	7
Period B 22,000-17,000	1	11	4
Period C 42,000-22,000	3	11	11
Period D 72,000-42,000	15	13	9
Period E 123,000-72,000	13	8	8
Period F 191,000-123,000	3	4	5
Total Assemblages (Total Sites)	**39** (10)	**56** (23)	**44** (20)

analytical criteria as currently defined. Extending Period F back in time would result in broader sampling in these regions.

The most robust samples for intra- and inter-regional comparisons are the Period D and Period E samples and, to a lesser extent, the Period C samples. They are relatively large and even across space and time. At the regional level, each dataset reflects known landuse and other patterns, indicating each is at least broadly representative of Pleistocene behaviors and sufficient for accessing general trends in information exchange among early human groups. The nature of the data that was captured– and that was not–is reviewed here by region, from the most recent to the earliest bin samples.

The African Dataset

Thirty-Nine assemblages from 10 sites in the African study area were selected for analysis (Table 4.2). Figure 4.1 shows the location of the sites that were included in the analysis.

Table 4.2. African Assemblages Under Analysis

Assemblage	Site	Lithic Industry
Period A: 17-11 ka		
BPA.CL	Boomplaas A	Robberg
NBC.UR	Nelson Bay Cave	Robberg
NBC.LA	Nelson Bay Cave	Early Albany
RC.W.ROB	Rose Cottage Cave	Robberg
Period B: 22-17 ka		
BPA.G/H	Boomplaas A	Blade Industry
–	–	–
Period C: 42-22 ka		
BPA.LPC	Boomplaas A	Blade Industry
RC.MSA.W.Ru	Rose Cottage Cave	MSA IV
SIB.F	Sibudu	"Final MSA" (eastern section)
Period D: 72-42 ka		
BOR.1WA	Border Cave	Early LSA
BOR.2BS.UP	Border Cave	MSA III / Post Howiesons Poort
BOR.2BS.LAB	Border Cave	MSA III / Post Howiesons Poort
BOR.2WA	Border Cave	MSA III / Post Howiesons Poort
DK1.UMSA	Die Kelders Cave 1	Middle Stone Age
DK1.LMSA	Die Kelders Cave 1	Middle Stone Age
DRS.HPEx	Diepkloof Rock Shelter	Howiesons Poort
KRM.HP	Klasies River Main Site	Howiesons Poort
KRM.III	Klasies River Main Site	MSA III
KRM.IV	Klasies River Main Site	MSA IV
RC.W.HP	Rose Cottage Cave	Howiesons Poort
RC.W.PoHP	Rose Cottage Cave	Post-Howiesons Poort / MSA III
SIB.L	Sibudu	Late MSA
SIB.PHP	Sibudu	Post-Howiesons Poort
SIB.HP	Sibudu	Howiesons Poort
Period E: 123-72 ka		
BBC.M1	Blombos Cave	Still Bay
BBC.M2	Blombos Cave	
BBC.M3	Blombos Cave	
BOR.4BS	Border Cave	MSA I
DRS.SB	Diepkloof Rock Shelter	Still Bay
DRS.PSB	Diepkloof Rock Shelter	Pre-Still Bay / MSA
DRS.MSA	Diepkloof Rock Shelter	Middle Stone Age
DRS.LMSA	Diepkloof Rock Shelter	Middle Stone Age
KRM.II	Klasies River Main Site	MSA II
KRM.I	Klasies River Main Site	MSA I
PP13B.W5	Pinnacle Point 13B	Middle Stone Age
PP13B.E5	Pinnacle Point 13B	Middle Stone Age
SIB.PSB	Sibudu	Pre-Still Bay / MSA

Table 4.2. Cont.

Period F: 191-123 ka		
Assemblage	**Site**	**Lithic Industry**
BOR.5BS	Border Cave	MSA I
PP13B.W6	Pinnacle Point 13B	Middle Stone Age
PP13B.LC6	Pinnacle Point 13B	Middle Stone Age

The Period A (17-11 ka) sample from the African study area includes four assemblages from three cave sites in inland mountain and coastal areas. Two of the assemblages were recovered from the deep sequence at Nelson Bay Cave and represent the Robberg and early Albany occupations. All of the Period A assemblages include beads made from various materials, most notably instances of incised bone beads at Nelson Bay and Boomplaas Caves.

As has been indicated, the Period B (22-17 ka) sample is remarkably small. The lack of deposits in the study area that date to this period may reflect the movement of hominin groups to coastal areas during the deteriorated and unstable conditions that characterize the Last Glacial Maximum and the subsequent loss of coastal sites to marine transgression (following Fisher et al. 2010 and Marean et al. 2007). The sample here consists in one assemblage from Boomplaas Cave in the Swartberg Mountains. Although one set of behavioral remains cannot support conclusions about the information exchange strategies in Southern Africa during the B period, in conjunction with assemblages from Boomplaas that are included in the Period A and Period C (42-23 ka) samples, it can shed light on long-term changes in information exchange in one context.

The Period C (42-23 ka) sample is the least redundant in the African study area, with four assemblages from four different sites. Rockshelter and cave occupations in inland areas, including riverine environments, are represented. The sample

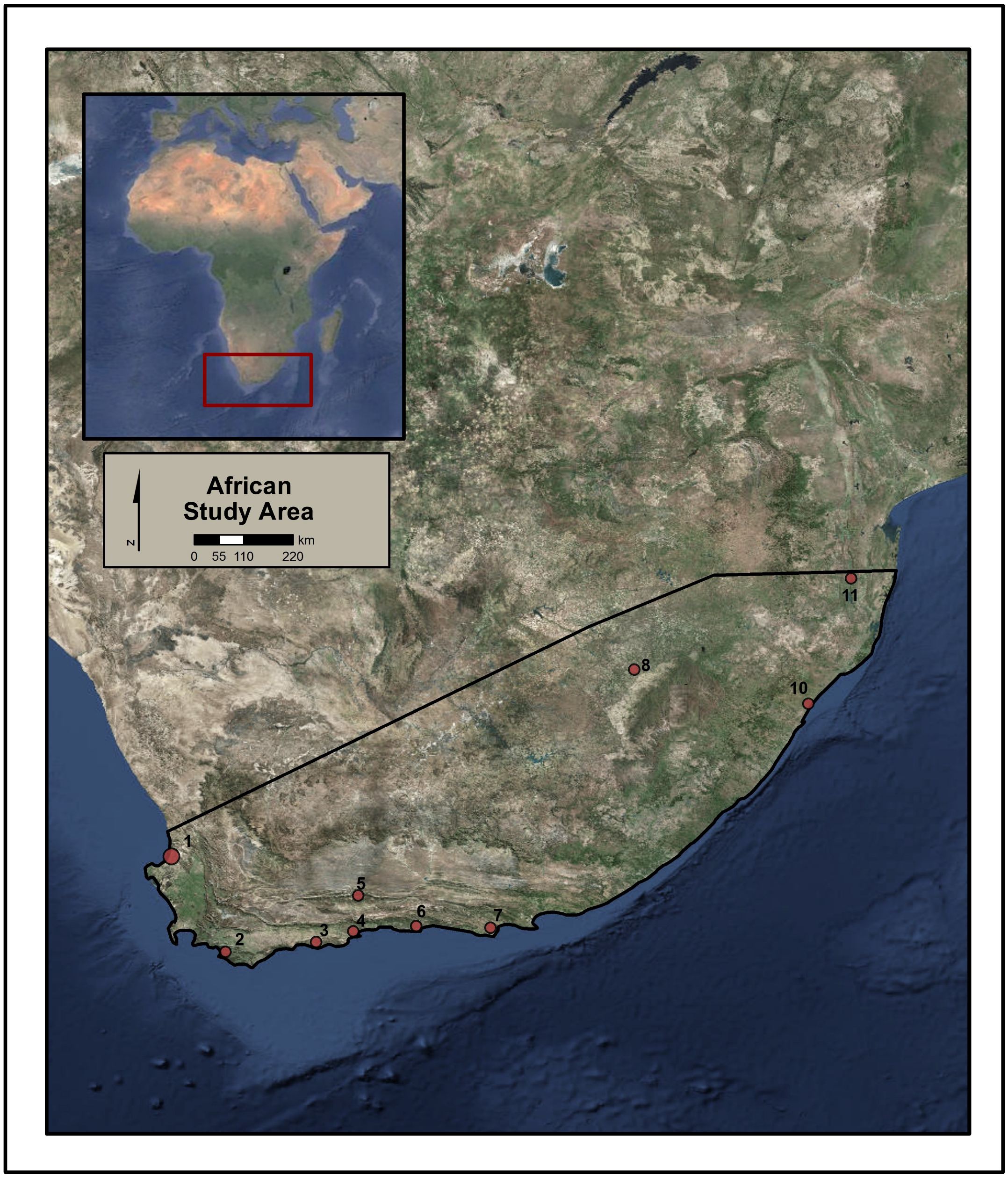

Figure 4.1. The African study area showing the location of all sites that are included in the analysis. Smaller dots represent a single locale; larger dots represent two or more sites. Sites Key: 1) Diepkloof and Klein Kliphuis Rockshelters; 2) Diekelders Cave; 3) Blombos Cave; 4) Pinnacle Point 13B; 5) Boomplaas; 6) Nelson Bay Cave; 7) Klasies River Mouth Main Site; 8) Rose Cottage Cave; 10) Sibudu Rockshelter; 11) Border Cave. Map by Erin Thompson (ESRI World Imagery Service Layer 2016).

assemblages were recovered from Boomplaas, Rose Cottage Cave, Sibudu, and Border Cave. The latter includes beads and marked objects and evidences the exploitation of a particularly wide array of raw material types.

The Period D (72-42 ka) sample is the largest and represents the broadest range of environments. The fifteen assemblages from six sites were recovered from rockshelters and caves in coastal cliff formations, inland areas with access to the rich Fynbos biome, and in the Lebombo and Maluti foothills. The sample captures four Howiesons Poort (HP) occupations from Diepkloof and Sibudu Rockshelters, Rose Cottage, and Klasies River Main Site that are integral to models of cognitive evolution. The HP assemblages include a number of marked objects, most notably the ostrich eggshell fragments engraved with recurring designs from Diepkloof (Texier et al. 2010). Younger Period D assemblages from Border Cave with Post-HP and early Later Stone Age lithic components also include marked objects.

The E Period (123-72 ka) sample is the second largest of the study area and captures 11 assemblages from five cave and rockshelter sites, mostly found along the coast. The assemblages include two early occupations at Pinnacle Point 13B (PP13B), as well as Still Bay (SB) deposits from Diepkloof and Blombos Cave. The shell beads, marked ochres, and pigment processing kit from Blombos that are often cited as the earliest evidence of symbolic behavior (Henshilwood et al. s011; Henshilwood and Debreuil 2011) were sampled.

Published collections that date to Period F (191-123 ka) and meet selection criteria are limited to one assemblages from Border Cave and two from PP13B. Similar to the Period B sample, the small set of behavioral remains cannot support conclusions about information exchange in the larger study area during MIS 6, but can reveal behavioral changes between Period F and Period E at Pinnacle Point.

It is worth noting that because there is no established chronological sequence for Middle Stone Age industries (Mitchell 2002; Thompson et al. 2010)– excepting now the HP and SB– very few assemblages from the African study area can be dated using lithic attributes. As a consequence, a relatively high percentage of the assemblages that could be used in the analysis have been chronometrically dated. These date assessments were frequently undertaken as part of new excavations or while revisiting and publishing older work with modern standards. Paradoxically, then, the archaeological record that is least known has generated the highest quality data for this analysis.

The Levantine Dataset

In the Levant, 56 assemblages from 23 sites were selected for analysis (Table 4.3). Figure 4.2 shows the location of all 22 sites within the Levantine study area.

The Period A (17-11 ka) sample includes nine assemblages from five sites and from a broader range of environments than all but the Period D materials. The A period sample captures extended occupations at Kebara and Hayonim Caves in the coastal and inland Mediterranean zones and at Wadi Hammeh 27 and Judayid in steppe oasis and upland steppe habitats. Assemblages from short-term occupations at Jilat 22 represent Terminal Pleistocene behaviors at open air sties in the Azraq Basin wetlands. The Period A assemblages are remarkable for their array of personal ornaments, decorated sickle shafts, and the only instance of engraved walls in the Levantine dataset.

Table 4.3. Levantine Assemblages Under Analysis

Period A: 17-11 ka		
Assemblage	**Site**	**Lithic Industry**
HY.B	Hayonim Cave	Natufian
HY.C	Hayonim Cave	Kebaran
HYT.N	Hayonim Terrace	Natufian
J2.C	Judayid (J2)	Early Natufian
KB.TP.B	Kebara	Natufian
KB.TP.C	Kebara	Kebaran
WH27.B	Wadi Hammeh 27	Natufian
WJ22.UP	Wadi Jilat 22	Mushabian
WJ22.MP	Wadi Jilat 22	Unspecified
Period B: 22-17 ka		
Assemblage	**Site**	**Lithic Industry**
ABUH.SP	Ain el-Buhira	Ahmarian / Late Masragan
KhIV.M.B	Kharaneh IV	Kebaran
KhIV.M.C	Kharaneh IV	Kebaran / Nizzanian
KhIV.M.D	Kharaneh IV	Geometric Kebaran
QY.A.IIIa	Ain Qasiyya	Kebaran
QY.B.IIIa	Ain Qasiyya	Kebaran
QY.D.IIIa	Ain Qasiyya	Nebekian
UCI.GK.EPI	Üçagizli Cave I	Kebaran-like
UWD14.UP	Uwaynid 14	Nebekian
WHS784X.1	Yutil al-Hasa	Ahmarian
WJ6.UP	Wadi Jilat 6	Nizzanan
Period C: 42-22 ka		
Assemblage	**Site**	**Lithic Industry**
ANI.I	Abu Noshra I	Ahmarian
ANII.I	Abu Noshra II	Ahmarian
UCI.GK.B	Üçagizli Cave	Ahmarian
UCI.GK.C	Üçagizli Cave	Early Ahmarian
UCI.GK.D	Üçagizli Cave	Unspecified
UCI.GK.E	Üçagizli Cave	Unspecified
UCI.GK.F	Üçagizli Cave	Transitional / Initial UP
UCI.GK.G	Üçagizli Cave	Transitional / Initial UP
UWD14.MP	Uwaynid 14	Nebekian
UWD18.UP	Uwaynid 18	Nebekian
UWD18.LP	Uwaynid 18	Unspecified
Period D: 72-42 ka		
Assemblage	**Site**	**Lithic Industry**
AM.H.B1	Amud	Tabun B
AM.H.B2	Amud	Tabun B
AM.H.B4	Amud	Tabun B
KB.VI	Kebara	Tabun B
KB.VII	Kebara	Tabun B
KB.VIII	Kebara	Tabun B
KB.IX	Kebara	Tabun B
KB.X	Kebara	Tabun B

Table 4.3. Cont.

Period D Cont.		
Assemblage	**Site**	**Lithic Industry**
KB.XI	Kebara	Tabun B
KB.XII	Kebara	Tabun B
TFAR.C	Tor Faraj	Tabun B/ Levallois-Mousterian
TFAR.D	Tor Faraj	Levallois-Mousterian/ Tabun B?
TSAB.C	Tor Sabiha	Tabun B/ Levallois-Mousterian
Period E: 123-72 ka		
Assemblage	**Site**	**Lithic Industry**
QZ.VMT.XIX	Qafzeh	Tabun C
QZ.VMT.XVII	Qafzeh	Tabun C
QZ.VMT.XVIII	Qafzeh	Tabun C
QZ.VMT.XX	Qafzeh	Tabun C
QZ.VMT.XXI	Qafzeh	Tabun C
QZ.VMT.XXII	Qafzeh	Tabun C
QZ.VMT.XXIII	Qafzeh	Tabun C
QZ.VMT.XIX	Qafzeh	Tabun C
Period F: 191-123 ka		
Assemblage	**Site**	**Lithic Industry**
DIF.A.1-6	Ain Difla	Tabun D
NRAM.II	Nesher Ramla	Levallois-Mousterian
NRAM.V	Nesher Ramla	Levallois-Mousterian
NRAM.VI	Nesher Ramla	Levallois-Mousterian/ Tabun C?

The Period B (22-17 ka) sample includes 11 assemblages from seven sites. The occupations correspond to the Last Glacial Maximum and reflect a patterned use of palustrine and lacustrine oases during the desertification of Levantine habitats (Henry 1994). Most notable are assemblages from Kharaneh IV and Jilat 6 with significant numbers of shell beads, ornaments, and marked objects. The “mega sites” in the Azraq Basin have been interpreted as aggregation sites (Richter et al. 2011) and, as such, may represent distinct information exchange strategies.

Of the 11 assemblages dating to the C period (42-23 ka), six are from Üçagizli Cave at the northern extent of the analytical region. Situated in a craggy cliff overlooking the Mediterranean, the cave is located in an area largely unaffected by changing sea

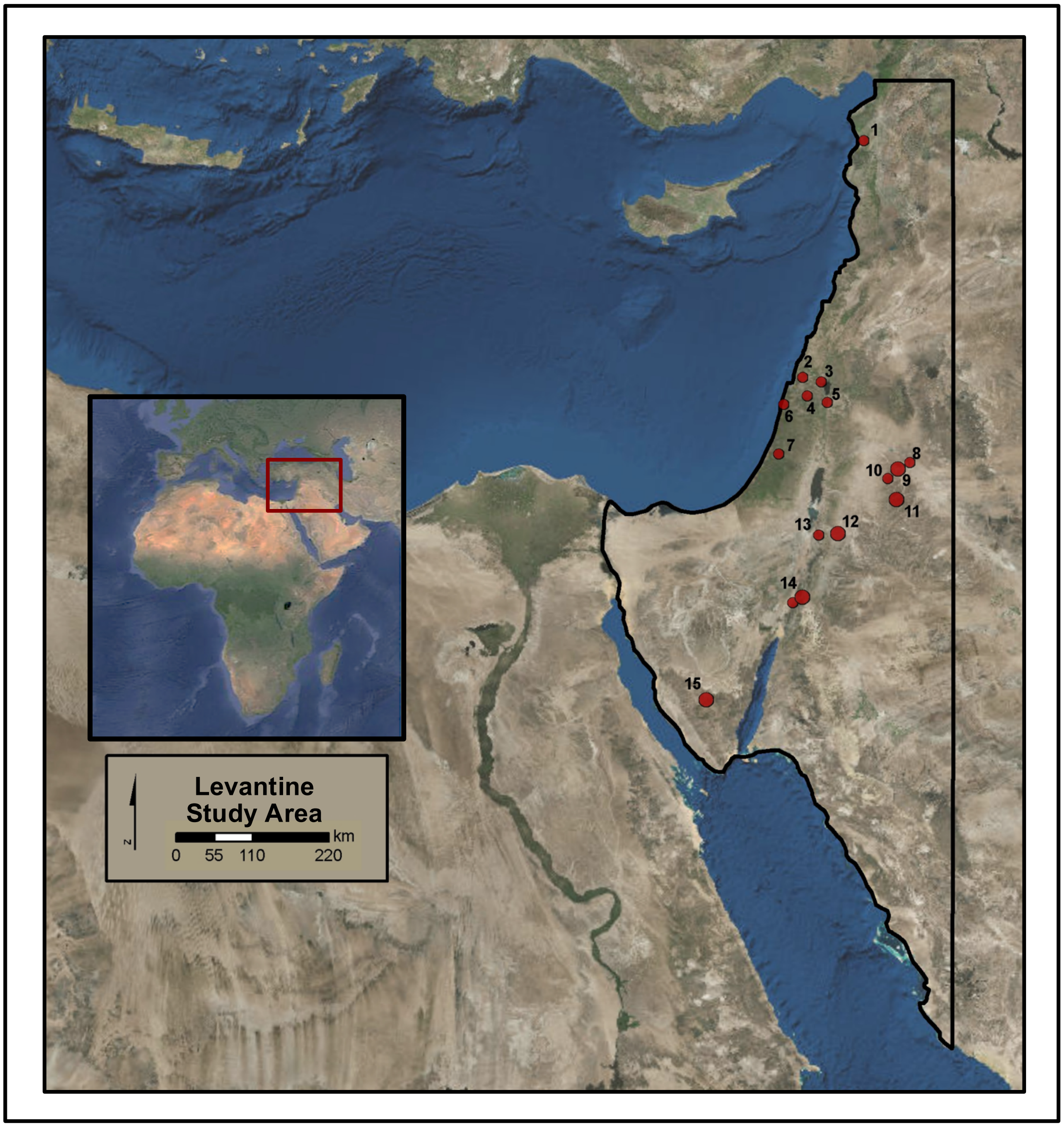

Figure 4.2. The Levantine study area showing the location of all sites that are included in the analysis. Smaller dots represent a single locale; larger dots represent two or more sites. Sites Key: 1) Üçagizli Cave; 2) Hayonim Cave; 3) Amud; 4) Qafzeh; 5) Wadi Hammeh 27; 6) Kebara; 7) Neshar Ramla; 8) Ain Qasiyya; 9) Uwaynid 14 and Uwaynid 18; 10) Kharaneh IV; 11) Jilat 6 and Jilat 22; 12) Ain el-Buhira and Yutil al-Hasa; 13) Ain Difla; 14) Tor Faraj; Wadi Judayid and Tor Sabiha; 15) Abu Noshra I and II. Map by John Langan (ESRI World Imagery Service Layer 2016).

levels; the lack of coastal plain and immediate access to marine resources would have been constant through time and the exploitation of shell is represented in the sample deposits. Other assemblages dating to Period C were recovered from four ephemeral camps linked to wetlands that once dotted the desert-steppe environments of the Azraq and Feiran Basins in the Levantine interior and Sinai Peninsula.

The Period D sample includes 13 assemblages dating from 72-42 ka, with many recovered from Kebara Cave. Although Kebara and other coastal range sites are located on or very near to the present-day shoreline, they would have been 8-15 km inland and overseen a rich coastal plain at this time (Bar-Yosef et al. 1992). Long-term occupations from other areas of the Mediterranean biome are also represented, as are seasonal camps and provisioning sites from the desert-steppe environment that defines the Levantine interior. As has been noted, the range of habitats and so concomitant adaptive strategies that may be represented in these deposits is unique to the Period D and Period A samples. However, none of the early assemblages include information exchange technologies.

The Period E (123-72 ka) and Period F (191-123 ka) samples are the smallest, with eight and four assemblages, respectively. Moreover, only four sites are represented. Seven of the E period assemblages are from Qafzeh Cave, including deposits with the earliest shell ornaments and ochre in the Levantine dataset. The Period E sample captures one additional assemblage from Neshar Ramla, which also contributes assemblages to the Period F sample. Despite the redundant nature of the data from these time periods, both short- and long-term occupations in upland Mediterranean and spring-fed lowland environments are represented.

The European Dataset

The European dataset includes 44 assemblages from 20 sites (Table 4.4). Figure 4.3 shows the location of the selected sites in the European study area.

In this region, the Period A (17-11 ka) corresponds to the Magdalenian and Azilian technocomplexes known for their carved atlatls, batons, and other bone, antler, and ivory pieces (Delluc et al. 1992). The sample includes seven Magdalenian assemblages, including from the type site, La Madeleine, with a possible Azilian component. The Period A bin sample is the least redundant, with each assemblage recovered from a different site. Most are lowland rockshelters overlooking the Vézère or other waterways and yielded an array of decorated objects and engraved roofspall. The Period A sample also includes three parietal art assemblages documented at Font-de-Gaume, Les Combarelles, and Ruffignac. The latter is the only upland forest site represented.

Period B (22-17 ka) corresponds to the Solutrean technocomplex and the Last Glacial Maximum when the study area provided a rich refugium from deteriorating glacial surroundings. Sampling expectations were high. However, most deposits from this period are not chronometrically dated and are imprecisely attributed to the Upper Solutrean *or* early Magdalenian, effectively spanning analytical time bins. Other deposits are poorly reported. Only four assemblages from two sites could be included in the analysis, most notably from Lascaux Cave. Lascaux is an upland forest site and unusual among the painted caves for its subsurface archaeological deposit and one clearly linked to the image production (Aujoulat 2005). All behavioral remains documented inside the cave and attributed to the B period were analyzed as a single assemblage. The remaining

Table 4.4. European Assemblages Under Analysis

Period A: 17-11 ka		
Assemblage	**Site**	**Lithic Industry**
FdG.ART1	Font de Gaume	Parietal Art
MAD.MAG	La Madeleine	Magdalenian
REV.MAG	L'Abri Reverdit	Magdalenian
COMB.ARTI	Les Combarelles	Parietal Art
LB.MAG	Laugerie-Basse	Magdalenian
LH.MAG	Laugerie-Haute	Magdalenian
ROU.ART1	Rouffignac	Parietal Art
Period B: 22-17 ka		
Assemblage	**Site**	**Lithic Industry**
LAS.SOL	Lascaux	Parietal Art / Solutrean
LH.SOL1	Laugerie-Haute	Solutrean
LH.SOL2	Laugerie-Haute	Solutrean
LH.SOL3	Laugerie-Haute	Solutrean
Period C: 42-22 ka		
Assemblage	**Site**	**Lithic Industry**
CAS.AUR	Abri Castanet	Aurignacian
POI.GRA	Abri du Poisson	Gravettian
POI.AUG	Abri du Poisson	Aurignacian
PAT.GRA	Abri Pataud	Gravettian
PAT.AUR	Abri Pataud	Aurignacian
CUS.ART.1	Cussac	Parietal Art
XVI.CH	Grotte XVI	Chatelperronian
LF.CH	La Ferrassie	Chatelperronian
LF.AU	La Ferrassie	Aurignacian
LF.GR	La Ferrassie	Gravettian
PECHI.L7	Pech de l'Azé I	MTA B
Period D: 72-42 ka		
Assemblage	**Site**	**Lithic Industry**
CG.M.1	Combe Grenal	Mousterian
PECHI.L4	Pech de l'Azé I	MTA A
PECHI.L6	Pech de l'Azé I	MTA B
PECHII.L2	Pech de l'Azé II	Mousterian
PECHII.L3	Pech de l'Azé II	Typical Mousterian
PECHIV.DM3	Pech de l'Azé IV	MTA
PECHIV.DM4C	Pech de l'Azé IV	not specified
RdM.U2	Roc de Marsal	Quina Mousterian
RdM.L11	Roc de Marsal	Quina Mousterian
Period E: 123-72 ka		
Assemblage	**Site**	**Lithic Industry**
CG.M.2	Combe Grenal	Mousterian
CG.TM	Combe Grenal	Typical Mousterian
VAU.II	Grotte Vaufrey	Typical Mousterian
VAU.III	Grotte Vaufrey	Mousterian
PECHII.L4	Pech de l'Azé II	Typical Mousterian
PECHIV.DM5	Pech de l'Azé IV	not specified

Table 4.4. Cont.

Period E Cont.		
Assemblage	**Site**	**Lithic Industry**
PECHIV.DM8	Pech de l'Azé IV	Typical Mousterian
PECHIV.DM6	Pech de l'Azé IV	Asinipodian
Period F: 191-123 ka		
Assemblage	**Site**	**Lithic Industry**
CG.ACH	Combe Grenal	Acheulean
PECHII.L6	Pech de l'Azé II	Acheulean
PECHII.L8	Pech de l'Azé II	Acheulean
PECHII.L7	Pech de l'Azé II	Acheulean
PECHII.L9	Pech de l'Azé II	Acheulean

sample assemblages were recovered from a series of intensive occupations at Laugerie-Haute, in site of the Vézère River.

The Period C (42-23 ka) sample captures assemblages that represent a number of technocomplexes and the behaviors of different hominid groups. The sample is dominated by eight Gravettian and Aurignacian assemblages attributed to Anatomically Modern Humans. The assemblages are from three riverfront rockshelters and include the oldest ornaments in the European dataset. The Period C sample also includes a parietal art assemblage from Grotte Cussac, and thus collectively represents the artistic 'revolution' said to follow *Homo sapiens sapiens* arrival in Western Europe (Mellars and Stringer 1989). Three assemblages from three different sites attributed to Neanderthals complete the period sample. Two are assigned to the Châtelperronean technocomplex but do not include the personal ornaments that characterize the industry at some sites outside the study area (e.g., Arcy-sur-Cure). Indeed, the Neanderthal 'transitional industries' are underrepresented in the analysis, with potentially significant implications for results. Two of the Neanderthal assemblages that are included are from cave sites; only Grotte XVI is in an upland environment.

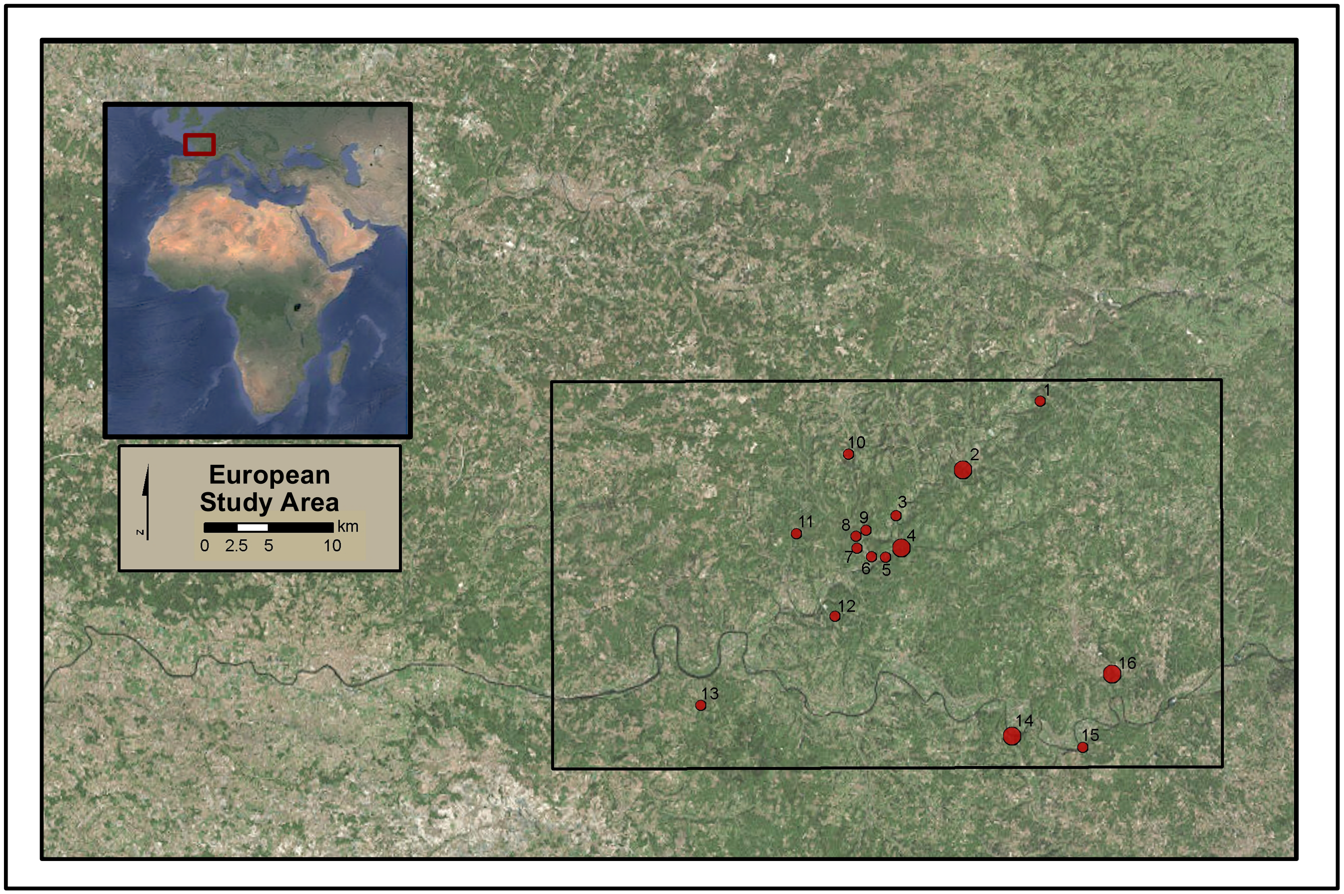

Figure 4.3. The European study area showing the location of all sites that are included in the analysis. Smaller dots represent a single locale; larger dots represent two or more sites. Sites Key: 1) Grotte Lascaux; 2) Abri Reverdit and Abri Castanet; 3) La Madeleine; 4) Les Combarelles; 5) Grotte Font de Gaume; 6) Abri Pataud; 7) Abri Poisson; 8) Laugerie Basse; 9) Laugerie Haute; 10) Grotte de Rouffignac; 11) La Ferassie; 12) Roc de Marsal; 13) Grotte Cussac; 14) Grotte Vaufrey and Grotte XVI; 15) Combe Grenal; 16) Pech de l'Aze I, II, and IV. Base map: ESRI World Imagery Service Layer 2016.

The Period D (72-42 ka) sample includes nine assemblages from five sites. All of the materials are classified as Mousterian and predate Modern Human's arrival. Three of the sites, Pech de l'Aze I, II, and IV, constitute a lowland site complex with a single cave and nearby rockshelter. The complex contributes six of the bin sample assemblages and the oldest marked object in the European dataset. Other assemblages are from Comb Grenal and Roc de Marsal, lowland and upland cave sites, respectively.

The Period E (123-72 ka) and Period F (191-123 ka) samples are also mostly comprised of Mousterian and Acheulean assemblages from the Pech de l'Aze sites and Comb Grenal, consequently seriating information exchange strategies in very specific contexts over an 80,000 year period. An additional upland forest site contributes two of the five assemblages in the E period sample.

The datasets share a number of qualities, including limitations over and above small sample sizes. The samples are redundant to the extent that individual bin samples are dominated by assemblages from a single site and with risk that site is not representative of the time and place in which it was deposited. The problem is compounded in the European dataset with assemblages from the Pech de l'Azé site complex dominating a number of bin samples. The redundancy does, however, provide opportunities for more intensive, site-specific research. Protocols for avoiding such redundancy in future comparative analyses, for exploiting it in highly localized studies, and for increasing sample sizes in general will be discussed in Chapter 7.

The datasets also conflate multiple lithic industries and probably Modern Human and Neanderthal behaviors within a single time period, masking differences in information exchange strategies that may track with and help define each contributing class. This is especially true for the African D period sample and the European C period sample; both capture periods of time that are significant in duration and to models of human evolution. The precision of the dates assigned to the D period assemblages suggest these sample materials are particularly appropriate for future analyses using temporal parameters tailored to the African data.

Most problematic is the likely under-representation of parietal imagery in both the African and Levantine datasets. The imagery is one of the few material consequences of group-level information exchange that can be expected in the Pleistocene record. Under-representation could undermine the identification of fully mobilized symboling capacities in early human groups. Additionally, open air sites and so traces of activity-specific deposits such as from butchering or lithic procurement and associated information exchange technologies are also under-represented.

Despite these limitations, the samples capture several behavioral trends known to each study area, indicating the representativeness of the datasets. This is especially true in the Levant where transhumance during Period D (Henry 1994; but see Bar-Yosef 1996) is represented in intensive lowland occupations and complimentary upland, seasonal camps. Known aggregation in well-watered areas of desert-steppe regions during the extreme climatic deterioration of the LGM and subsequent expansion (Garrard 1988; Bar-Yosef 1996) are also evident in the Period C and later bin samples. In the African dataset, the lack of sites dating to Period B is also consistent with probable settlement patterns during the LGM (following Fisher et al. 2010 and Marean et al. 2007).

The European samples similarly capture the patterned occupation of rockshelters adjacent to natural fords in the Vézère and Dordogne rivers during the Upper Paleolithic

(White 1985; Sisk 2011). The exploitation of forested upland caves for image production is also represented in the Period B and Period C samples. Indeed, the datasets capture the European Upper Paleolithic 'revolution,' as well as the 'precocious' artifacts from the African and Levantine records. The selection criteria, then, have generated small samples that are nonetheless broadly representative of adaptive strategies and behavioral trends that characterize each region and the information exchange strategies that were integral to them. The following chapter presents the protocols for entering and tabulating data for exploratory data analysis.

CHAPTER 5: ANALYTICAL PROCEDURES

This research program includes three methodological protocols: data collection and classification, regional data analysis and semiotic profile building, and finally a multi-regional analysis exploring patterning in the combined dataset. These, in turn, consist in a series of procedures detailed below.

Data Collection and Classification

All data were compiled using FileMaker Pro 14. The software combines a powerful database engine with multiple programming languages, graphic interfaces, and GIS to support interactions with a range of data types, data sources, and devices. Its use here not only supports the current analytical needs, but also anticipates web publication to broaden access to the current dataset and to allow the integration of and/or interfaces with other catalogs. The scope of data collection similarly looked toward future research and provides adequate information for assemblages or assemblage components to be selected and analyzed based on different criteria than used here. Analytical results point to many avenues to pursuit.

Artifact Classification. For each assemblage that met the selection criteria detailed in Chapter 3.2 and that was included in the analysis, brief summaries of the stratigraphic layer(s) from which the materials were recovered, the overall site stratigraphy, and the site's excavation history were recorded. Any variables such as poor recovery methods that have a particular impact on data integrity but that did not warrant the exclusion of materials were noted. Each relevant artifact that was documented in the published assemblage catalogs was initially recorded in the project database as a marked object, decorated object, figurine, ornament, or example of parietal art (see Chapter 3.2 for class definitions). Brief summaries of their physical properties, markings, and decorations were also recorded. All members in each major class were then re-grouped based on shared properties and stipulated attributes that define each object's semiotic potential. These groupings make no effort to capture every sign that may have been manifest and recognized, such as through variation in the color of raw materials or in the placement of marks on objects. Artifacts were instead grouped by their dominant semiotic characteristics. In cases where multiple distinct patterns or motifs were identified, classification favored standardized (symbolic) designs. If multiple idiosyncratic or multiple standardized patterns were observed, under-represented sub-classes were favored. The sub-classes then ultimately capture the minimum range of variation in sign systems and the diversity of information that was exchanged.

Marked objects were grouped by raw material type and general 'motif' or mark 'type,' such as irregularly notched bones, irregularly incised stone, marked ochres, etc. Decorated objects are mostly utilitarian in nature and were grouped by tool type or overall form and by 'design' or depiction. For example, batons that are carved into or decorated with the regional bestiary were grouped together, regardless of raw material. Batons with edge scalloping were grouped into another class, as were spatulas with standardized basketry-like patterns. Figurines were grouped by general shape or design: female figurines, phallus figurines, opposing horse figurines, etc.

Grouping personal ornaments poses a particular problem as it is impossible to know if several beads or pendants were originally part of the same piece of jewelry or other decorative item and, in the absence of point-proveniencing, if they were even deposited in spatial and temporal proximity. Grouping like ornaments that actually represent different ‘ornamental compositions’ may under-represent the frequency and variation in interpersonal exchange, while not grouping them will surely overestimate expression. The published descriptions of these items is also highly variable, limiting options for classification. The sub-groups here reflect an effort to preserve but not inflate variation within the confines of available data.

Shell beads were grouped by genus. As noted in the discussion of analytical variables in Chapter 3.2, non-perforated shells were not considered ornaments, and as isolated finds, were classified as aesthetic curios. In cases where unworked shell and shell ornaments were reported in the same deposit, the former were cataloged as bead ‘blanks’ or preforms. Bone beads were grouped by general shape as distinguished by principle researchers. For example, irregular, tear-drop shaped pendants and tubular beads were both recognized. Bone ornament preforms were also grouped with their finished counterparts. Perforated canines were defined as an independent class, whereas all other perforated teeth were grouped together. Other miscellaneous kinds of ornaments were generally classified by raw material and shape or by general anatomical part (e.g., pierced phalanges).

Cataloging parietal art is also problematic. It is simply not manageable in this research context to catalog each image independently. Moreover, as with the individual ornaments, some imagery is likely best considered part of a ‘composition,’ such as the series of “swimming deer” in Lascaux cave (Dobrez 2010). In this context then, all instances of parietal art documented in an assemblage or that constitute an assemblage were cataloged as a single “artifact.” In this dataset, each of these “artifacts” is dominated by representations of standardized bestiary and so are members of the same sub-class.

All relevant artifacts from all assemblages within a single spatiotemporal unit (e.g., the European A period) were completely cataloged and re-grouped into the above sub-classes prior to re-classification as instances of assertive, extra-assertive, emblemic, or extra-emblemic expression. This allowed each sub-class that had been identified in each assemblage to be compared to the entire range of marks and forms that had been sampled to ensure their characterization as idiosyncratic or standardized could be supported.

Finally, all artifacts within each sub-class were re-classified as a single instance of idiosyncratic assertive or standardized extra-assertive interpersonal exchange, or as a single instance of standardized emblemic or extra-emblemic group-level exchange. For example, three irregularly notched bones would be classified as a single instance of assertive expression; an additional marked ochre "crayon" and two shell beads would constitute a sum total of three instances. The number of sub-classes of each style of information exchange captures the approximate extent to which each strategy was developed and employed at an occupation.

Materials Classification. The relevant indicators of levels of engagement with materiality that were used in the analysis include raw material types, altered raw material types, and aesthetic objects or curios. All raw material types that were directly observed in the published assemblages, whether used in information exchange or not, were cataloged as one of 19 raw material types (Table 3.2). Raw materials that could be inferred from evidence of hafting or painting were similarly cataloged. Any altered raw materials were documented separately, as was each aesthetic object. The total number of materials observed in all three classes provides a measure of engagement with materiality.

Temporal Classifications. All chronological information that could be used to bracket deposits in time was documented, including direct and indirect dates, chrono-industrial assignments, and apparent climate conditions. A final "analytical date range" based on the synthesis of chronological data (see Chapter 3.2) was logged independently and used to classify assemblages as dating to a specific analytical time bin. The re-classified assemblages were simply grouped by location and time period to generate bin samples for each region.

In sum, the classification system groups seemingly disparate behaviors in terms of shared attributes and the maximum semiotic potential those attributes engender. In so doing, the system captures and seriates the presence of, and variability in, different styles of information exchange and levels of material engagement. Ultimately, the system allows patterning in indicators of symboling capacities to be isolated and evaluated against model predictions.

Regional Data Analysis and Profile Building

Analytical Concerns and Methodological Solutions. Testing the semiotic model hinges on identifying the presence or absence of each style of information exchange in bin samples, as well as changes in the frequency of their expression and relative importance through time. However, when defining and identifying behavioral trends in terms of class richness– whether in the number of subclasses observed or the number of times each subclass is represented– the potential under-representation of materials is problematic. A number of factors, including the differential effects of taphonomic processes relative to artifact durability, time-vectored degradation of all materials, and variable sampling efforts can impact the survival and recovery rate of artifacts. In smaller samples, entire artifact classes may be lost or missed. Conversely, in larger samples, more classes can be expected (Gotelli and Colwell 2011; Kintigh 1984; Bush et al. 2004).

The assemblages in the current dataset represent significant variation in accumulation rates, geological contexts, time depth, and so the preservation of materials. The assemblages also represent significant variation in research histories and excavation methods. Sample sizes are quite different within and across regions and must be accounted for before meaningful comparisons of sample richness can be made.

A number of statistical methods can be used to determine the effects of sampling size on class richness, and rarefaction techniques are often the most powerful for small sample sizes. Rarefaction calculates the expected number of classes in a sample by generating a series of subsamples from the larger reference sample under analysis and averaging the number of classes retrieved. This average, variance, and standard deviation are compared to the actual number of classes that were sampled to determine the significance of any differences and the level of diversity it represents (Colwell and Coddington 1994; Gotelli and Colwell 2001; Chiarucci et al. 2008; Colwell et al. 2012). Rarefaction estimates can thus be used to test the independence of sample richness and size or plotted against sample size for direct comparisons with other samples (Gotelli and Colwell 2001; Newton 1999).

Although favored in biology and genetics, rarefaction techniques have a number of limitations and embed assumptions that are problematic in the current research context. Estimates are based on conditional variance and so are limited to the upper and lower ranges of the pooled subsamples. For this and other reasons, a minimum of 20 class members is recommended and cannot be met by many, if not most, of the assemblages under analysis (Gotelli and Colwell 2001; Colwell et al. 2012). Rarefaction also assumes that the number of class members that are observed reflects sampling intensity and is therefore not effective if classes are actually rare (Bush et al. 2004). The assumption is particularly unrealistic for almost any emergent or newly adopted behavior that, by definition, should be rare.

Recommended alternatives to rarefaction include non-parametric estimates of class richness that extrapolate from sample data to determine the number of individuals that were likely present but not observed (Smith and van Belle 1984; Colwell and Coddington 1994; Hortal et al. 2006; Colwell et al. 2012). Extrapolated estimates have proven particularly robust for small samples; however, the number of times data is resampled to generate estimates is based on the largest number of individual class members (Colwell and Coddington 1994; Colwell et al. 2012) and can be inappropriate when frequency ranges are high. This is the case for many of the European assemblages and so cannot be used here.

There are also obstacles to simply standardizing the assemblage data against sample size. The size of archaeological assemblages dating to the Pleistocene– including all lithic materials and the behavioral remains relevant here– often go unreported. Moreover, there is significant variability in what lithic material is collected and how it is described and tallied, such that sample sizes that are documented capture different variables and so may effectively constitute different measures. Standardizing relative to sample size or any number of other measures also assumes a uniform, linear relationship between sample size and sample diversity that may not pertain (Raymondo 1999).

Given the limitations of methods that traditionally provide the most robust diversity estimates, a multi-pronged approach is most appropriate. The methodology adopted draws on a suite of Exploratory Data Analysis (EDA) and Confirmatory Data Analysis (CDA) techniques to identify patterning in the frequency of information exchange strategies in the regional datasets and to establish their representativeness of human behaviors. Each technique is described in some detail– as are similar approaches used for the analysis of the combined dataset– before the analytical results are presented in Chapter 6.

Pattern Searching Using Relative Frequencies. Exploratory Data Analysis proceeded first using the relative frequency of each style of information exchange documented in each bin sample. For this approach, the total number of assemblages in a bin sample that included one or more instances of a given style of information exchange was divided by the total number of assemblages in that bin sample. For example, to determine the relative frequency of assertive exchange during Period A in the European study area, the total number of assemblages with assertive artifacts (N=4) was divided by the total number of assemblages in the Period A bin sample (N=7): 57%. The calculations were repeated for each style of information exchange in each sample assemblage.

The relative frequencies as defined here are independent of sample size and its affects on sample diversity, while yet indicating the prevalence of non-symbolic and symbolic interpersonal and group-level exchange for each time period. The values for each dataset were examined for increases and decreases in exchange strategies, their prevalence relative to one another, and for the overall tempo of change through time– whether a sporadic or relatively even developmental trajectory in each region. The relative frequencies were also evaluated using Pearson's Chi Squared test of independence to determine the probability patterning was captured by chance and would be misinterpreted as behavioral in nature.

It must be noted that the indicators of relationships with materiality during the Later Pleistocene cannot be evaluated in this manner. All assemblages have at least one raw material type (stone), necessarily resulting in a relative frequency of 100% for all bin samples. Consequently, changes in levels of engagement with materiality and the potential role of engagement in the emergence of stipulated object use are assessed through different measures.

Pattern Searching Using Simple Means. The mean number of assertive, extra-assertive, emblemic, and extra-emblemic artifact classes that were documented in assemblages comprising each bin sample were also evaluated for change through time. These "simple means" provide an indication of the extent to which each style of information exchange had been developed, in terms of the number of classes manifest at a given place and time. They are measures of development or "expansiveness." Simple means were also calculated for the indicators of relationships with materiality to gain insight on the relationship between levels of engagement with materiality and stipulated object use not otherwise accessible.

The untransformed means are certainly vulnerable to sampling bias. While this limits their value as an independent analytical measure, the degree of consistency between simple means and other statistics can be taken as an indicator of the robustness of patterning in the archaeological record. Changes through time in simple mean values were therefore compared to patterning in the relative frequencies, as well as to patterning in diversity estimates that are based on class member frequencies.

Pattern Searching Using Diversity Estimates. The Inverse Simpson Index (Simpson 1949) is a diversity measure that calculates expected class frequencies relative to sample size, evenness, and class abundance. Importantly, the measure provides for rare types. The index is widely used as proportional to rarefied richness estimates in smaller samples and generates values that are appropriate for comparison across samples of varying size and composition (Simpson 1949; Oksanen and O'Hara 2016). Inverse Simpson is then a particularly appropriate method for estimating diversity in the current dataset.

Diversity estimates were calculated for each assemblage in each bin sample. The mean values for each time bin were evaluated for changes in patterning in the diversity of information exchange, thereby complimenting and expanding insights on the prevalence and development of stipulated object use through time.

The distribution of assemblage estimates was also plotted and analyzed. Boxplots were evaluated for patterning in the diversity of different styles of expression, and specifically for the limited nature of exchange that is predicted for *Emergent* capacities and the ubiquity and coherence predicted for *Mobilized* capacities. The distributions were also considered relative to the different hominin groups that occupied the Levantine and European study areas.

Semiotic Profile Building. Finally, a semiotic profile of *Ancestral*, *Emergent*, or *Mobilized* was assigned to each regional bin sample based on consistencies with each stage of development. The semiotic profiles constitute a uniform conceptual framework that seriates a wide array of behavioral remains that arose from regionally-specific resources, social contexts, and selective pressures. They facilitate comparisons across space and time for the present research agenda, as well as establish a context within which other Pleistocene behaviors can and should be explored. The analyses and resulting profile assignments for each region are presented and discussed independently, prior to the multiregional analysis.

Multiregional Analysis

A similar combination of EDA and CDA techniques were used for the analysis of the combined dataset. Initially, the relative frequency values for each study region were subject to the Kruskal-Wallis test of statistical significance to assess the probability they were sampled from the same population. The number of assertive, extra-assertive, emblemic, and extra-emblemic classes that were documented in each region in each time period were then combined to create multiregional bin samples of each style of exchange. Relative frequency values for the new bin samples were used in conjunction with the regional profiles to evaluate the evolution of symboling capacities as a singular, (sub)global phenomenon. The multiregional relative frequency values were also subject to Pearson's Chi Squared test to assess the probability global trends were not sampled by chance. The results of these analyses are discussed prior to Chapter 7, which provides a concluding synthesis of model testing and its implications.

Chapter Summary

The methodological protocols adopted here are quite basic, yet are appropriate for revealing general behavioral trends for model testing within the limitations of the archaeological data. Moreover, a multi-pronged methodology accesses dimensions that characterize information exchange (prevalence, range of development, diversity) that are not revealed by more traditional analyses of frequency data. The protocols adopted here, then, begin operationalizing the semiotic model as a research method and initiate deductive analyses of cognitive evolution in the Pleistocene.

CHAPTER 6: ANALYTICAL RESULTS

The semiotic model posits that higher order signification emerged from lower order sign relations as a consequence of sustained engagements with and shared attention to material signs and the recognition that signs can be stipulated. The evolution of higher order signification will occur in two distinct stages: *Emergent*, as characterized by the exploration of materiality and sign stipulation, and *Mobilized*, as characterized by the full exploitation of materiality and obligatory symbolic behavior. Emergence should be visible archaeologically in a sporadic but steady increase in the indicators of material engagement and in the use of assertive artifacts. Instances of extra-assertive information exchange may be present, but rare. As stipulated object use– and specifically the formation and transmission of abstract ideas– becomes a fixed adaptive strategy, fully *Mobilized* capacities should be evident in further increases in material engagement and in the relative frequencies of extra-assertive, emblemic, and extra-emblemic object use. Symbolic expression should be constant, coherent, and variable in terms of media (raw material), content (rules of design), and possibly use-context (inter- and intra-group exchange). The results of the Exploratory and Confirmatory Data Analyses used for model testing are presented here.

Information Exchange in Pleistocene Africa

Trends in Stipulated Object Use Through Time. Table 6.1 presents the relative frequencies of assemblages with assertive, extra-assertive, emblemic, and extra-emblemic expression in each of the bin samples from the African study area (see Appendix A-D for raw class frequencies and class member frequencies used in the analysis). The data indicate both non-symbolic and symbolic information exchange first appeared during

Period E and persisted through Period D. However, neither was documented in the C period sample, and only non-symbolic material was reported in the B period. The A period sample shows notable increases in the prevalence of both assertive and extra-assertive behavior. All of the assemblages include assertive artifacts, and 75% include extra-assertive. Emblemic and extra-emblemic materials that affect group-level exchange were not present in any of the African bin samples. The general trajectory of stipulated object use through time and the dramatic shifts in information exchange strategies that characterize Period A are represented graphically in Figure 6.1.

The data are consistent with the predicted patterning for *Emergent* and *Mobilized* symboling capacities. The relative frequencies show that while stipulated object use initially occurred at over half (57%) of the occupations dating from 127,000-42,000 years ago (Period E and Period D), non-symbolic behavior was far more prevalent. Moreover, both styles of information exchange remained unstable and sporadic through much of the Later Pleistocene. Mobilization is evident in the significant and simultaneous increases in interpersonal exchange, and particularly in the increasing dominance of symbolic object

Table 6.1. Relative Frequencies of Assemblages in the African Study Area with Assertive, Extra-Assertive, Emblemic, or Extra-Emblemic Materials

		Assertive IE		Extra-Assert. IE		Emblemic IE		Extra-Embl. IE	
	Total No. Assmbl	No. Assmbl. w/ Indic	% Assembl. w/ Indic	No. Assmbl. w/ Indic	% Assembl. w/ Indic	No. Assmbl. w/ Indic	% Assembl. w/ Indic	No. Assmbl. w/ Indic	% Assembl. w/ Indic
Period A (~11-17 ka)	4	4	100%	3	75%	0	0%	0	0%
Period B (17-22 ka)	1	1	100%	0	0%	0	0%	0	0%
Period C (22-42 ka)	3	0	0%	0	0%	0	0%	0	0%
Period D (42-72 ka)	15	6	40%	1	7%	0	0%	0	0%
Period E (72-123 ka)	13	6	46%	2	15%	0	0%	0	0%
Period F (123-191 ka)	3	0	0%	0	0%	0	0%	0	0%

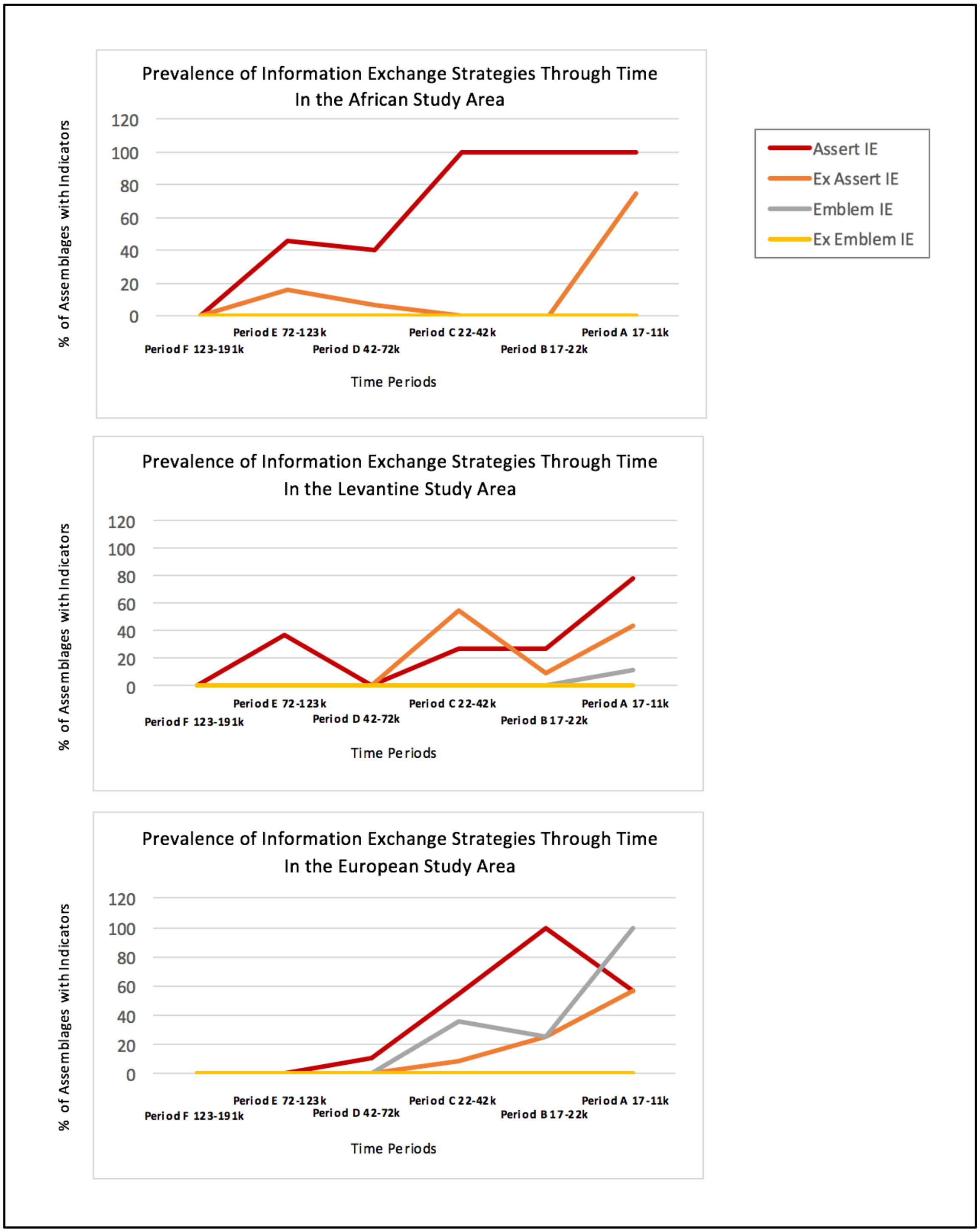

Figure 6.1. Line graphs showing increases and decreases in the prevalence of different styles of information exchange over time in each study area.

use following the Last Glacial Maximum. Moreover, Chi Squared tests of independence indicate it is unlikely these trends were sampled by chance (Table 6.2). Other measures indicate the patterning is behavioral in nature.

The mean number of stipulated objects in bin sample assemblages reflect the extent to which each style of information exchange had been developed at any given time and place. The relationship between levels of engagement with materiality and the step-wise scaffolding of increasingly higher order behaviors is also apparent in the untransformed means (Table 6.3). Levels of engagement appear relatively high even during the F period ($\overline{x}$=4.33), given the limited range of raw materials associated with

Table 6.2. Results for Chi Squared Tests to Determine Randomness of Trends in the Prevalence of Styles of Information Exchange Over Time[1]

	N	Assertive	Ex-Assert	Emblemic
African Trends	39	X2 = 11.22 (.05)	X2 = 13.07 (.02)	N/A
Levantine Trends	56	X2 = 17.81 (.00)	X2 = 18.88 (.00)	X2 = 5.32 (.38)
European Trends	44	X2 = 20.27 (.00)	X2 = 15.36 (.01)	X2 = 27.39 (4.8E-05)

[1]Chi Squared test results are for the relative frequency of assemblages in each bin sample in each region with one or more instances of the relevant style of information exchange observed. In all cases, degrees of freedom = 5. The number of original values tested (N) is unchanging within each region and provided in the lefthand column. Test statistics and probabilities are reported for each style of information exchange that was evaluated; emblemic artifacts were not observed in the African study area.

Table 6.3. Mean Number of Classes of Information Exchange Styles in the African Bin Sample Assemblages

	No Assm	Rel Indic	Assert	Ex-Assert	Embl	Ex-Embl
Period A (~11-17 ka)	4	33.00	1.75	.75	.00	.00
Period B (17-22 ka)	1	6.00	1.00	.00	.00	.00
Period C (22-42 ka)	3	14.00	.00	.00	.00	.00
Period D (42-72 ka)	15	60.00	.47	.13	.00	.00
Period E (72-123 ka)	13	57.00	.69	.23	.00	.00
Period F (123-191 ka)	3	13.00	.00	.00	.00	.00

older and presumably "Archaic" hominin sites (Klein 2009). The F Period values capture the early heat treatment of lithic materials and other relationship indicators that are documented in assemblages from Pinnacle Point 13B (PP13B) and suggest the process of emergence began some time before stipulated objects appear in the record. In fact, increases in mean levels of material engagement occur simultaneously with or predate increases in stipulated object use throughout the sequence. The same step-wise patterning occurs between increases in non-symbolic and symbolic interpersonal exchange, with development in the number of assertive artifact classes occurring prior to the development of extra-assertive classes.

Mean values for indicators of relationships with materiality ($\bar{x}$=33.00), assertive exchange ($\bar{x}$=1.75), and extra-assertive exchange ($\bar{x}$=.75) all increase dramatically in the Period A sample and thereby mirror increases in the prevalence of stipulated object use. Overall, the mean number of raw material types and aesthetic curios that were collected, used, and/or fundamentally altered nearly doubled through time. The mean number of assertive classes of information exchange increased over two-fold since first appearing in the African study area, and classes of symbolic exchange increased over three-fold. The development of non-symbolic and symbolic exchange is dramatic during Period A and consistent with the mobilization of capacities near the end of the Pleistocene.

Similar patterning is evident in the mean diversity estimates for assertive and extra-assertive expression (Table 6.4). Of note is the near equal levels of expected variation in both assertive and extra-assertive expression in the E period sample. The values suggest a particular adaptive value in stipulated object use was not simply driving the use of information exchange technology, but the emergence of a non-symbolic and symbolic exchange system. The values also suggest that the scaffolding of lower to higher order strategies and their respective diversification can happen rapidly and yet fail to persist through time. Although both assertive and extra-assertive artifacts are documented in the Period D assemblages, the level of diversity in extra-assertive expression decreases before symbolic exchange disappears in Period C. However, the level of diversity in assertive expression in the D period actually increases, indicating non-symbolic interpersonal exchange remained integral to lifeways until ~42,000 years ago.

The Inverse Simpson estimates suggest the most dramatic changes in stipulated object use occurred during Period A. Diversity in both assertive and extra-assertive expression increases significantly, and the richness and thus relative importance of non-symbolic and symbolic expression appears more equal again. The patterning is consistent with the shift from *Emergent* to fully *Mobilized* symbolic behavior that is evident in both the relative frequency of assemblages with non-symbolic and symbolic information exchange and the mean number of classes of information exchange strategies in bin

Table 6.4. Mean Values of Diversity Estimates for the African Dataset

	No Assm	Assert	Ex-Assert	Embl	Ex-Embl
Period A (~11-17 ka)	4	1.72	1.19	N/A	N/A
Period B (17-22 ka)	1	1.00	.00	N/A	N/A
Period C (22-42 ka)	3	.00	.00	N/A	N/A
Period D (42-72 ka)	15	.84	.43	N/A	N/A
Period E (72-123 ka)	13	.56	.50	N/A	N/A
Period F (123-191 ka)	3	.00	.00	N/A	N/A

sample assemblages. Indeed, patterning is sufficiently robust to be visible in and markedly consistent across all three independent measures.

The identification of trends among the mean diversity estimates is particularly significant. Here, mean values are independent of sample size and its effects on variation in non-symbolic and symbolic exchange. In tandem with the Chi Squared test, the diversity measures show the observed patterning in stipulated object use is behavioral in nature and effectively confirm model predictions for two stages in the evolution of symboling capacities. The distribution of diversity estimates for each bin sample assemblage provide additional insights into the nature of stipulated object use in the African study area.

Diversity in Stipulated Object Use Through Time. The boxplots in Figure 6.2 illustrate the early emergence of both assertive and extra-assertive expression in Period E and their persistence through Period D. Of particular note here is the levels of diversity in both non-symbolic and symbolic exchange that is estimated for all bin sample assemblages, over and above what is currently documented. The Period E sample includes nine instances of assertive information exchange and three of extra assertive– the standardized marked ochres and *Nassarius kraussianus* shell beads from various MSA deposits at Blombos Cave (d'Errico et al. 2005; Henshilwood et al. 2004; Henshilwood et al. 2009; Henshilwood et al. 2002). As previously noted, the non-symbolic, assertive materials typically pre-date the symbolic expressions from the same sample and can therefore be interpreted as scaffolds for higher-order signification. The dynamic pertains in Period D, as well.

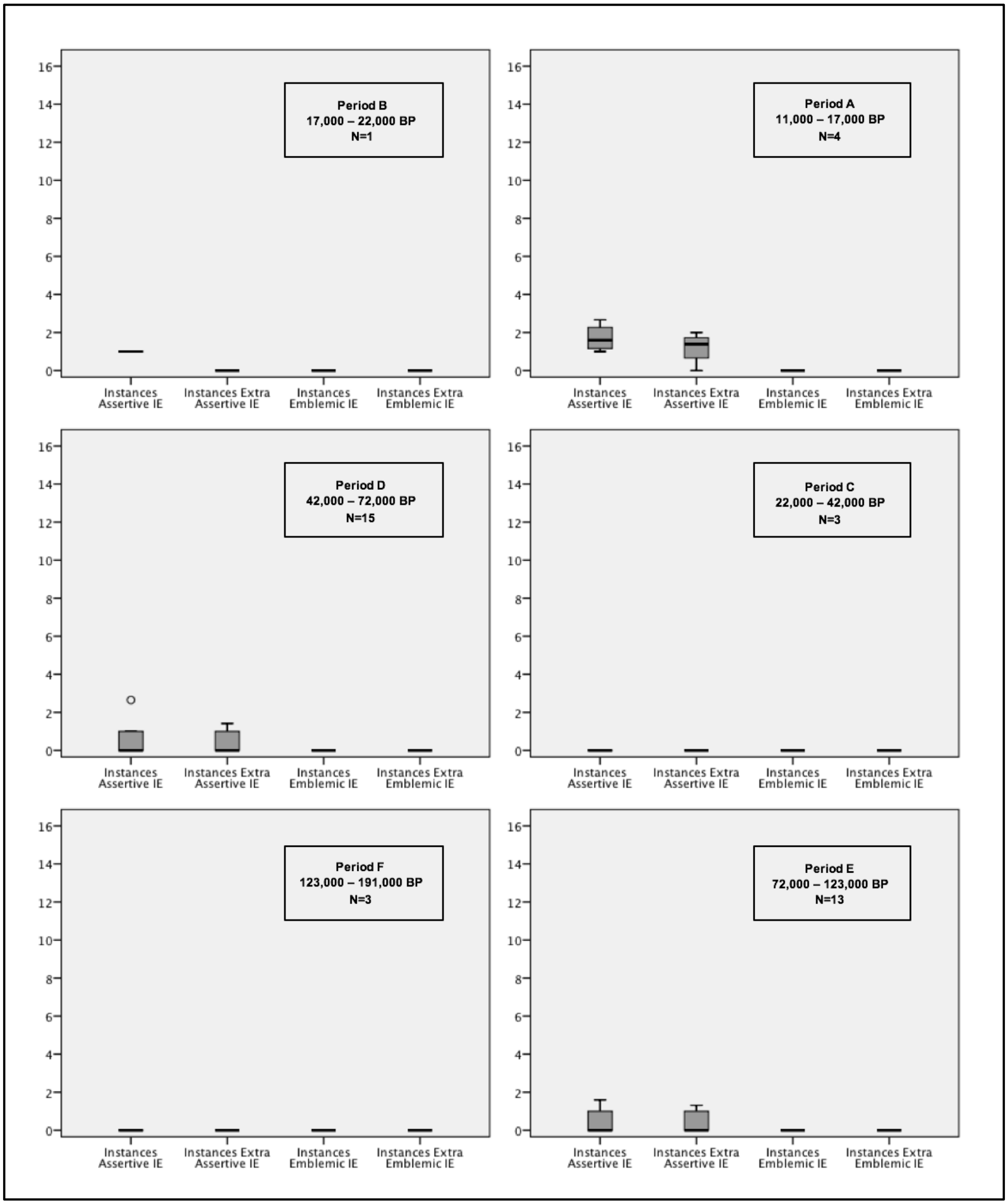

Figure 6.2. Distributions of diversity estimates for information exchange strategies in the African dataset.

However, the diversity estimates imply symbolic behavior was more widespread and more complex than currently known and may reflect different relationships with non-symbolic expression and patterns of emergence than claimed here. Significantly, co-occurring and equally well-developed assertive and extra-assertive exchange during Period E and Period D may simply indicate *Emergent* symbolic expression predates the current analytical time frame. The interpretation is consistent with the unexpectedly high, untransformed mean values for material engagement beginning in the F Period.

The diversity estimates for the E and D periods must also be considered in light of the composition of assertive artifacts in the bin sample assemblages. Thirty-nine percent of the Period E assemblages and 67% of the Period D assemblages include at least one irregularly notched bone fragment. The rate of recurrence and longevity of the assertive artifact type suggests a particular value in the information they transmitted, or that the notching is utilitarian and not semiotic in nature. If the latter, and erroneously included in the analysis, the level of diversity– but not the initial emergence– of assertive expression during these time periods may be very different than estimated here.

Stipulated object use is uniformly present in all but one assemblage in the Period A bin sample. The deposit from Rose Cottage Cave does not include extra-assertive artifacts. The boxplots show the diversity of assertive exchange to be skewed toward higher levels, both relative to the range of diversity estimated for the A period assemblages and relative to all earlier time periods. Diversity estimates for extra-assertive exchange are skewed toward lower values, but are still high for the African study area. The distributions largely reflect higher rates of stipulated object use documented at Boomplaas Cave in the Little Karoo and at Nelson Bay Cave, on the coastline.

Boomplaas has been interpreted as an aggregation site (Wadley 2001), and as such, higher levels of interpersonal exchange and group-level exchange can be expected as integrative mechanisms for aggregating populations. However, symbolic exchange at Boomplaas is restricted to ostrich eggshell ornaments, and the expected level of diversity for both assertive and extra-assertive expression is higher for Nelson Bay Cave. It is possible that Boomplaas has been mis-identified (see Conkey 1980b on problems identifying aggregation in the archaeological record), or that non-symbolic expression is a more effective exchange strategy among extended social networks. Similar patterning is seen at aggregation sites in the Levantine and European study areas and is explored further in those contexts.

The analysis shows the African dataset conforms to model predictions and supports a number of conclusions. Symbolic behavior appears early but sporadically in the human lineage and, when present, is neither prevalent nor developed in terms of the types of assertive and extra-assertive objects that have been documented. The importance of material engagement in the emergence of stipulated object use and of lower order sign use in scaffolding higher order expression are implicated in the analyses. Significantly, levels of engagement with materiality and diversity estimates both suggest information exchange technologies may have emerged even earlier than considered here.

Although very poor sample sizes in the C and B periods limit even general conclusions about the evolutionary trajectory of symbolic behavior for the entire time of interest, all measures indicate mobilization occurred during Period A. Notable increases in the prevalence, range of development, and diversity of stipulated objects are documented. It is then appropriate to assign semiotic profiles to the African bin samples to facilitate comparative analyses (Table 6.5).

At this juncture, several additional observations can be made about the timing of *Emergent* and *Mobilized* capacities and other significant events in the human career. The earliest symbolic behaviors coincide with the technological advances that characterize the Still Bay (SB) and Howiesons Poort (HP) industries, as well as Anatomically Modern Humans' initial forays into the Levant and seafaring migrations to Australia. Material engagement and *Emergent* capacities are thus heavily implicated in a reciprocal, co-evolutionary dynamic with their social and economic consequences. It is equally significant that fully *Mobilized* symbolic behavior is *not* implicated in any of these watershed events.

The precise chronologies of the SB and HP assemblages that are masked by the coarse analytical framework can support a more focused analysis of Period E and Period D materials that moves beyond the limitations of the current research parameters. Indeed, the results suggest both the need and potential for greater understanding of the

Table 6.5. Semiotic Profiles for the African Bin Samples

	Material Engagement	Assertive Exchange	Ex-Assert Exchange	Emblemic Exchange	Ex-Embl Exchange	Symboling Capacities
		P/A	P/A	P/A	P/A	
Period A (~11-17 ka)	**Exploitive**	P	P	A	A	**Mobilized**
Period B (17-22 ka)	**Exploitive**	P	A	A	A	**Emergent**
Period C (22-42 ka)	**Exploratory**	A	A	A	A	**Emergent**
Period D (42-72 ka)	**Exploratory**	P	P	A	A	**Emergent**
Period E (72-123 ka)	**Exploratory**	P	P	A	A	**Emergent**
Period F (123-191 ka)	**Exploratory**	A	A	A	A	**Emergent**

relationship between increases in material engagement, stipulated object use, specific styles of exchange, and advances in other domains. The Levantine dataset may provide additional support in this regard, with Anatomically Modern Human's *Emergent* capacities also evident in Period E assemblages from that region.

Information Exchange in Pleistocene Levant

Trends in Stipulated Object Use Through Time. The relative frequencies of assemblages with assertive, extra-assertive, emblemic, and extra-emblemic expression in each of the bin samples from the Levantine study area are presented in Table 6.6 (see Appendix E-I for raw class frequencies and class member frequencies used in the analysis). The measures of prevalence in stipulated object use show patterning consistent with model predictions, including stepwise advances in multiple styles of information exchange as *Emergent* capacities become full *Mobilized*.

Assertive information exchange is first documented in 38% of the assemblages dating to Period E, but does not occur again until Period C and then at lower levels (27%). The first extra-assertive exchange also occurs in Period C. At this time 55% of

Table 6.6. Relative Frequencies of Assemblages in the Levantine Study Area with Assertive, Extra-Assertive, Emblemic, or Extra-Emblemic Materials

		Assertive IE		Extra-Assert. IE		Emblemic IE		Extra-Embl. IE	
	Total No. Assmbl	No. Assmbl. w/ Indic	% Assembl. w/ Indic	No. Assmbl. w/ Indic	% Assembl. w/ Indic	No. Assmbl. w/ Indic	% Assembl. w/ Indic	No. Assmbl. w/ Indic	% Assembl. w/ Indic
Period A (~11-17 ka)	9	7	78%	4	44%	1	11%	0	0%
Period B (17-22 ka)	11	3	27%	1	9%	0	0%	0	0%
Period C (22-42 ka)	11	3	27%	6	55%	0	0%	0	0%
Period D (42-72 ka)	13	0	0%	0	0%	0	0%	0	0%
Period E (72-123 ka)	8	3	38%	0	0%	0	0%	0	0%
Period F (123-191 ka)	4	0	0%	0	0%	0	0%	0	0%

assemblages evidence symbolic interpersonal exchange, which appears to dominate stipulated object use. The prevalence of extra-assertive artifacts nonetheless decreases significantly in the B period (9%), indicating symbolic behavior was not yet "fixed" in the region. Both assertive and extra-assertive objects increase dramatically in the A period, with 78% of assemblages including the former and 44%, the latter. These increases coincide with the only evidence of emblemic expression in the Levantine samples– all hallmarks of *Mobilized* symboling capacities. Line graphs of the relative percentages of all variables under analysis illustrate the distinct nature of the Period A occupations, during which all forms of stipulated object use intensify, in concert (Figure 6.1). As with the African dataset, Chi Squared tests of significance that were conducted on trends in the relative frequencies of assertive, extra-assertive, and emblemic artifacts in the Levantine bin samples indicate the patterning in all styles of information exchange is non-random. In fact, p-values are notably low (Table 6.2).

Table 6.7 provides the untransformed, simple means that indicate the range of development in stipulated object use. Here, the relationship between *Emergent*

Table 6.7. Mean Number of Classes of Information Exchange Styles in the Levantine Bin Sample Assemblages

	No Assm	Rel Indic	Assert	Ex-Assert	Embl	Ex-Embl
Period A (~11-17 ka)	9	68.00	5.10	2.44	.11	.00
Period B (17-22 ka)	11	55.00	.91	.55	.00	.00
Period C (22-42 ka)	11	52.00	.27	2.64	.00	.00
Period D (42-72 ka)	13	14.00	.00	.00	.00	.00
Period E (72-123 ka)	8	23.00	.50	.00	.00	.00
Period F (123-191 ka)	4	7.00	.00	.00	.00	.00

information technologies and levels of engagement is clear. Significant increases in the mean occurrence of relationship indicators coincide with the first assertive expression in the E period, as well as with the first extra-assertive expression in the C period. Stepwise advances as material engagement and lower-order exchange strategies scaffold higher order expressions are apparent throughout the sequence. As with the prevalence of stipulated object use in the Levantine bin samples, the most significant changes in the development of non-symbolic and symbolic exchange occur during Period A. At this time, the total increase in mean levels of engagement in the Levantine study area is over fourfold and in non-symbolic information exchange over tenfold. Symbolic interpersonal exchange strategies also appear well-developed ($\overline{x}$=2.44), and the first and intra-group exchange is also present ($\overline{x}$=.11).

Mean values for the Inverse Simpson estimates of diversity in information exchange show the same overall trends that are evident in the prevalence and development of stipulated object use in the Levantine study area, independent of potential sampling bias (Table 6.8). An apparent exception is the diversity estimate for assertive

Table 6.8. Mean Values of Diversity Estimates for the Levantine Dataset

	No Assm	Assert	Ex-Assert	Embl	Ex-Embl
Period A (~11-17 ka)	9	1.01	.92	.78	N/A
Period B (17-22 ka)	11	.63	.78	N/A	N/A
Period C (22-42 ka)	11	.73	2.00	N/A	N/A
Period D (42-72 ka)	13	N/A	N/A	N/A	N/A
Period E (72-123 ka)	8	.48	N/A	N/A	N/A
Period F (123-191 ka)	4	N/A	N/A	N/A	N/A

information exchange during Period B that seems low relative to the other measures characterizing the same bin sample. Conversely, the diversity estimate for extra-assertive expression seems high. Nevertheless, the Inverse Simpson means for both non-symbolic and symbolic exchange increase during Period A. At this time, assertive and extra-assertive interpersonal exchange and group-level exchange are notably variable.

For the Levantine dataset, then, the patterning of all three measures of stipulated object use conform to model predictions. Significantly, each shows assertive exchange emerged at the same time as in the African study area, but extra-assertive expression is much slower to appear. Increases and decreases in the prevalence, range of development, and diversity of stipulated object use are sporadic for most of the Later Pleistocene. Both non-symbolic and symbolic interpersonal expression show the most notable increases in all measures during the A Period, as does the relative importance of symbolic information exchange strategies. The appearance and estimated diversity in intra-group expression is perhaps the most indicative of mobilization.

Patterning is markedly consistent and thus taken as robust. Moreover, as with the African analyses, the EDA and CDA techniques indicate the shared patterning not consistent with random patterning encountered by chance, and is most likely anthropogenic in nature. Patterning in the Levantine dataset, then, must be considered in light of the different hominin populations that occupied the study area during the periods in question.

Diversity in Stipulated Object Use Through Time. The lack of stipulated object use in the earliest Levantine bin samples is immediately obvious in the distribution of diversity estimates for sample assemblages (Figure 6.3). The notable exception is the

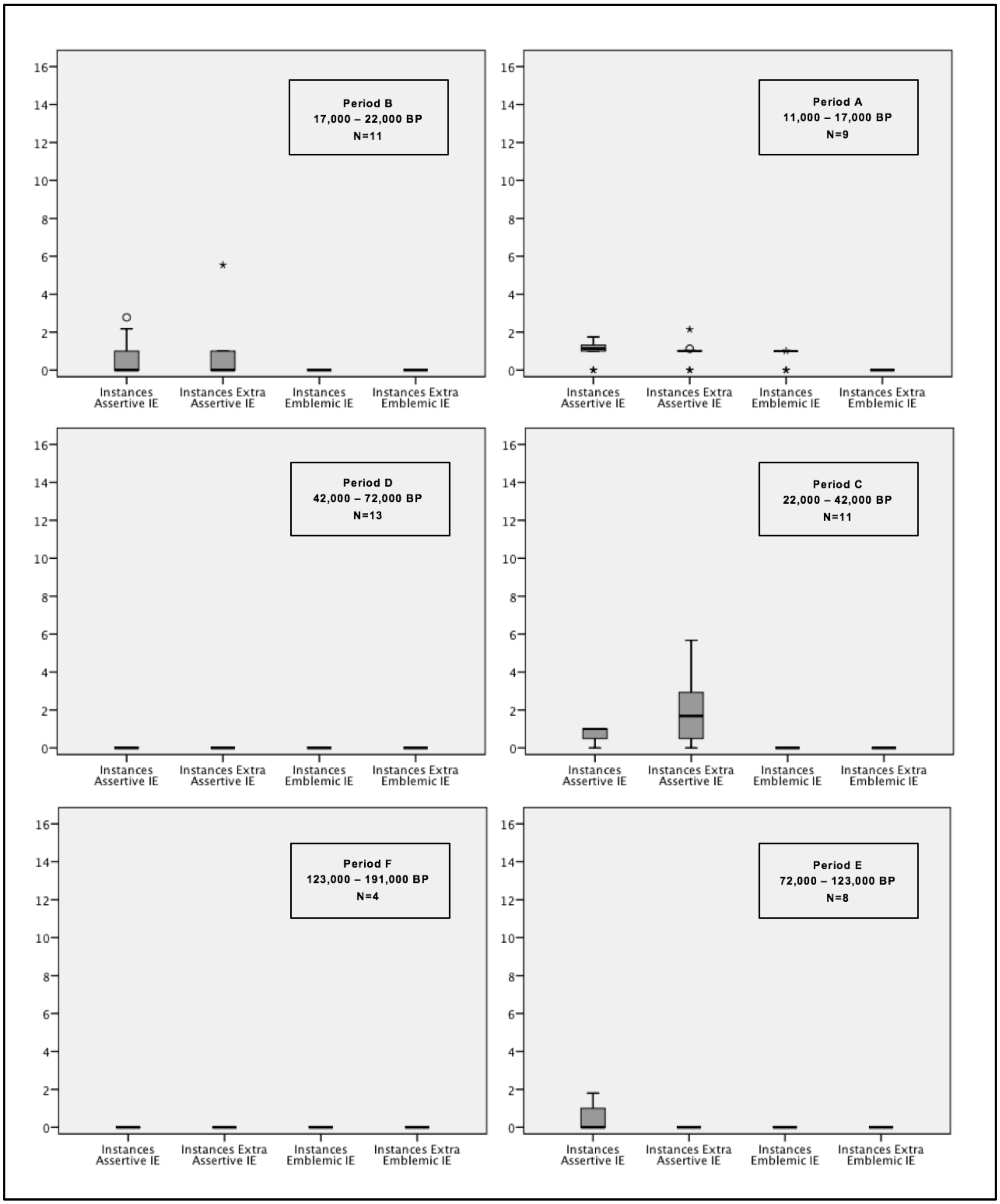

Figure 6.3. Distributions of diversity estimates for information exchange strategies in the Levantine dataset.

Period E distribution plot for assertive information exchange. The distribution is based on the presence of four assertive artifacts from three occupations at Qafzeh Cave: shell ornaments, an incised cortical flake, and red deer antlers cataloged as "grave goods" (Hovers et al. 1997; Bar-Yosef Mayer 2009). Evidence of *Emergent* capacities at Qafzeh is particularly significant. The site contributes the only assemblages pre-dating Period C that are attributed to Anatomically Modern Humans and, in conjunction with the first evidence of stipulated object use in Africa, suggest the AMH immigrant population entered the Levant with, and facilitated by, those capacities. Moreover, in contrast with the behavioral trends that are captured in the Levantine dataset and attributed to Neanderthals, the Period E samples from Africa and the Levant suggest real differences in symboling capacities– or at least expressions thereof.

In the Levantine dataset, all of the Period C sample assemblages are attributed to Anatomically Modern Humans, and the distribution of diversity estimates is also consistent with *Emergent* capacities. Assertive artifacts have only been documented at two occupations from Uwaynid 18 and one from Üçagizli Cave, and the diversity estimates for non-symbolic interpersonal exchange are correspondingly low. The distribution of extra-assertive artifacts in the same time period is very different. Instances of symbolic interpersonal exchange were documented in over half of the collections and include 29 total instances of six different types of standardized beads that account for the higher diversity suggested here. However, all of the materials were recovered from occupations at Üçagizli, limiting symbolic expression to a single site over the 5,000 years represented. Coupled with the singular nature of the finds (aquatic shell beads), the diversity index is probably misleading. In fact, extra-assertive artifacts in the B period sample are limited to shell beads from Üçagizli, as well, indicating the selective pressure for and value in symbolic expression remained highly localized and restricted in form until ~17,000 years ago.

In the Period B sample, evidence for non-symbolic exchange includes 10 assertive artifacts from three occupations at three separate sites that account for the higher levels of diversity anticipated in the distribution plot. The most extreme estimates are associated with Jilat 6 and Kharaneh IV and support previous designations of both locales as aggregation sites (Jones 2015). However, as stated in relation to Boomplaas Cave in the Africa study area, the coming together of multiple, independent groups that share a larger social network should select for both interpersonal and group-level information exchange strategies. The lack of extra-assertive and emblemic materials at Jilat 6 and Kharaneh IV and the low diversity estimates for both styles of symbolic exchange– and specifically for these sites– is then problematic. The site designations may be incorrect, or expectations for when and why symboling occurs should be refined.

Interestingly, mobilization is not readily apparent in the distribution plots for the A period sample assemblages, excepting for emblemic expression. In fact, the diversity estimate for symbolic group-level exchange is consistent with the apparent frequency of emblemic materials outside the study area. During Period A, the prevalence and extent to which assertive and extra-assertive artifact classes have been developed are higher than earlier periods. Moreover, stipulated object use is particularly coherent at this time. The same standardized rules of design (symbols) were often found on different media and/or on different artifact types that may have been used in, and thus effectively integrated, different contexts and context participants. The discrepancy between the diversity estimates and other measures is most likely situated in the uneven distribution of known assertive and extra-assertive artifacts among sample assemblages and underscores the importance of multiple EDA techniques in this research context.

The suite of approaches used here supports the assignment of semiotic profiles to each of the Levantine bin samples (Table 6.9) and, in turn, preliminary comparisons and conclusions. Stipulated object use appears simultaneously in both Africa and the Levant during the E period. However, engagement with materiality is low in the Levantine study area, and the expected scaffolding of symbolic expression is not evident there for another 30,000 years. The patterning indicates symboling capacities emerged in AMH populations prior to or during migrations into the area and amid the persistence of *Ancestral* behaviors in resident Neanderthal groups. The differences between Anatomically Modern Human and Neanderthal behaviors here are fairly distinct; however, any conclusions regarding Neanderthals' *capacity* for stipulated object use must consider the European data.

Table 6.9. Semiotic Profiles for the Levantine Bin Samples

	Material Engagement	Assertive Exchange	Ex-Assert Exchange	Emblemic Exchange	Ex-Embl Exchange	Symboling Capacities
		P/A	P/A	P/A	P/A	
Period A (~11-17 ka)	**Exploitive**	P	P	P	A	**Mobilized**
Period B (17-22 ka)	**Exploitive**	P	P	A	A	**Emergent**
Period C (22-42 ka)	**Exploratory**	P	P	A	A	**Emergent**
Period D (42-72 ka)	**Non-Reflexive**	A	A	A	A	**Ancestral**
Period E (72-123 ka)	**Exploratory**	P	A	A	A	**Emergent**
Period F (123-191 ka)	**Non-Reflexive**	A	A	A	A	**Ancestral**

Following Anatomically Modern Humans' second incursion into the Levant, levels of engagement with materiality and the prevalence and range of development in stipulated object use are consistent with *Emergent* capacities. Moreover, they mirror the evolutionary trajectory seen in Africa. Assertive expression increases slowly and only occasionally gives rise to more advanced interpersonal exchange; significant increases in all but extra-emblemic artifacts signal mobilization near the end of the Pleistocene. Both datasets indicate that group-level symboling is *not* integral to *Mobilized* capacities. Several phenomena highlight the importance of specific contexts for the expression of capacities, whether *Emergent* or *Mobilized*, including the highly localized but ubiquitous interpersonal exchange at Üçagizli and the absence of symbolic behaviors at even later and more intensely occupied sites. The European data make the importance of context in the expression of capacities particularly clear.

Information Exchange in Pleistocene Europe

Trends in Stipulated Object Use Through Time. The relative frequencies for the European dataset are presented in Table 6.10 and must be also be evaluated with different hominin groups in mind (see Appendix J-N for raw data used in th analysis). However, it should be noted that few skeletal remains have been recovered from these deposits, and the distinction between Anatomically Modern Human and Neanderthal occupations for analysis as independent samples is largely by convention. All of the assemblages that date to the F, E, and D periods are attributed to Neanderthals, whereas the C period sample includes deposits from both hominins. The Period B and Period A assemblages post-date Neanderthals' extinction and so are securely attributed to Anatomically Modern Humans only.

In this context, the lack of assemblages with stipulated object use of any kind during Period F and Period E is consistent with the behavioral trends documented at Neanderthal occupations in the Levantine study area. However, assertive exchange is evident in a single assemblage in the D period sample and indicates *Emergent* capacities for symbolic behavior. The prevalence of stipulated object use increases dramatically following the immigration of Anatomically Modern Human during the C Period.

At this time, assertive interpersonal exchange is documented in over half (55%) of the sample assemblages and extra-assertive exchange is documented in 9%. Emblemic group-level exchange is also present and even more widespread. The prevalence of non-symbolic and symbolic interpersonal exchange increases further during Period B; however, group-level exchange decreases and was only documented at a single occupation. The relative frequencies of stipulated object use in the C and B periods is somewhat ambiguous. In the earlier bin sample, the extent of assertive and extra-assertive exchange is consistent with the *Emergent* capacities that can be expected with immigrant

Table 6.10. Relative Frequencies of Assemblages in the European Study Area with Assertive, Extra-Assertive, Emblemic, or Extra-Emblemic Materials

		Assertive IE		Extra-Assert. IE		Emblemic IE		Extra-Embl. IE	
	Total No. Assmbl	No. Assmbl. w/ Indic	% Assembl. w/ Indic	No. Assmbl. w/ Indic	% Assembl. w/ Indic	No. Assmbl. w/ Indic	% Assembl. w/ Indic	No. Assmbl. w/ Indic	% Assembl. w/ Indic
Period A (~11-17 ka)	7	4	57%	4	57%	7	100%	0	0%
Period B (17-22 ka)	4	4	100%	1	25%	1	25%	0	0%
Period C (22-42 ka)	11	6	55%	1	9%	4	36%	0	0%
Period D (42-72 ka)	9	1	11%	0	0%	0	0%	0	0%
Period E (72-123 ka)	8	0	0%	0	0%	0	0%	0	0%
Period F (123-191 ka)	5	0	0%	0	0%	0	0%	0	0%

AMH populations. However, the prevalence of emblemic exchange is most consistent with fully *Mobilized* capacities.

During the A Period, non-symbolic, interpersonal expression decreases but remains relatively widespread, as evidenced in over half of the sample assemblages. Symbolic information exchange is ubiquitous, and *Mobilized* capacities are clearly evident in the prevalence of group-level exchange in particular. Extra-emblemic exchange is not documented in the European study area. These trends are represented graphically in Figure 6.1.

Despite the dataset including two different hominin groups and the ambiguity relative to the C and B Period semiotic profiles, the European patterning is *not* consistent with patterning encountered by chance. The p-values for Chi Squared tests of independence on all three styles of information exchange are again notably low (Table 6.2).

The simple mean frequencies for classes of assertive, extra-assertive, and emblemic exchange strategies in the European bin samples are similar to the relative frequency values and thus also ambiguous (Table 6.11). The values do, however, implicate increased levels of engagement with materiality in the emergence of stipulated object use among European Neanderthals and show the same step-wise development of behaviors that is seen in the African and Levantine study areas.

The Inverse Simpson mean values include some discrepancies between the degree of prevalence and development attributed to the later bin samples and the estimated levels of diversity (Table 6.12) during the same time periods. In all three samples, diversity estimates appear somewhat low for assertive exchange. However, the mean estimates for

Table 6.11. Mean Number of Classes of Information Exchange Styles in the European Bin Sample Assemblages

	No Assm	Rel Indic	Assert	Ex-Assert	Embl	Ex-Embl
Period A (~11-17 ka)	7	58.00	13.29	3.43	1.00	.00
Period B (17-22 ka)	4	41.00	4.75	.50	.25	.00
Period C (22-42 ka)	11	96.00	4.55	.09	.36	.00
Period D (42-72 ka)	9	22.00	.11	.00	.00	.00
Period E (72-123 ka)	8	11.00	.00	.00	.00	.00
Period F (123-191 ka)	5	5.00	.00	.00	.00	.00

Table 6.12. Mean Values of Diversity Estimates for the European Dataset

	No Assm	Assert	Ex-Assert	Embl	Ex-Embl
Period A (~11-17 ka)	7	4.50	1.19	1.02	N/A
Period B (17-22 ka)	4	4.26	.40	.31	N/A
Period C (22-42 ka)	11	1.39	.64	.59	N/A
Period D (42-72 ka)	9	.11	N/A	N/A	N/A
Period E (72-123 ka)	8	N/A	N/A	N/A	N/A
Period F (123-191 ka)	5	N/A	N/A	N/A	N/A

extra-assertive and emblemic exchange appear high relative to other measures during Period C. The Inverse Simpson means, then suggest sample size may be affecting patterning in the prevalence and development of information exchange in the later European dataset.

The patterning in diversity is nonetheless consistent with model prediction in the slow development of stipulated object use and erratic increases and decreases in information exchange strategies through Period B. Although symboling capacities may have mobilized earlier in the European study area, the dynamic is very clear in all measures of the Period A assemblages. The general trends predicted by the semiotic model are then consistent across all measures and sufficiently robust, despite any sample size effects on measures of prevalence and development. In conjunction with the Chi Squared tests, the patterning in the mean diversity estimates can be interpreted with some confidence as behavioral in nature.

Diversity in Stipulated Object Use Through Time. The distribution of diversity estimates, however, is no less ambiguous in terms of when the mobilization of symboling capacities occurred in the European study area (Figure 6.4). The distribution plots for the Period F and Period E samples reflect the absence of stipulated object use in assemblages associated with Neanderthals in all three study areas prior to ~72,000 years ago. The D period distributions are then unique in evidencing stipulated object use ~50k years ago at a single occupation. The assertive expression consists in two manganese blocks that were intentionally marked with linear patterns (d'Errico and Soressi 2002).

Although it is difficult to draw conclusions based on a single instance of a given behavior, the patterning of *all* measures relating to the Neanderthal occupations in the European dataset is highly consistent with model predictions for *Emergent* symboling capacities. Moreover, while the Inverse Simpson values indicate expected levels of diversity in stipulated object use were captured in the dataset, Châtelperronian sites that fall outside the study area support the interpretation of *Emergent* symboling behaviors in the D period sample. The Châtelperronian sites are well known for large numbers of assertive and possibly extra-assertive ornaments that evidence frequent interpersonal exchange in at least some Neanderthal groups (c.f. White 2001; Bar-Yosef and Bordes 2010).

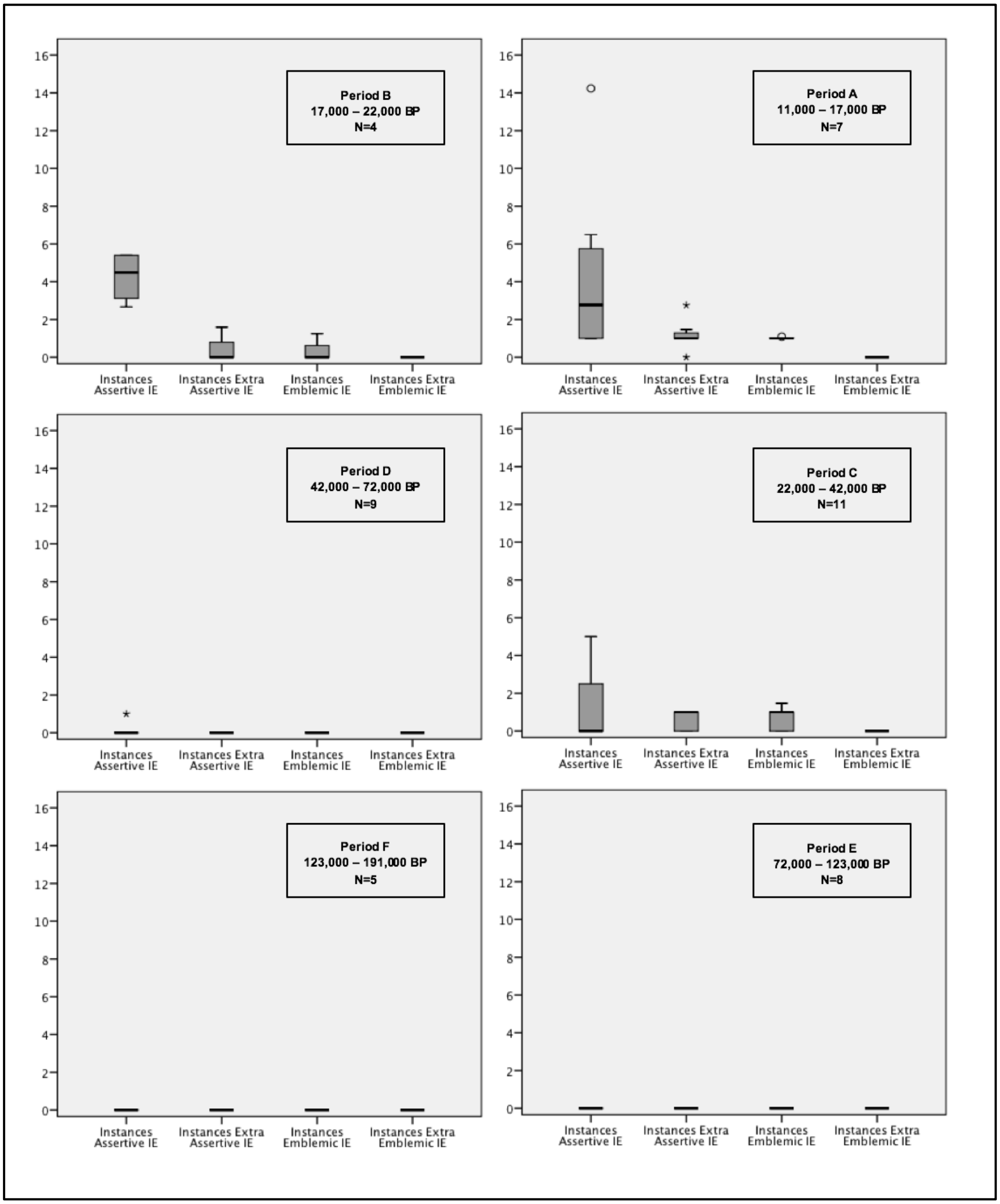

Figure 6.4. Distributions of diversity estimates for information exchange strategies in the European dataset.

The distributions for Period C capture the stipulated object use that characterizes early Aurignacian occupations of immigrant AMH populations only. The estimated level of diversity in symbolic interpersonal exchange remains low, and the dominance of non-symbolic interpersonal exchange and group-level exchange apparent in the mean Inverse Simpson values is well-illustrated here. The distribution of emblemic exchange includes Grotte Cussac, one of the oldest decorated caves in Pleistocene Europe. Cussac is remarkable, not only for its large and deeply engraved images, but also for their association with human remains (Aujoulat et al. 2013).

The much smaller Period B sample shows similar patterning in the diversity of exchange strategies. The large numbers of assertive artifacts that have been documented at all of the sample occupations are reflected here. Occurrences at Laugerie-Haute are of particular note due to its designation as an aggregation site. Three of the four sample assemblages were collected from this site and none includes symbolic materials. The importance of non-symbolic interpersonal expression to the aggregation of groups is now implicated in all three study area, as is the unimportance of symbolic exchange among long-distance networks. The diversity in symbolic interpersonal and group level exchange illustrated in the distribution reflect the cave paintings at Lascaux Cave, as well as the archaeological materials that were associated with them.

The distribution plots for the A period sample show dramatic shifts in engagement with materiality and the use of information exchange strategies at the end of the Pleistocene. The diversity in assertive artifacts is unprecedented, even when accounting for sample size. Forty-two and thirty-four instances of assertive expression were documented in the Magdalenian occupations of La Madeleine and Laugerie-Basse, respectively. A number of grave goods and idiosyncratic “phallus figurines” were recovered from La Madeleine, as were dozens of decorated objects and tools from both occupations. However, the diversity plots both reflect and predict notable variation: no assertive artifacts were documented at Abri Reverdit, for example.

Most significant to the Period A bin sample is the marked increase in symbolic artifacts. Here, Reverdit evidences symbolic interpersonal exchange and contributes a single extra-assertive artifact to the bin sample. Symbolic ornaments, batons, atlatls, and other extra-assertive objects were recovered from La Madeleine and Laugerie-Basse. Moreover, group-level symbolic exchange is ubiquitous. Diversity in emblemic expression appears negligible due to the way that parietal imagery was tallied.

The level of diversity in symbolic information exchange and particularly the uniform presence of emblemic materials distinguishes the Period A sample in the European study area from all other samples in the same region, as well as in Africa and the Levant. In this regard, the notion of an Upper Paleolithic ‘revolution’ is apropos. The integrated and integrative nature of the symbolic exchange is nonetheless shared with the Period A samples from the Levant and, to a lesser extent, from Africa. The rules of design, or symbols, that are documented in the European A period cross-cut most raw material types, artifact classes, and so use contexts, to effectively integrate activities, actors, and ideas through information exchange. Integration in the European and the Levantine study areas occurs among and spans both individuals and groups. Moreover, symboling appears constant and obligatory. The symbolic capacities that are evident in the European Period A assemblages are unequivocally *Mobilized*. Indeed, the sample’s representativeness of model predictions for fully developed and exploited symbolic behaviors brings back into question the *Emergent* or *Mobilized* nature of capacities during the C and B periods.

Assigning semiotic profiles to the European bin samples is complicated, first, by the presence of multiple hominin groups in the study area and, second, by the ambiguity of the later bin samples. The possibility that assemblages have been incorrectly attributed to Neanderthal or AMH groups in the Period D and Period C samples and the impact such an error could have on the analytical results cannot be overstated. Nonetheless, as currently designated, patterning among the Neanderthal assemblages supports the assignment of semiotic profiles (Table 6.13) while simultaneously highlighting the need for a more comprehensive analyses. Although stipulated object use and emergent symboling capacities are evidenced here, attention to Châtelperronian deposits and other 'transitional' occupations should help define the extent to which emergent capacities were actually expressed and, specifically, if symbolic interpersonal exchange developed as an adaptive response to the influx of AMH groups or other pressures prior to extinction.

Table 6.13. Semiotic Profiles for the European Bin Samples

	Material Engagement	Assertive Exchange	Ex-Assert Exchange	Emblemic Exchange	Ex-Embl Exchange	Symboling Capacities
		P/A	P/A	P/A	P/A	
Period A (~11-17 ka)	**Exploitive**	P	P	P	A	**Mobilized**
Period B (17-22 ka)	**Exploitive**	P	P	P	A	**Mobilized**
Period C (22-42 ka)	**Exploitive**	P	P	P	A	**Mobilized**[1] **Emergent**[2]
Period D (42-72 ka)	**Exploratory**	P	A	A	A	**Emergent**
Period E (72-123 ka)	**Non-Reflexive**	A	A	A	A	**Ancestral**
Period F (123-191 ka)	**Non-Reflexive**	A	A	A	A	**Ancestral**

[1]The archaeological record associated with AMH that dates to Period C is Mobilized. [2]The archaeological record associated with Neanderthals that dates to Period C is Emergent.

Ambiguity in the Period C and subsequent Period B occupations that are attributed to Anatomically Modern Humans make the assignment of semiotic profiles to these bin samples more difficult. A final determination here that symboling was fully *Mobilized* in Period C and Period B rests on the nature of emblemic expression represented at Cussac and Lascaux Caves. More specifically, the determination rests on the ritualized construction and use of place, the ideologically bound motivation of image production in niches and crevices where imagery cannot be seen, and the coherent makeup of the symboling at hand, each of which necessarily required the scaffolding of extant symbolic and non-symbolic concepts to be manifest.

With the semiotic profiles for all three study areas, consistent across all data types, and seriated within a uniform time scale, patterning in the evolution of symbolic behaviors can be considered at the multiregional level.

Information Exchange in the Human Lineage

The regional analyses have drawn on a suite of EDA and CDA techniques to reveal patterning in the prevalence, range of development, and diversity in stipulated object use over ~180k year period to establish the integrity and behavioral origins of each trend, and to show the consistency of patterning with the predictions of the semiotic model. More specifically, the analysis has shown that the evolution of symboling capacities are situated in increased engagement with materiality and sign recognition and proceeds in two stages that are identifiable through variation in information exchange strategies. Moreover, the trends in the African, Levantine, and European study areas are not only consistent with model predictions, but are also markedly consistent with each other.

The study areas capture significant variation in environmental contexts and concomitant selective pressures on behavior, as well as probable variation in social structures due to resource-driven mobility patterns and population size. Certainly the study areas capture distinct hominin populations. And yet patterning in different styles of information exchange that have been exploited, the tempo and overall rate of change in patterned exploitation, and the resulting semiotic profiles appear uniform across significant space and time (Table 6.14). The analysis, then, implicates a shared evolutionary process situated in the capacities for sign recognition and stipulated object use of Anatomically Modern Human's and Neanderthals most recent common ancestor.

The hypothesis was tested using the Kruskal-Wallis test of statistical significance. The Kruskal-Wallis test in a non-parametric technique that establishes the probability samples originate from the same population based on ranked means (Laerd Statistics 2016). The distribution of relative frequencies for assertive, extra-assertive, and emblemic information exchange in each region through time were evaluated against one another. In all cases, the results show that it cannot be said that the distributions are not

Table 6.14. Semiotic Profiles for All Study Areas

	African	Levantine	European
Period A (~11-17 ka)	Mobilized	Mobilized	**Mobilized**
Period B (17-22 ka)	Emergent	Emergent	**Mobilized**
Period C (22-42 ka)	Emergent	Emergent	**Mobilized**[1] **Emergent**[2]
Period D (42-72 ka)	Emergent	Ancestral	**Emergent**
Period E (72-123 ka)	Emergent	Emergent	**Ancestral**
Period F (123-191 ka)	Emergent	Ancestral	**Ancestral**

[1]The archaeological record associated with AMH that dates to Period C is Mobilized. [2]The archaeological record associated with Neanderthals that dates to Period C is Emergent.

from the same population. More simply put, there is no statistical difference in the evolutionary patterning in the prevalence of information exchange strategies, through time, in the three study areas. The singular global pattern is represented graphically in Figure 6.5 using the relative frequencies of each style of information exchange from the entire dataset, in which the relevant values from each region are combined.

The implications are significant for our understanding of human evolution and of symboling and for our analytical approaches to them. The evidence for a single, uniform, and shared evolutionary process resulting in complex symbolic behaviors and the complex socioeconomic phenomenon they support directly undermines the different cognitive capacities traditionally assumed for AMH and Neanderthals. The semiotic definition of symboling as situated in a matrix of capacities and sign types is also reinforced. Consequently, our attention must shift to why capacities for symbolic expression are expressed by some groups and not others and the implication of those

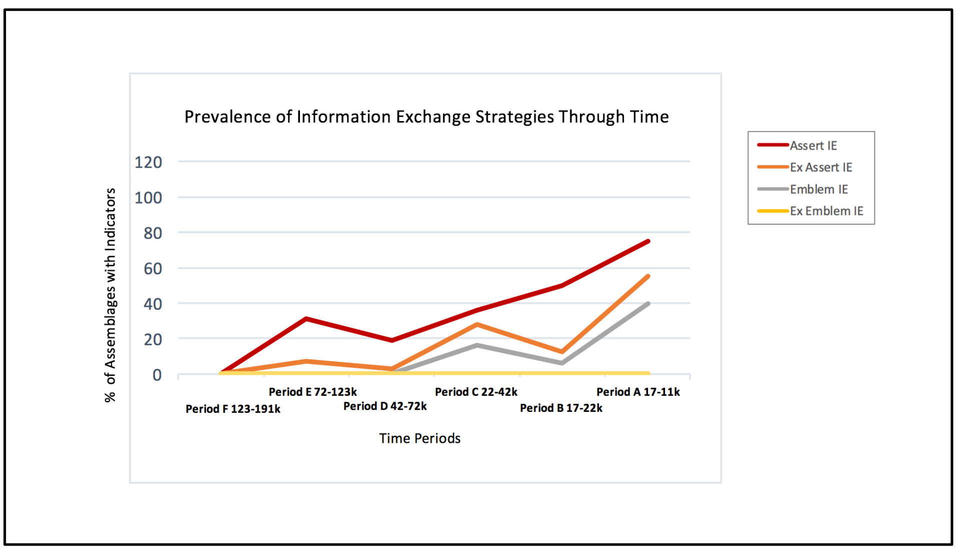

Figure 6.5. Line graphs showing increases and decreases in the prevalence of information exchange styles across all regions under analysis.

expressions for other advanced behaviors. The uniformly seriated semiotic profiles provide a context in which those questions can be explored. The following chapter re-engages the theoretical ground of this research and offers a final synthesis of the implications of the regional and multiregional results, with specific attention to the implications for operationalizing the semiotic paradigm as an analytical research method.

.

CHAPTER 7: SYNTHESIS AND CONCLUDING DISCUSSION

A Synthesis of Results and Their Implications

The semiotic model states symbolic behavior arose from increased levels of engagement with materiality and the recognition that objects can be made meaningful– or stipulated. The model predicts stipulated object use emerged slowly and sporadically and was initially dominated by non-symbolic interpersonal exchange. As the adaptive value and salience of information exchange strategies became fixed, *Emergent* capacities became fully *Mobilized*. *Mobilized* capacities are characterized by widespread, coherent, and obligatory symbolic expression, including interpersonal, inter-group, and intra-group information exchange. The semiotic model does not state when, where, or among what hominin groups these processes occurred.

Among the study areas in question, the earliest non-symbolic stipulated object use occurs in Africa ~100,000 years ago and appears to scaffold symbolic expression at a number of sites. However, both styles of information exchange subsequently disappear from the record, and symbolic expression does not recur in Africa for another ~25k years. In the Levant, non-symbolic exchange also appears early (~100ky) and is sustained through a series of occupations at one locale. Yet here, the first symbolic exchange is not evident until approximately 40,000 years ago. Stipulated object use is not documented in the European study area until ~50,000 years ago and is restricted to just one instance of non-symbolic exchange. Symbolic expression did not emerge in this region until ~35,000 years ago. In all cases, stipulated object use develops in a step-wise fashion as engagement with materiality and lower order expression give rise to increasingly abstracted ideas and mechanisms of exchange. Non-symbolic and symbolic behaviors are temporally sporadic, spatially mosaic, and effect only interpersonal exchange.

Significant changes in stipulated object use occur toward the end of the Pleistocene (~17ky) in both Africa and the Levant but are documented much earlier in the European study area (~42ky). At these times, information exchange increases dramatically, with both non-symbolic and symbolic expression much more diverse and more widespread. Symbolic expression also increases in relative importance and is coherent across a wide range of media and presumed use contexts. In the European study area, symbolic intra-group exchange is ubiquitous; however, in Africa and the Levant, it is not an integral component of fully developed stipulated object use. Instead, non-symbolic interpersonal exchange appears integral to group aggregation and/or dense occupation under all circumstances.

The general trends that are discernable in the archaeological record from all three regions under analysis conform to model predictions for the evolution of symbolic behavior in the human lineage. Indeed, the analysis shows the underlying processes of emergence and mobilization are sufficiently robust to appear as highly consistent trends in three independent measures– and despite limitations with each datasets. Both raw and transformed class frequencies, as well as diversity estimates, show the same distinct patterning in the volume, prevalence, and richness of each information exchange strategy, within and across regions. Moreover, the standardized data withstand tests of statistical significance that increase confidence in the anthropogenic nature and integrity of the archaeological patterning and in the implications thereof. The analysis, then, effectively confirms the model's central hypotheses and, in so doing, establishes the semiotic paradigm as a viable framework for archaeological research.

One of the most important contributions of the paradigm is redefining the capacity for symbolic behavior as a consequence of engagement with materiality, the recognition that signs are signs, and that objects can be stipulated. Symboling issues from a matrix of capacities and the socioeconomic dynamics that select for its expression. The analysis indicates the capacity for sign recognition and stipulated object use dates back to Anatomically Modern Humans' and Neanderthals' most recent common ancestor. The earliest symbolic behaviors, then, do not reflect a new and more advanced cognitive ability, but the outcome of an extended, uniform, and shared evolutionary process. The full mobilization of symbolic behavior may have been inevitable among surviving populations.

The analysis ultimately undermines teleological notions of modernity and the consequent false dichotomies that inform interpretations of Modern Human and Neanderthal behavioral remains. Attention is redirected from the earliest symbolic or symbolically mediated behavior as the origin of cognitive modernity to the dynamics that selected for stipulated object use and for symbolic exchange at different times among different groups.

A number of researchers have argued demographic variables drive cultural complexity (e.g., Shennan 2001; Henrich 2004; Powell et al. 2009). Population density has been implicated in the "Upper Paleolithic Revolution" and in the fluorescence of rock art production, in particular (e.g., Clark et al. 1996; Barton et al. 1994). The Neanderthal behaviors that mostly fall outside the current study areas but that are nonetheless consistent with *Emergent* symboling capacities are frequently interpreted as being adopted from intrusive AMH groups (e.g., Mellars 1989, 1993; see also Tostevin 2007). However, the demographic changes and presumed inter-group competition associated with Modern Human's initial excursions into the Levant and subsequent colonization of Eurasia did not select for symbolic behavior, nor prompt any discernable change in stipulated object use in sample occupations. Symbolic information exchange strategies are also unexpectedly low at aggregation sites. In fact, inter-group symbolic expression does not conform to model predictions for *Mobilized* capacities beyond the European study area.

The results presented here, then, suggest the ubiquity of group-level exchange in later European sites was driven by a level of and/or persistence in population density and competition that was unique to the local environment during the Last Glacial Maximum. Alternatively, the patterning may reflect the institutionalization of ideological beliefs and practices, a process that would have required group-level and regionally-integrative information exchange strategies. Perhaps most importantly, while the results emphasize the need to better specify the relationship between demographic variables, non-symbolic, and symbolic exchange, they also point to ways of applying the model for more nuanced understandings of stipulated object use.

Model as Method: Operationalizing the Semiotic Paradigm

The greatest hindrance to operationalizing the semiotic paradigm as a research method is the nature of the data itself. Analysis of the African and Eurasian archaeological records is severely limited by the quality of early research, including incomplete reporting of assemblage components and insufficient artifact descriptions.

Early site reports can be difficult or impossible to access, even when published and widely cited. Building the most useful dataset necessarily requires sustained efforts to secure all available information and to ensure deposits meet selection criteria; some collections should be accessed directly. The number of assemblages that can be used is thus likely to remain low and unevenly distributed across space and time.

Moreover, the potential for sample size to affect class richness and thus the integrity of results is inherent to archaeological research in deep time and will persist in future applications of the model. The insufficient site reports undermine traditional means of normalizing data for meaningful analyses and, as previously detailed, many techniques for estimating diversity cannot be used or rely on problematic assumptions. A multi-pronged approach for identifying and interpreting the significance of patterning in the archaeological record is therefore required and must be tailored to the specific research questions, analytical parameters, and data at hand.

It is equally important to emphasize that– no matter how robust– any patterning identified using the current research parameters will be very course-grained and consequent insights into symbolic behavior concomitantly so. The chronological framework adopted here was specifically designed to capture stylistically dated materials from three separate areas and constitutes a trade-off between analytical resolution and multiregional hypothesis testing. However, the approach not only supported model testing but also identified materials that are appropriate for highly localized, finer-grained studies that can address many of the questions raised here. The present argument, then, calls for operationalizing the model at different scales of analysis such that hypotheses that are generated at one level can be further specified and/or tested at another.

Indeed, the most significant methodological contribution of the semiotic paradigm is the ability to group and seriate seemingly disparate data types (ochre, marked tools, ornaments, art) based on their semiotic potential. Independent of spatially-bound and bias-laden lithic classification systems, as well as assumptions about hominin cognitive capacities, the approach can be used with any chronological framework and in any location.

This is a pilot study, a first step in reframing research on the evolution of symboling capacities in the human lineage. As with Peirce's *Interpretants* it offers a powerful lens for reconceptualizing the archaeological record and developing a better understanding of the human career.

END NOTES

1. Saussure published very little during his lifetime, and most of his semiology is taken from a series of lectures he gave from 1907 to 1911 while teaching at the University of Geneva. Following his death in 1913, his students compiled and edited their class notes with the acknowledgement irregular content typical of oral presentations had undergone substantial modification. *Cours de Linguistique Générale* was published posthumously in 1916. There are now several English translations, as well as bilingual editions (Saussure 1993, 1996, 1997) of each lecture. Unless otherwise noted, primary material is taken from Baskin's translation (Saussure 1966[1959]). Summaries of Saussure's work also draw from Preucel (2006), Sperber (1975), and Nöth (1990).

2. Parenthetical citations for Peirce's work provide key sources on a given topic but do not exhaust his writings or ideas on that topic. Peirce revisited and continued to develop favored philosophical ideas and questions throughout his lifetime, such that ideas recur, run through, and integrate his body of work. This is especially true for interrelated topics like signification, synechism, pragmatism, logic, and abduction, where a treatise on one often directly or indirectly develops more nuanced understandings of another (following Atkin 2013).

Pursuing these intellectual threads has been difficult historically with many of Peirce's writings unpublished at the time of his death or distributed among various monthly magazines, professional journals, and lecture annals. Early compilations suffer from organizational issues. This inaccessibility, along with the amount and density of Peirce's work have been cited as additional reasons his ideas are not fully exploited (Preucel 2006; Deacon 2012; Burch 2014). Indiana University-Purdue University Indianapolis established the Peirce Edition Project in 1976 to find, organize, date, edit, and publish his complete works according to modern standards (http://www.iupui.edu/~peirce/). Six of 30 volumes have been published to date as the *Writings of Charles S. Peirce: A Chronological Edition* (Peirce Edition Project 1982, 1984, 1986, 1988, 1993, 2000). The Peirce Edition Project has also generated *The Essential Peirce: Selected Philosophical Writings, Volume II* (PEP 1998), collections of Peirce's most seminal essays from the Project volumes. Other good annotated compilations emerged in the 1980s and 1990s, including *The Essential Peirce: Selected Philosophical Writings, Volume I* (Peirce 1998) and *Peirce on Signs* (Hoopes 1991). Excellent summaries and discussions of Peirce's semiotic and related philosophical theories include entries in *The Stanford Encyclopedia of Philosophy* (Atkin 2013; Burch 2014), the *Handbook of Semiotics* (Nöth 1990), *An Introduction to C. S. Peirce* (Corrington 1993), and *Peirce's Theory of Signs* (Short 2007). See Nöth (1990:40-41) and Preucel (2006:48) for more detailed bibliographies of Peirce's work and discussions of it.

As a matter of convention among Peircean scholars, references for any content taken directly from the Peirce Edition Project publications will attribute the Project instead of Peirce's authorship. Parenthetical citations will use the abbreviation PEP, followed by the publication date of the relevant volume and any specific page numbers. For example, a quote taken from the *Writings of Charles S. Peirce: A Chronological Edition, Volume 4: 1879-1884* would be cited as: (PEP 1988:202).

3. The capitalization of *Object* and *Interpretant* maintains Peirce's convention. In this context, italics are also used to help distinguish the formal term *Object* from material objects, the domain of archaeological research and focus of later discussions, and to help distinguish *Interpretant* from interpreter. Other formal terms are italicised as well.

4. Peirce identified up to 66 different sign relations and varied his terminology significantly over the course of his lifetime. However, he consistently argued that only 10 of those sign types are actually *logically* possible, whether natural or conventional, and these remained at the core of his semiotic theory. Only those portions of the basic typology that help clarify the nature of symbolic behavior and how it could have emerged in the human lineage are relevant to the current discussion (Atkins 2013; see also Preucel 2006, Deacon 2012, and Burch 2014).

5. See Deacon 2012 for a detailed discussion of how the arbitrary nature of the symbolic sign-Object relationship is often misunderstood in anthropology and results in a conflation of the sign-sign and sign-Object relationships, or *legisigns* and symbols.

6. Here, "complex" is relative to existing technologies and norms and is defined by the number of interaction events and redundant affirmations required for individuals to accept, learn, and adopt new phenomena. "Complex phenomena" may be sophisticated technology, social movements that are counter to prevailing norms, or otherwise difficult to transmit knowledge, actions, and ideas. The transmission of complex phenomena requires a different population structure than the "weak ties" (Granovetter 1973) through which "simple" phenomena most effectively diffuse (Centola and Macy 2007; Centola 2010).

7. All area perimeter points were generated by Geoplaner V2.7, via online interface with Google Maps and JScoord V1.1.1 (http://www.geoplaner.com). Google Maps are based on Landsat-7 satellite images, using the WGS 84 ellipsoid reference and with vector data accuracy varying from 0.1m in urban areas to 15m in Antarctica. Geoplaner rounds the derived coordinates to a precision of 1m. Areas calculations were generated using Daft

Logic's Google Maps Area Calculator Tool 6.0 (http://www.daftlogic.com/projects-google-maps-area-calculator-tool.htm).

8. All references to marine isotope stages are as defined by Lisiecki and Raymo (2005).

REFERENCES CITED

Alexander, Mary
2016 Drakensberg: Barrier of Spears. Electronic document, http://www.southafrica.info/about/geography/drakensberg-050705.htm, accessed January 22, 2016.

Ambrose, Stanley H.
2010 Coevolution of Composite-Tool Technology, Constructive Memory, and Language: Implications for the Evolution of Modern Human Behavior. *Current Anthropology* 51(S1):S135-S147.

Ambrose, Stanley H. and Katharina G. Lorenz
1990 Social and Ecological Models for the Middle Stone Age in Southern Africa. In *The Emergence of Modern Humans: An Archaeological Perspective*, edited by Paul Mellars, pp. 3–33. Cornell University Press, Ithaca.

Ames, Christopher J.H., Julien Riel-Salvatore, and Benjamin R. Collins
2013 Why We Need an Alternative Approach to the Study of Modern Human Behaviour. *Canadian Journal of Archaeology/Journal Canadiend'Archéologie* 37:21-47.

Anati, Emmanuel
1993 *Har Karkom. In the Light of New Discoveries*. Studi Camuni XI, English Edition. Edizioni del Centro, Valcamonica, Italy

Arnold, Kate and Klaus Zuberbühler
2006 The Alarm-Calling System of Adult Male Putty-Nosed Monkeys, *Cercopithecus nictitans* martini. *Animal Behaviour* 72:643-653.

Atkin, Albert
2013 "Peirce's Theory of Signs." In The Stanford Encyclopedia of Philosophy (Summer 2013 Edition), edited by Edward N. Zalta. Electronic document, http://plato.stanford.edu/archives/sum2013/entries/peirce-semiotics/, accessed April 5, 2014.

Aujoulet, Norbert
2005 Lascaux: Movement. Space, and Time. Abrams, New York.

Aujoulat, Norbert, Valérie Feruglio, Nathalie Fourment, Dominique Henry-Gambier, and Jacques Jaubert
2013 The Gravettien Sanctuary Of Cussac (Le Buisson-De-Cadouin, Dordogne, France): First Results Of A Team Research Project. *INORA* 65:8-19.

Backwell, Lucinda, Francesco d'Errico, and Lyn Wadley
2008 Middle Stone Age Bone Tools from the Howiesons Poort Layers, Sibudu Cave, South Africa. *Journal of Archaeological Science* 35:1566-1580.

Barham, Lawrence
2007 Modern is as Modern Does? Technological Trends and Thresholds in the South-central African Record. In *Rethinking the Human Revolution*, edited by Paul Mellars, Katie Boyle, Ofer Bar-Yosef, and Chris Stringer, pp.165-176.

Barrett, John C.
2012 The Archaeology of Mind: It's Not What You Think. *Cambridge Archaeological Journal* 23(1):1-17.

Barton, C. Michael, Geoffrey A. Clark, and Allison Cohen
1994 Art as Information: Explaining Upper Paleolithic Art in Western Europe. *World Archaeology* 26(2):186-207.

Bar-Yosef, Ofer
1996 The Impact of Late Pleistocene-Early Holocene Climatic Changes on Humans in Southwest Asia. *In Humans at the End of the Pleistocene*, edited by L.S. Straus et al., pp. 61-78. Plenum, New York.

2002 The Upper Paleolithic Revolution. *Annual Review of Anthropology* 31:363-393.

Bar-Yosef, Ofer and Jean-Guillaume Bordes
2010 Who were the makers of the Châtelperronian culture?. *Journal of Human Evolution* 59(5): 586-593.

Bar-Yosef, Ofer, Bernard Vandermeersch, B. Arensburg, Anna Belfer-Cohen, Paul Goldberg, H. Laville, L. Meignen, Y. Rak, John D. Speth, E. Tchernov, and S. Weiner
1992 The Excavations in Kebara Cave, Mt. Carmel. *Current Anthropology* 33(5): 497-550.

Bar-Yosef Mayer, Daniella E., Bernard Vandermeersch, and Ofer Bar-Yosef
2009 Shells and Ochre in Middle Paleolithic Qafzeh Cave, Israel: Indications for Modern Behavior. *Journal of Human Evolution* 56(3): 307-314.

Bednarik, Robert G.
1995 The Coa Petroglyphs: An Obituary to the Stylistic Dating of Palaeolithic Rock-Art. *Antiquity* 69(266):877-884.

Bekoff, Marc
1995 Play Signals as Punctuation: The Structure of Social Play in Canids. *Behaviour* 132(5/6):419-429.

Belfer-Cohen, Anna and Paul Goldberg
1982 An Upper Paleolithic Site in South Central Sinai. *Israel Exploration Journal* 32(4):185-189.

Bernatchez, Jocelyn A.
2012 The Role of Ochre in the Development of Modern Human Behavior: A Case Study from South Africa. Unpublished Ph.D. dissertation, Department of Anthropology, Arizon State University.

Betts, Alison V.G.
1999 Dhuweila: Rock Carvings. In *The Harra and the Hamad: Excavations and Surveys in Eastern Jordan, Volume 1*, edited by A. Betts, et al., pp. 143-158. Sheffield Academic Press, Sheffield.

2001 The Middle East. In *Handbook of Rock Art Research*, edited by David S. Whitley, pp. 786-823. Altamira Press, New York.

Bocquet-Appel, Jean-Pierre, Pierre-Yves Demarsb, Lorette Noiretc, and Dmitry Dobrowsky
2005 Estimates of Upper Palaeolithic Meta-Population Size in Europe from Archaeological Data. *Journal of Archaeological Science* 32(11):1656-1668.

Borgatti, Stephen P., Ajay Mehra, Daniel J. Brass, Giuseppe Labianca
2009 Network Analysis in the Social Sciences. *Science* 323:892-895.

Bouissac, Paul
1993 Ecology of Semiotic Space: Competition, Exploitation and the Evolution of Arbitrary Signs. *The American Journal of Semiotics* 10(3/4):143-163.

1994 Deixis vs. Modeling in the Phylogeny of Artistic Behavior. In *Origins of Semiosis: Sign Evolution in Nature and Culture*, edited by W. Nöth, pp.405-418. Mouton de Gruyter, Berlin.

2000 Steps Toward Evolutionary Semiotics. *Semiotica* 3/4:317-342.

Braun, David P. and Stephen Plog
1982 Evolution of "Tribal" Social Networks: Theory and Prehistoric North American Evidence. *American Antiquity* 47(3):505-524.

Brown, Kyle S., Curtis W. Marean, Andy I. R. Herries, Zenobia Jacobs, Chantal Tribolo, David Braun, David L. Roberts, Michael C. Meyer, and Jocelyn Bernatchez
2009 Fire as an Engineering Tool of Early Modern Humans. *Science* 325:859-862.

Brown, Kyle S., Curtis W. Marean, Zenobia Jacobs, Benjamin J. Scoville, Simen Oestmo, Erich C. Fisher, Jocelyn Bernatchez, Panagiotis Karkanas, and Thalassa Matthews
2012 An Early and Enduring Advanced Technology Originating 71,000 Years Ago in South Africa. *Nature* 491:590-593.

Brumm, Adam, Gitte M. Jensen, Gert D. van den Bergh, Michael J. Morwood, Iwan Kurniawan, Fachroel Aziz, and Michael Storey
2010 Hominins on Flores, Indonesia, by One Million Years Ago. *Nature* 464:748-752. doi:10.1038/nature08844

Burch, Robert
2014 "Charles Sanders Peirce." In The Stanford Encyclopedia of Philosophy (Winter 2014 Edition), edited by Edward N. Zalta. Electronic document, http://plato.stanford.edu/archives/win2014/entries/peirce/, accessed April 5, 2014.

Bush, Andrew M., Molly J. Markey, Charles R. Marshall
2004 Removing Bias from Diversity Curves: The Effects of Spatially Organized Biodiversity on Sampling-Standardization. *Paleobiology* 30(4): 666–686.

Butzer, Karl W.
1982 Geomorphology and Sediment Stratigraphy. In *The Middle Stone Age at Klasies River Mouth, South Africa*, edited by R. Singer and J. Wymer, pp.33-42. University of Chicago Press, Chicago.

Cann, R., Olga Rickards and J.Koji Lum
1994 Mitochondrial DNA and Human Evolution: Our One Lucky Mother. In *Origins of Anatomically Modern Humans* (M. Nitecki and D. Nitecki, eds.), pp. 135-148. New York, Plenum.

Carbonella, Eudald and Zaida Castro-Curel
1992 Palaeolithic Wooden Artefacts from the Abric Romani (Capellades, Barcelona, Spain). *Journal of Archaeological Science* 19 (6):707–719.

Castro-Curel, Zaida and Eudall Carbonell
1995 Wood Pseudomorphs From Level I at Abric Romani, Barcelona, Spain. *Journal of Field Archaeology* 22(3): 376-384. DOI: 10.1179/009346995791974206.

Centola, Damon
2010 The Spread of Behavior in an Online Social Network Experiment. *Science* 329:1194-1197.

Centola, Damon and Macy Michael
2007 Complex Contagions and the Weakness of Long Ties. *American Journal of Sociology* 113(3):702-734.

Chase, Philip
2003 Comments on The Origin of Modern Human Behaviour: Critique of the Models and Their Test Implications, by Christopher S. Henshilwood and Curtis W. Marean. *Current Anthropology* 44:627–651.

Chase, G. Philip and Harold L. Dibble
1987 Middle Paleolithic Symbolism: A Review of Current Evidence and Interpretations. *Journal of Anthropological Archaeology* 6:263-296.

Cheney, Dorothy L. and Robert M. Seyfarth
1985 Vervet Monkey Alarm Calls: Manipulation through Shared Information? *Behaviour* 93:150-166.

1990 *How Monkeys See the World*. Chicago University Press.

Chiarucci, A., G. Bacaro, D. Rocchini, and L. Fattorini
2008 Discovering and Rediscovering the Sample-Based Rarefaction Formula in the Ecological Literature. *Community Ecology* 9(1):121-123.

Clark, Geoffrey A., C. Michael Barton, and Allison E. Cohen
1996 Explaining Art in the Franco Cantabrian Refugium: An Information Exchange Model. In Debating Complexity. *Proceedings of the 26th Annual Chacmool Conference*, edited by D.A. Meyer, P.C. Dawson, and D.T. Hanna, pp.241-253. University of Calgary, Calgary.

Clark, Geoffrey A., Joel Schuldenrein, M.L. Donaldson, H.P. Schwarcz, W.J. Rink, and Susan K. Fish
1997 Chronostratigraphic Contexts of Middle Paleolithic Horizons at the 'Ain Difla Rockshelter (WHS 634), West-Central Jordan. In *The Prehistory of Jordan 2: Perspectives from 1997*, edited by H.G.K. Gebel, Z. Kafafi, and G.O. Rollefson, pp. 7-10. Ex Oriente, Berlin.

Cleyet-Merle J.
1995 La province préhistorique des Eyzies: 400 000 ans d'implantation humaine. *CNRS Editions*, Paris.

Clottes, Jean
1993 Post-Stylistic? In *Rock Art Studies: The Post-Stylistic Era or Where Do We Go From Here?* Edited by Paul Bahn and Micheal Lorblanchet, pp. 19–25. Oxbow, Oxford.

Colwell, Robert K. and Jonathan A. Coddington
1994 Estimating Terrestrial Biodiversity through Extrapolation. *Philosophical Transactions: Biological Sciences* 345(1311):101-118.

Colwell, Robert K., Anne Chao, Nicholas J. Gotelli, Shang-Yi Lin, Chang Xuan Mao, Robin L. Chazdon, and John T. Longino
2012 Models and Estimators Linking Individual-Based and Sample-Based Rarefaction, Extrapolation and Comparison of Assemblages. *Journal of Plant Ecology* 5(1):3-21.

Conard, Nicholas J.
2003 Palaeolithic Ivory Sculptures from Southwestern Germany and the Origins of Figurative Art. *Nature* 426:830-832.

2010 Cultural Modernity: Consensus or Conundrum? *Proceedings of the National Academy of Sciences* 107(17):7621-7622.

Conkey, Margaret W.
1978 Style and Information in Cultural Evolution: Toward a Predictive Model for the Paleolithic. In *Social Archeology*, edited by Charles L. Redman, Mary Jane Berman, Edward V. Curtin, William T. Langhorne, Jr., Nina M. Versaggi, and Jeffery C. Wanser, pp. 61-85. Academic Press, New York.

1980a Context, Structure, and Efficacy in Paleolithic Art and Design. In *Symbol as Sense,* edited by M. L. Foster and S. Brandes, pp. 225-248. Academic Press, New York.

1980b The Identification of Prehistoric Hunter-gatherer Aggregation Sites: The Case of Altamira. *Current Anthropology* 21(5): 609-630.

2001 Structural and Semiotic Approaches. In *Handbook of Rock Art Research*, edited by David S. Whitley, pp. 273-310. Altamira Press, Walnut Creek, California.

2009 Materiality and Meaning Making in the Understanding of Palaeolithic 'Arts.' In *Becoming Human: Innovation in Prehistoric Material and Spiritual Culture*, edited by Colin Renfrew and Iain Morley, pp. 179-194. Cambridge University Press, Cambridge.

Coolidge, Frederick L. and Thomas Wynn
2009 The Rise of Homo sapiens: The Evolution of Modern Thinking. Wiley-Blackwell, Malden, Massachusetts.

Corrington, Robert S.
1993 An Introduction to C. S. Peirce: Philosopher, Semiotician, and Ecstatic Naturalist. Rowman & Littlefield, Lanham, Maryland.

Crémades, Michèle
1994 Oeuvres d'art Mobilier Inédites de la Madeleine (Tursac-Dordogne). *Paléo* 6:233-246.

Culley, Elisabeth V.
2006 The Meaning of Metaphor: A Cognitive Approach to Prehistoric Ideation. Unpublished master's thesis, Department of Anthropology, Northern Arizona University, Flagstaff.

Culley, Elisabeth V. and Geoffrey A. Clark
2010 Review Article: The Rise of *Homo sapiens*: The Evolution of Modern Thinking. *Journal of Anthropological Research* 66(3):403-404.

Davidson, Iain
2003 Comments on The Origin of Modern Human Behaviour: Critique of the Models and Their Test Implications, by Christopher S. Henshilwood and Curtis W. Marean. *Current Anthropology* 44:627-651.

2010 The Colonization of Australia and Its Adjacent Islands and the Evolution of Modern Cognition. *Current Anthropology* 51(S1).

2013 Origins of Pictures: An Argument for Transformation of Signs. In *Origins of Pictures*. *Anthropological Discourses in Image Science*. Edited by K. Sachs-Hombach and J. R. J. Schirra, pp.15-45. Halem, Cologne.

Davidson, Iain and Willian C. McGrew
2005 Stone Tools and The Uniqueness of Human Culture. *Journal of Royal Anthropological Institute* 11:793-817.

Davidson, Iain and William Noble
1989 The Archaeology of Perception: Traces of Depiction and Language. *Current Anthropology* 30(2):125-155.

Deacon, J.
1984 *The Later Stone Age of Southernmost Africa*. British Archaeological Reports International Series 213. BAR, Oxford.

d'Errico, Francesco
2003 The Invisible Frontier. A Multiple Species Model for the Origin of Behavioral Modernity. *Evolutionary Anthropology* 12:188-202.

d'Errico, Francesco, Lucinda R. Backwell, and LynWadley
2012 Identifying regional variability in Middle Stone Age bone technology: the case of Sibudu Cave. *Journal of Archaeological Science* 39(7): 2479-2495.

d'Errico, Francesco and Christopher Henshilwood
2007 Additional Evidence for Bone Technology in the Southern African Middle Stone Age. *Journal of Human Evolution* 52(2):142-163.

d'Errico, Francesco, Christopher Henshilwood, Graeme Lawson, Marian Vanhaeren, Anne-Marie Tillier, Marie Soressi, Frédérique Bresson, Bruno Maureille, April Nowell, Joseba Lakarra, Lucinda Backwell, and Michéle Julien
2003 Archaeological Evidence for the Emergence of Language, Symbolism, and Music—An Alternative Multidisciplinary Perspective. *Journal of World Prehistory* 17(1):1-70.

d'Errico, Francesco, Christopher S. Henshilwood, and Peter Nilssen
2001 An Engraved Bone Fragment From c. 70,000-Year-Old Middle Stone Age Levels at Blombos Cave, South Africa: Implications for the Origin of Symbolism and Language. *Antiquity* 75:309-318.

d'Errico, Francesco, Christopher Henshilwood, Marian Vanhaeren, K. van Niekerk
2005 *Nassarius kraussianus* Shell Beads from Blombos Cave: Evidence for Symbolic Behaviour in the Midde Stone Age. *Journal of Human Evolution* 48:3-24.

d'Errico, Francesco and Christopher B. Stringer
2011 Evolution, Revolution or Saltation Scenario for the Emergence of Modern Cultures? *Philosophical Transactions of the Royal Society B* 366:1060-1069.

d'Errico, Francesco and Marie Soressi
2002 *Systematic use of manganese pigment by Pech-de-l'Azé Neandertals: implications for the origin of behavioral modernity*. Paper presented at the Paleoanthropology Society Meetings, Denver.

d'Errico, Francesco, João Zilhão, Dominique Baffier, Michèle Julien, and Jacques Pelegrin
1998 Neanderthal Acculturation in Western Europe? A Critical Review of the Evidence and Its interpretation. *Current Anthropology* 39:S1–S44.

Deacon, Terrence W.
1997 The Symbolic Species: The Co-evolution of Language and the Brain. Norton, New York.

2012 The Symbol Concept. The Oxford Handbook of Language Evolution. Edited by Maggie M. Tallerman and Kathleen R.K. Gibson, pp. 393-405. Oxford University Press, Oxford.

Deely, John
1991 Modeling Anthroposemiosis. In *On Semiotic Modeling*, editing by Myrdene Anderson and Floyd Merrell, pp.525-593. Mouton de Gruyter, Berlin.

2002 *What Distinguishes Human Understanding?* St. Augustine's Press, South Bend, Indiana.

Delluc, Brigitte and Gilles, Alain Roussot, and Julia Roussot-Larraque
1992 Discovering Périgord Prehistory, English Edition. Editions Sud Ouest, Bordeaux.

Dennett, Daniel C.
2000 Making Tools for Thinking. In *Metarepresentation: A Multidisciplinary Perspective,* Vancouver Studies in Cognitive Sciences 10, edited by Daniel Sperber, pp.17-30. Oxford University Press, Oxford.

Donald, Merlin
1997 Precis of Origins of the Modern Mind: Three Stages in the Evolution of Culture and Cognition. *Behavioral and Brain Sciences* 16(4):737-791.

Drennan, Robert D.
1996 *Statistics for Archaeologists: A Commonsense Approach*. Plenum, New York.

Dyson-Hudson, Rada and Eric Alden Smith
1978 Human Territoriality. *American Anthropologist* 80(1):21-41.

Eco, Umberto
1979 *A Theory of Semiotics*. Indiana University Press, Bloomington.

1989 Introduction. In *The Meaning of Meaning*, 4th Edition, edited by C. K. Ogden and I. A. Richards, pp. v–xi. Harcourt, San Diego.

Edwards, Phillip C. (editor)
2013 *Wadi Hammeh 27, an Early Natufian Settlement at Pella in Jordan*. Brill, Leiden, the Netherlands.

Eisenberg-Degen, Davida and Steven A. Rosen
2013 Chronological Trends in Negev Rock Art: The Har Michia Petroglyphs as a Test Case. *Arts* 2(4):225-252.

Eriksson, Anders and Andrea Manica
2012 Effect of Ancient Population Structure on the Degree of Polymorphism Shared between Modern Human Populations and Ancient Hominins. *Proceedings of the National Academy of Sciences* 109(35):13956-13960.

2014 The Doubly Conditioned Frequency Spectrum Does Not Distinguish between Ancient Population Structure and Hybridization. *Molecular Biology and Evolution* 31(6):1618-1621.

Feathers, James
2015 Luminescence dating at Diepkloof Rock Shelter – new dates from single-grain quartz. *Journal of Archaeological Science* 63: 164-174.

Fetzer, James H.
1998 Other Animals with Minds. *Journal of Social & Evolutionary Systems* 21(2):233-237.

Finlayson, Clive, Kimberly Brown, Ruth Blasco, Jordi Rosell, Juan José Negro, Gary R. Bortolotti, Geraldine Finlayson, Antonio Sánchez Marco, Francisco Giles Pacheco, Joaquín Rodríguez Vidal, Jose´ S. Carrión, Darren A. Fal, and José M. Rodríguez Llanes
2012 Birds of a Feather: Neanderthal Exploitation of Raptors and Corvids. *PLoS ONE* 7(9): e45927. doi:10.1371/journal.pone.0045927.

Flynn, Bernard
2011 “Maurice Merleau-Ponty." In The Stanford Encyclopedia of Philosophy (Fall 2011 Edition), edited by Edward N. Zalta. Electronic document, http://plato.stanford.edu/archives/fall2011/entries/merleau-ponty, accessed January 23, 2016.

Foley, Robert and Marta Lahr
1997 Mode 3 Technologies and the Evolution of Modern Humans. *Cambridge Archaeological Journal* 7(1):3-36.

Foucault, Michel
1973[1969] *The Archaeology of Knowledge and Discourse on Language*. Pantheon, New York.

Fu, Qiaomei, Heng Li, Priya Moorjani, Flora Jay, Sergey M. Slepchenko, Aleksei A. Bondarev, Philip L. F. Johnson, Ayinuer Aximu-Petri, Kay Prüfer, Cesare de Filippo, Matthias Meyer, Nicolas Zwyns, Domingo C. Salazar-García, Yaroslav V. Kuzmin, Susan G. Keates, Pavel A. Kosintsev, Dmitry I. Razhev, Michael P. Richards, Nikolai V. Peristov, Michael Lachmann, Katerina Douka, Thomas F. G. Higham, Montgomery Slatkin, Jean-Jacques Hublin, David Reich, Janet Kelso, T. Bence Viola, and Svante Pääbo
2014 Genome Sequence of a 45,000-Year-old Modern Human from Western Siberia. *Nature* 514:445-449.

Gamble, Clive
1999 *The Palaeolithic Societies of Europe.* Cambridge University Press, Cambridge.

2003 Comments on The Origin of Modern Human Behaviour: Critique of the Models and Their Test Implications, by Christopher S. Henshilwood and Curtis W. Marean. *Current Anthropology* 44:627-651.

Garlake, Peter
2001 Sub-Saharan Africa. In *Handbook of Rock Art Research*, edited by David S. Whitley, pp. 637-664. Altamira Press, Walnut Creek, California.

Garrard, Andrew N., S. Colledge, R. Montague, and G. Hunt
1988 Environment and subsistence during the Late Pleistocene and Early Holocene in the Azraq Basin. *Paléorient* 14(2):40-49.

Garrod, Dorothy A.E. and Dorothea M.A Bate
1937 *The Stone Age of Mount Carmel Volume I: Excavations at the Wadi Mughara*. Clarendon Press, Oxford.

Gibson, Kathleen R.
1996 The Biocultural Human Brain, Seasonal Migrations, and the Emergence of the Upper Palaeolithic. In *Modeling the Human M*ind, edited by Paul Mellars and Kathleen Gibson, pp. 33–36. McDonald Institute for Archeological Research, Cambridge.

Gimbutas, Marija
2001 *The Language of the Goddess*. Thames & Hudson, London.

Glassie, Henry
1975 *Folk Housing in Middle Virginia*. University of Tennessee Press, Knoxville.

Goren-Inbar, Naama
2004 Culture and Cognition in the Acheulian Industry: A Case Study from Gesher Benot Ya'aqov. *Philosophical Transactions of the Royal Society B* 366 (1567):1038-1049.

Gotelli, Nicholas J. and Robert K. Colwell
2001 Quantifying Biodiversity: Procedures and Pitfalls in the Measurement and Comparison of Species Richness. *Ecology Letters* 4:379-391.

Green, Richard E., Richard E. Green, Johannes Krause, Adrian W. Briggs, Tomislav Maricic, Udo Stenzel, Martin Kircher, Nick Patterson, Heng Li, Weiwei Zhai, Markus Hsi-Yang Fritz, Nancy F. Hansen, Eric Y. Durand, Anna-Sapfo Malaspinas, Jeffrey D. Jensen, Tomas Marques-Bonet, Can Alkan, Kay Prüfer, Matthias Meyer, Hernán A. Burbano, Jeffrey M. Good, Rigo Schultz, Ayinuer Aximu-Petri, Anne Butthof, Barbara Höber, Barbara Höffner, Madlen Siegemund, Antje Weihmann, Chad Nusbaum, Eric S. Lander, Carsten Russ, Nathaniel Novod, Jason Affourtit, Michael Egholm, Christine Verna, Pavao Rudan, Dejana Brajkovic, Željko Kucan, Ivan Gušic, Vladimir B. Doronichev, Liubov V. Golovanova, Carles Lalueza-Fox, Marco de la Rasilla, Javier Fortea, Antonio Rosas, Ralf W. Schmitz, Philip L. F. Johnson, Evan E. Eichler, Daniel Falush, Ewan Birney, James C. Mullikin, Montgomery Slatkin, Rasmus Nielsen, Janet Kelso, Michael Lachmann, David Reich, and Svante Pääbo
2010 A Draft Sequence of the Neanderthal Genome. *Science* 328:710-722.

Greenfield, Patricia M., Heidi Lyn, and E. Sue Savage-Rumbaugh
2008 Protolanguage in Ontogeny and Phylogeny: Combining Deixis and Representation. *Interaction Studies* 9(1):34-50.

Hallin, Kristin A., Margaret J. Schoeninger, and Henry P. Schwarcz
2012 Paleoclimate During Neandertal and Anatomically Modern Human Occupation at Amud and Qafzeh, Israel: The Stable Isotope Data. *Journal of Human Evolution* 62(1):59-73.

Harpending, Henry C., Mark A. Batzer, Michael Gurven, Lynn B. Jorde, Alan R. Rogers, and Stephen T. Sherry
1998 Genetic Traces of Ancient Demography. *Proceedings of the National Academy of Sciences* 95:1961-1967.

Harpending, Henry and Alan Rogers
2000 Genetic Perspectives on Human Origins and Differentiation. *Annual Review of Genomics and Human Genetics* 1:361–385.

Hartshorne, Charles, Paul Weiss, and Arthur W. Burks (editors)
1932-1958 *The Collected Papers of Charles Sanders Peirce*. 8 vols. The Belknap Press, Cambridge, MA.

Hegmon, Michelle
1992 Archaeological Research on Style. *Annual Review in Anthropology* 21:517-536.

Henrich, Joseph
2004 Demography and Cultural Evolution: How Adaptive Cultural Processes can Produce Maladaptive Losses- The Tasmanian Case. *American Antiquity* 69(2):197-214.

Henry, Donald O.
1986 The Prehistory and Paleoenvironments of Jordan: An Overview. *Paléorient* 12(2): 5-26.

1994 Cultural Ecology in Southern Jordan. *Science* 265(5170): 336-331.

1995 Prehistoric Cultural Ecology and Evolution. Insights from Southern Jordon. Plenum Press, New York.

1988 The Epipaleolithic Sequence within the Ras En Naqb-El Quweira Area, Southern Jordan. *Paléorient* 14(2):245-256.

2012 The Palimpsest Problem, Hearth Pattern Analysis, and Middle Paleolithic Site Structure. *Quaternary International* 247: 246-266

Henshilwood, Christopher S.
2009 The Origins of Symbolism, Spirituality, and Shamans: Exploring Middle Stone Age Material Culture in South Africa. In *Becoming Human: Innovations in Prehistoric Material and Spiritual Culture*, edited by Colin Renfrew and Iain Morley, pp. 3-49. Cambridge University Press, Cambridge.

Henshilwood, Christopher, S. and Benoît Dubreuil
2011 The Still Bay and Howiesons Poort, 77-59 ka: Symbolic Material Culture and the Evolution of the Mind During the African MSA. *Current Anthropology* 52(3):361-400.

Henshilwood, Christopher S., Francesco d'Errico, Marian Vanhearen, Karen L. van Niekerk, and Zenobia Jacobs
2004 Middle Stone Age Shell Beads from South Africa. *Science* 304:404.

Henshilwood, Christopher S, Francesco d'Errico, Karen L. van Niekerk, Yvan Coquinot, Zenobia Jacobs, Stein-Erik Lauritzen, Michel Menu, and Renata García-Moreno
2011 A 100,000-Year-Old Ochre-Processing Workshop at Blombos Cave, South Africa. *Science* 334:219-222.

Henshilwood, Christopher S., Francesco d'Errico, and Ian Watts
2009 Engraved Ochres from the Middle Stone Age Levels at Blombos Cave, South Africa. *Journal of Human Evolution* 57:27-47.

Henshilwood, Christopher S., Francesco d'Errico, Royden Yates, Zenobia Jacobs, Chantal Tribolo, Geoff A. T. Duller, Norbert Mercier, Judith C. Sealy, Hélène Valladas, Ian Watts, and Ann G. Wintle
2002 Emergence of Modern Human Behavior: Middle Stone Age Engravings from South Africa. *Science* 295(5558):1278-1280.

Henshilwood, Christopher S. and Curtis S. Marean
2003 The Origin of Modern Human Behavior: Critique of the Models and Their Test Implications. *Current Anthropology* 44(5):627-651.

Higham, Tom, Katerina Douka, Rachel Wood, Christopher Bronk Ramsey, Fiona Brock, Laura Basell, Marta Camps, Alvaro Arrizabalaga, Javier Baena, Cecillio Barroso-Ruíz, Christopher Bergman, Coralie Boitard, Paolo Boscato, Miguel Caparrós, Nicholas J. Conard, Christelle Draily, Alain Froment, Bertila Galván, Paolo Gambassini, Alejandro Garcia-Moreno, Stefano Grimaldi, Paul Haesaerts, Brigitte Holt, Maria-Jose Iriarte-Chiapusso, Arthur Jelinek, Jesús F. Jordá Pardo, José-Manuel Maíllo-Fernández, Anat Marom, Julià Maroto, Mario Menéndez, Laure Metz, Eugène Morin, Adriana Moroni, Fabio Negrino, Eleni Panagopoulou, Marco Peresani, Stéphane Pirson, Marco de la Rasilla, Julien Riel-Salvatore, Annamaria Ronchitelli, David Santamaria, Patrick Semal, Ludovic Slimak, Joaquim Soler, Narcís Soler, Aritza Villaluenga, Ron Pinhasi, and Roger Jacobi

2014 The Timing and Spatiotemporal Patterning of Neanderthal Disappearance. *Nature* 512:306-309.

Hodder, Ian (editor)
1989 *The Meaning of Things: Material Culture and Symbolic Expression*. Unwin Hyman, London.

Hodder, Ian
1986 *Reading the Past.* Cambridge University Press, Cambridge.

Hodgson, Derek
2014 Decoding the Blombos Enngravings, Shell Beads and Diepkloof Ostrich Eggshell Patterns. *Cambridge Archaeological Journal* 24(1):57-69.

Hoopes, James
1991 Introduction. In *Peirce on Signs: Writings on Semiotics*, edited by James Hoopes, pp.1-13. University of North Carolina Press, Chapel Hill.

Hoopes, James (editor)
1991 *Peirce on Signs: Writings on Semiotics*. University of North Carolina Press, Chapel Hill.

Hortal, Joaquín, Paulo A.V. Borges, and Clara Gaspar
2006 Evaluating Performance of Species Richness Estimators: Sensitivity to Sample Grain Size. *Journal of Animal Ecology* 75(1):274-287.

Houser, Nathan and Christian J.W. Kloesel (editors)
1992 *Essential Peirce: Selected Philosophical Writings, Volume I (1867-1893)*. Indiana University Press, Bloomington.

Hovers, Erella
2009 *The Lithic Assemblages of Qafzeh Cave.* Oxford University Press, Oxford.

Hovers, Erella, Bernard Vandermeersch, and Ofer Bar-Yosef
1997 A Middle Paleolithic Engraved Artefact from Qafzeh Cave, Israel. *Rock Art Research* 14: 79-87.

Ingman, Max H., Henrik Kaessmann, Svante Pääbo, and Ulf Gyllensten
2000 Mitochondrial Genome Variation and the Origin of Modern Humans. *Nature* 408:708-713.

Jacobs, Zenobia, Richard G. Roberts, Rex F. Galbraith, Hilary J. Deacon, Rainer Grün, Alex Mackay, Peter Mitchell, Ralf Vogelsang, Lyn Wadley
2008 Ages for the Middle Stone Age of Southern Africa: Implications for Human Behavior and Dispersal. *Science* 32:733-735.

Jacobs, Zenobia and Richard G. Roberts
2015 An improved single grain OSL chronology for the sedimentary deposits from Diepkloof Rockshelter, Western Cape, South Africa. *Journal of Archaeological Science* 63:175-192.

Janik, Vincent M., L. S. Sayigh, and R. Spencer Wells
2006 Signature Whistle Shape Conveys Identity Information to Bottlenose Dolphins. *Proceedings of the National Academy of Sciences* 103(21):8293-8297.

Jolly, Alison
1999 Primate Communication, Lies and Ideas. In *Handbook of Symbolic Evolution*, edited by Andrew Lock and Charles R. Peters, pp.167-177. Blackwell, London.

Jones, Matthew D., Lisa A Maher, Danielle A. Macdonald, Conor Ryan, Claire Rambeau, Stuart Black, and Tobias Richter,
2015 The Environmental Setting of Epipalaeolithic Aggregation Site Kharaneh IV. *QuaternaryInternational* doi:10.1016/j.quaint.2015.08.092.

Joordens, Josephine C.A., Francesco d'Errico, Frank P. Wesselingh, Stephen Munro, John de Vos, Jakob Wallinga, Christina Ankjærgaard, Tony Reimann, Jan R. Wijbrans, Klaudia F. Kuiper, Herman J. Mücher, Hélène Coqueugniot, Vincent Prié, Ineke Joosten, Bertil van Os, Anne S. Schulp, Michel Panuel, Victoria van der Haas, Wim Lustenhouwer, John J. G. Reijmer and Wil Roebroeks
2015 *Homo erectus* at Trinil on Java Used Shells for Tool Production and Engraving. *Nature* 518:228-231.

Ketner, Kenneth Laine
1988 A Comprehensive Bibliography of The Published Works of Charles Sanders Peirce with A Bibliography of Secondary Studies, second, revised edition. Bowling Green State University, Ohio.

Kintigh, Keith
1984 Measuring Archaeological Diversity y Comparison with Simulated Assemblages. *American Antiquity* 49:44-54.

Klein, Richard G.
2000 Archeology and the Evolution of Human Behavior. *Evolutionary Anthropology* 9:17-36.

2009[1989] *The Human Career: Human Biological and Cultural Origins*. University of Chicago Press, Chicago.

Laerd Statistics
2016 Kruskal-Wallis H Test Using SPSS Statistics. Electronic document. https://statistics.laerd.com/spss-tutorials/kruskal-wallis-h-test-using-spss-statistics.php. Accessed June 25, 2016.

Langley, Michelle C., Christopher Clarkson, and Sean Ulm
2008 Behavioural Complexity in Eurasian Neanderthal Populations: A Chronological Examination of the Archaeological Evidence. *Cambridge Archaeological Journal* 18:289-307. doi:10.1017/S0959774308000371.

Laville H., J. Rigaud, and J. Sackett
1980 *Rock Shelters of the Périgord*. Academic Press, New York.

Lehrer, Keith
1990 *Metamind.* Oxford University Press, Oxford.

Leroi-Gourhan, Andre
1965 Treasures of Paleolithic Art. Abrams, New York.

Lévi-Strauss, Claude
1969 The Raw and the Cooked: Introduction to a Science of Mythology, Volume 1. Translated by John and Doreen Weightman. Harper and Row, New York.

Lewis-Williams, J. David
1972 The Syntax and Function of the Giant's Castle Rock Paintings. *South African Archaeological Bulletin* 27:49-65.

Lewis-Williams, J. David and Thomas Dowson
1989 Images of Power. Understanding Bushman Rock Art. Southern Book Publishers, Johannesburg.

Lewis-Williams, J. David and Thomas A. Dowson
1992 *Rock Paintings of the Natal Drakensberg*. Ukhahlamba Series No. 5. University of Natal Press, Pietermaritzburg.

Lisiecki, Lorraine E. and Maureen E. Raymo
2005 A Pliocene-Pleistocene Stack of 57 Globally Distributed Benthic δ18O Records. *Paleoceanography* 20(1): doi:10.1029/2004PA001071.

Locke, John
1993 [1690] *An Essay Concerning Human Understanding*. Edited by J.W. Yolton. Everyman Library, London.

Macumber, Phillip G.
1992 The Geological Setting of Palaeolithic Sites at Tabaqat Fahl, Jordan. *Paléorient* 18(2):31-44.

Madden, Joah R.
2003 Male Spotted Bowerbirds Preferentially Choose, Arrange and Proffer Objects That Are Good Predictors of Mating Success. *Behavioral Ecology and Sociobiology* 53:263–268.

2008 Do Bowerbirds Exhibit Cultures? *Animal Cognition* 11(1):1-12.

Marshack, Alexander
1972 *The Roots of Civilization: the Cognitive Beginning of Man's First Art, Symbol and Notation*. McGraw-Hill, New York.

Mazel, Aron
2009 Images in Time: Advances In The Dating Of Maloti-Drakensber Rock Art Since The 1970s. In *The Elands's People. New Perspectives in the Rock Art of the Maloti-Drakensberg Bushman. Essays in Memory of Patricia Vinnicombe*, edited by Peter Mitchell and Benjamin Smith, pp. 81-97. Wits University Press, Johannesburg.

McBrearty, Sally and Alison S. Brooks
2000 The Revolution that Wasn't: A New Interpretation of the Origin of Modern Human Behavior. *Journal of Human Evolution* 39:453-563.

McPherron, Shannon P., Sahra Talamo, Paul Goldberg, Laura Niven, Dennis Sandgathe, Michael P. Richards, Daniel Richter, Alain Turq, Harold L. Dibble
2012 Radiocarbon Dates for the Late Middle Palaeolithic at Pech de l'Azé IV, France. *Journal of Archaeological Science* 39:3436-3442.

Meier-Oeser, Stephan
2011 "Medieval Semiotics." In The Stanford Encyclopedia of Philosophy (Summer 2011 Edition), edited by Edward N. Zalta. Electronic document, http://plato.stanford.edu/archives/sum2011/entries/semiotics-medieval, accessed April 30, 2014.

Mellars, Paul A.
1989 Major Issues in the Emergence of Modern Humans. *Current anthropology* 30(3): 349-385.

1992 Archaeology and the Population-dispersal Hypothesis of Modern Human Origins in Europe. *Philosophical Transactions of the Royal Society of London B: Biological Sciences* 337(1280): 225-234.

2005 The Impossible Coincidence: A Single-species Model for the Origins of Modern Human Behavior in Europe. *Evolutionary Anthropology* 14:12-27.

2006 Why did Modern Human Populations Disperse from Africa ca 60,000 years ago? A New Model. *Proceedings of the National Academy of Sciences* 103(25):9381-9386.

Mellars, Paul and Christopher Stringer (editors)
1989 *The Human Revolution: Behavioural and Biological Perspectives on the Origins of Modern Humans.* Edinburgh University Press, Edinburgh.

Mertz, Elizabeth and Richard J. Parmentier (editors)
1985 *Semiotic Mediation: Sociocultural and Psychological Perspectives*. Academic Press, Orlando, Florida.

Meyer, Matthias, Martin Kircher, Marie-Theres Gansauge, Heng Li, Fernando Racimo, Swapan Mallick, Joshua G. Schraiber, Flora Jay, Kay Prüfer, Cesare de Filippo, Peter H. Sudmant, Can Alkan, Qiaomei Fu, Ron Do, Nadin Rohland, Arti Tandon, Michael Siebauer, Richard E. Green, Katarzyna Bryc, Adrian W. Briggs, Udo Stenzel, Jesse Dabney, Jay Shendure, Jacob Kitzman, Michael F. Hammer, Michael V. Shunkov, Anatoli P. Derevianko, Nick Patterson, Aida M. Andrés, Evan E. Eichler, Montgomery Slatkin, David Reich, Janet Kelso, and Svante Pääbo
2012 A High-Coverage Genome Sequence from an Archaic Denisovan Individual. *Science* 338 (6104):222-226.

Mithen, Steven J.
1996 The Prehistory of the Mind: The Cognitive Origins of Art, Religion and Science. Thames and Hudson, Ltd., London.

Moncel, Marie-Hélène, L. Chiotti, Claire Gaillard, Gérard Onoratini, and David Pleurdeau
2012 Non-utilitarian lithic objects from the European Paleolithic. *Archaeology, Ethnology and Anthropology of Eurasia*, *40*(1): 24-40.

Movius Jr., Hallam L.
1977 Excavation of the Abri Pataud, Les Eyzies (Dordogne). Stratigraphy. *American School of Prehistoric Research Bulletin* 31:1-167.

Nagel, Ernest
1982 Peirce's Place in Philosophy. *Historia Mathematica* 9:302-310.

Newton, Adrian C.
1999 *Forest Ecology and Preservation: A Handbook of Techniques*. Oxford University Press, Oxford.

Noble, William and Iain Davidson
1993 Tracing the Emergence of Modern Human Behavior: Methodological Pitfalls and A Theoretical Path. *Journal of Anthropological Archaeology* 12:121-149.

1996 Human Evolution, Language and Mind. A Psychological and Archaeological Inquiry. Cambridge University Press, Cambridge.

Nöth, Winfried
1990 *Handbook of Semiotics.* Indiana University Press, Bloomington.

Nowell, April
2010 Defining Behavioral Modernity in the Context of Neandertal and Anatomically Modern Human Populations. *Annual Review of Anthropology* 39:437-452.

Jari Oksanen and Robert O'Hara
2016 "Ecological Diversity Indices." In R Documentation. RStudio Vegan 2.4. Accessed July 26, 2016.

Otárola-Castillo, Erik, Benjamin J. Schoville, and Janni Pedersen
2009 Pleistocene Ochre Engravings are not Evidence of the Origins of Modern Human Behavior. Unpublished manuscript on file at the Ecology and Evolutionary Biology Program, Iowa State University.

Parmentier, Richard J.
1997 The Pragmatic Semiotics of Culture. *Semiotica* 116:1-115.

Peirce, Charles Sanders
1878a *Charles S. Peirce: Essays in the Philosophy of Science*. Edited by V. Thomas. Liberal Arts, New York.

1878b Photometric Researches Made in the Years 1872–1875. *Annals of the Astronomical Observatory of Harvard College Volume 9.* Harvard College Observatory, Cambridge, Massachusetts.

1879 A Quincuncial Projection of the Sphere. *American Journal of Mathematics* 2(4):394–397.

1905 What Pragmatism Is. *The Monist* 15:161–181.

1960[1931] The Collected Papers of Charles Sanders Peirce: Volumes I & II. Edited by Charles Hartshorne and Paul Weiss. The Belknap Press of Harvard University Press, Cambridge.

1991 *Peirce on Signs: Writings on Semiotics*, edited by James Hoopes. University of North Carolina Press, Chapel Hill.

Peirce Edition Project (editors)
1982-2000 Writings of Charles S. Peirce: A Chronological Edition. 8 vols. Indiana University Press, Bloomington.

1998 Essential Peirce: Selected Philosophical Writings, Volume II (1893-1913). Indiana University Press, Bloomington.

2015 The Peirce Edition Project. Electronic document, http://www.peirce.iupui.edu/edition.html, accessed September 3, 2015.

1982 Writings of Charles S. Peirce: A Chronological Edition. Volume 1: 1857–1866. Indiana University Press, Bloomington.

1984 Writings of Charles S. Peirce: A Chronological Edition. Volume 2: 1867–1871. Indiana University Press, Bloomington.

1986 Writings of Charles S. Peirce: A Chronological Edition. Volume 3: 1872–1878. Indiana University Press, Bloomington.

1988 Writings of Charles S. Peirce: A Chronological Edition. Volume 4: 1879–1884. Indiana University Press, Bloomington.

1993 Writings of Charles S. Peirce: A Chronological Edition. Volume 5: 1884–1886. Indiana University Press, Bloomington.

2000 Writings of Charles S. Peirce: A Chronological Edition. Volume 6: 1886–1890. Indiana University Press, Bloomington.

Peresani, Marco, Ivana Fiore, Monica Gala, Matteo Romandini, and Antonio Tagliacozzo
2011 Late Neandertals and the intentional removal of feathers as evidenced from bird bone taphonomy at Fumane Cave 44 ky BP, Italy. *Proceedings of the National Academy of Sciences* 108(10): 3888-3893.

Peresani, Marco, Marian Vanhaeren, Ermanno Quaggiotto, Alain Queffelec, Francesco d'Errico
2013 An Ochered Fossil Marine Shell From the Mousterian of Fumane Cave, Italy. *PLoS ONE* 8(7): e68572. doi:10.1371/journal.pone.0068572.

Pettitt, Paul and Alistair Pike
2007 Dating European Palaeolithic Cave Art: Progress, Prospects, Problems. *Journal of Archaeological Method and Theory*. 14(1):27-47.

Peyrony, Denis
1926 Fouille de La Madeleine. In *Carnet de Fouilles D. Peyrony*, pp. 110-112. Archives du Musée National de Préhistoire, Les Eyzies-de-Tayac, France.

Phillips, James L. and Bruce G. Gladfelter
1989 A Survey in the Upper Wadi Feiran Basin, Southern Sinai. *Paléorient* 15(2):113-122.

Pinkett, Suzie and Steven Mithen
2007 Rock Art of WF400, Wadi Ghuwayr. In *The Early Prehistory of Wadi Faynan, Southern Jordan: Archaeological Survey of Wadis Faynan, Ghuwayr and al-Bustan*

and Evaluation of the Pre-Pottery Neoloithic A Site of WF16, edited by Bill Finlayson and Steven Mithen. Oxbow Books, London.

Popper, Karl R.
1972 *Objective Knowledge: An Evolutionary Approach*. Clarendon Press, Oxford.

Powell, Adam, Stephen Shennan, Mark G. Thomas
2009 Late Pleistocene Demography and the Appearance of Modern Human Behavior. *Science* 324:1298-1301.

Preucel, Robert W.
2006 *Archaeological Semiotics*. Blackwell Publishing, Oxford.

Preuschoft, Signe and Holger Preuschoft
1994 Primate Non-verbal Communication: Our Communication Heritage. In *Origins of Semiosis: Sign Evolution in Nature and Culture*, edited by Winfried Nöth, pp.61-100. Mouton de Gruyter, Berlin.

Prüfer, Kay, Fernando Racimo, Nick Patterson, Flora Jay, Sriram Sankararaman, Susanna Sawyer, Anja Heinze, Gabriel Renaud, Peter H. Sudmant, Cesare de Filippo, Heng Li, Swapan Mallick, Michael Dannemann, Qiaomei Fu, Martin Kircher, Martin Kuhlwilm, Michael Lachmann, Matthias Meyer, Matthias Ongyerth, Michael Siebauer, Christoph Theunert, Arti Tandon, Priya Moorjani, Joseph Pickrell, James C. Mullikin, Samuel H. Vohr, Richard E. Green, Ines Hellmann, Philip L. F. Johnson, Hélène Blanche, Howard Cann, Jacob O. Kitzman, Jay Shendure, Evan E. Eichler, Ed S. Lein, Trygve E. Bakken, Liubov V. Golovanova, Vladimir B. Doronichev, Michael V. Shunkov, Anatoli P. Derevianko, Bence Viola, Montgomery Slatkin, David Reich, Janet Kelso, and Svante Pääbo
2014 The Complete Genome Sequence of a Neanderthal from the Altai Mountains. *Nature* 505:43–49.

Quiles, Anita, Hélène Valladas, Hervé Bocherens, Emmanuelle Delqué-Količ, Evelyne Kaltnecker, Johannes van der Plicht, Jean-Jacques Delannoy, Valérie Feruglio, Carole Fritz, Julien Monney, Michel Philippe, Gilles Tosello, Jean Clottes, and Jean-Michel Geneste
2016 A high-precision chronological model for the decorated Upper Paleolithic cave of Chauvet-Pont d'Arc, Ardèche, France. *Proceedings of the National Academy of Sciences*, *113*(17), pp.4670-4675.

Radovčić, Davorka, Ankica Oros Sršen, Jakov Radovčić,and David W. Frayer
2015 Evidence for Neandertal Jewelry: Modified White-Tailed Eagle Claws at Krapina. *PloS ONE* 10(3):e0119802. doi:10.1371/journal. pone.0119802

Raymondo, James C.
1999 *Statistical Analysis in the Behavioral Sciences*. McGraw Hill College, Boston.

Rech, Jason A., Jeffrey S. Pigati, Mustafa Al Kuisi, and Jordon Bright
2013 The Rise and Fall of Late Pleistocene Paleolakes in Southern Jordan. Paper. *Geological Society of America Annual Meeting.* Denver, Colorado.

Reese, D. S.
1991 Marine Shells in the Levant Upper Palaeolilhic, Epipalaeolithic and Neolithic. In *The Natufian Culture in the Levant*, edited by O. Bar-Yosef and F. R. Valla, pp. 613-628. International Monographs in Prehistory, Ann Arbor.

Reich, David, Richard E. Green, Martin Kircher, Johannes Krause, Nick Patterson, Eric Y. Durand, Bence Viola, Adrian W. Briggs, Udo Stenzel, Philip L. F. Johnson, Tomislav Maricic, Jeffrey M. Good, Tomas Marques-Bonet, Can Alkan, Qiaomei Fu, Swapan Mallick, Heng Li, Matthias Meyer, Evan E. Eichler, Mark Stoneking, Michael Richards, Sahra Talamo, Michael V. Shunkov, Anatoli P. Derevianko, Jean-Jacques Hublin, Janet Kelso, Montgomery Slatkin, and Svante Pääbo
2010 Genetic History of an Archaic Hominin Group from Denisova Cave in Siberia. *Nature* 468:1053–1060.

Renfrew, Colin
1994 Towards a Cognitive Archaeology. In *The Ancient Mind: Elements of Cognitive Archaeology,* edited by Colin Renfrew and Ezra B. W. Zubrow, pp.3-12. Cambridge University Press, Cambridge.

Richter, Tobias, Andrew N. Garrard, Samantha Allock and Lisa A. Maher
2011 Interaction Before Agriculture: Exchanging Material and Sharing Knowledge in the Final Pleistocene Levant. *Cambridge Archaeological Journal* 21:95-114.

Richter, Tobias., Lisa A. Maher, Andrew N. Garrard, Kevan Edinborough, Matthew D. Jones, and Jay T. Stock
2013 Epipalaeolithic Settlement Dynamics in Southwest Asia: New Radiocarbon Evidence from the Azraq Basin. *Journal of Quaternary Science* 28(5):467-479.

Richerson, Peter J. and Robert Boyd
2000 Climate, Culture, and the Evolution of Cognition. In *Evolution of Cognition,* edited by Cecelia Heyes and Ludwig Huber, pp. 329-346. MIT Press, Cambridge.

Riel-Salvatore, Julien and Geoffrey A. Clark
2001 Grave Markers: Middle and Early Upper Paleolithic Burials and the use of Chronotypology in Contemporary Paleolithic Research. *Current Anthropology* 42(4):449- 479.

Rifkin, Riaan F., Christopher.S. Henshilwood, and Magnus M. Haaland
2015 Pleistocene Figurative 'Art Mobilier' From Apollo 11 Cave, Karas Region, Southern Namibia. *South African Archaeological Bulletin* 70(201):113-123.

Romandini, Matteo, Marco Peresani, Véronique Laroulandie, Laure Metz, Andreas Pastoors, Manuel Vaquero, and Ludovic Slimak
2014 Convergent Evidence of Eagle Talons Used by Late Neanderthals in Europe: A Further Assessment on Symbolism. *PLOS ONE* 9(7):1-11.

Russell, Bertrand
1959 *Wisdom of the West*. Garden City. Doubleday, New York.

Sankararaman, Sriram, Nick Patterson, Heng Li, Svante Pääbo, David Reich
2012 The Date of Interbreeding between Neandertals and Modern Humans. *PLoS Genetics* 8(10):e1002947. doi:10.1371/journal.pgen.1002947.

Saussure, Ferdinand de
1916 *Cours de Linguistique Générale.* Edited by C. Bally and A. Sechehaye. Payot, Paris.

1966[1959] *Course in General Linguistics*, edited and translated by W. Baskin. McGraw-Hill, New York.

1993 Troisième Cours de Linguistique Générale/Third Course of Lectures on General *Lingustics (1910–1911)*. Translated and edited by E. Komatsu and R. Harris. Pergamon, Oxford.

1996 Premier Cours de Linguistique Générale/First Course of Lectures on General *Lingustics (1907)*. Translated and edited by E. Komatsu and G. Wolf. Pergamon, Oxford.

1997 Deuxième Cours de Linguistique Générale/Second Course of Lectures on General *Lingustics (1908-1909)*. Translated and edited by E. Komatsu and G. Wolf. Pergamon, Oxford.

Savage-Rumbaugh and Roger Lewin
1994 Kanzi: The Ape at the Brink of the Human Mind. Doubleday, New York.

Sealy, Judith, Tim Maggs, Antonieta Jerardino and Jonathan Kaplan
2004 Excavations at Melkbosstrand: Variability among Herder Sites on Table Bay, South Africa. *The South African Archaeological Bulletin* 59(179):17-28.
Sebeok, Thomas A.
1979a Semiosis in Nature and Culture. In *The Sign and Its Masters.* University Press of America, Lanham, Maryland.

1979b *The Sign and Its Masters.* University Press of America, Lanham, Maryland.

1991 *A Sign is Just a Sign*. Indiana University Press, Bloomington.

Seguin-Orlando, Andaine, Thorfinn S. Korneliussen, Martin Sikora, Anna-Sapfo Malaspinas, Andrea Manica, Ida Moltke, Anders Albrechtsen, Amy Ko, Ashot Margaryan, Vyacheslav Moiseyev, Ted Goebel, Michael Westaway, David Lambert, Valeri Khartanovich, Jeffrey D. Wall, Philip R. Nigst, Robert A. Foley, Marta Mirazon Lahr, Rasmus Nielsen, Ludovic Orlando, and Eske Willerslev
2014 Genomic Structure in Europeans Dating Back at Least 36,200 Years. *Science* 346(6213): 1113-1118.

Seuss, Dr.
1957 *The Cat in the Hat*. Houghton Mifflin.

Seyfarth, Robert M. and Dorothy L. Cheney
1990 The Assessment by Vervet Monkeys of Their Own and Another Species' Alarm Calls. *Animal Behaviour* 40:754-764.

Shanks, Michael and Christopher Tilley
1987 *Social Theory and Archaeology*. Polity Press, Cambridge.

Shea, John J.
2003 Neandertals, Competition, and the Origin of Modern Human Behaviour in the Levant. *Evolutionary Anthropology* 12:173–87.

2011a *Homo sapiens* Is as *Homos sapiens* Was: Behavioral Variability versus “Behavioral Modernity” in Paleolithic Archaeology. *Current Anthropology* 52(1):1-35.

2011b Refuting a Myth about Human Origins. *American Scientist* 99:127-135.

Shennan, Stephen J.
2001 Demography and Cultural Innovation: A Model and Some Implications for the Emergence of Modern Human Culture. *Cambridge Archaeology Journal* 11: 5–16.

Short, T. L.
2007 *Peirce's Theory of Signs*. Cambridge University Press, Cambridge.

Sisk, Matthew L.
2011 Settlement and Site Location in the Middle and Upper Paleolithic of the Vézère Valley,France. Unpublished Ph.D. dissertation, Department of Anthropology, Stony Brook University, New York.

Simpson, Edward H.
1949 Measurement of Diversity. *Nature* 163: 688.

Sommer, Robert S. and Adam Nadachowski
2006 Glacial Refugia of Mammals in Europe: Evidence from Fossil Records. *Mammal Review* 36(4): 251-265.

Soressi, Marie and Francesco d'Errico
2007 Pigments, Gravures, Parures: Les Comportements Symboliques Controversés des Néandertaliens. In *Les Néandertaliens: Biologie et Cultures,* Documents Préhistoriques 23, edited by B. Vandermeersch and B. Maureille, pp. 297-309. C.T.H.S., Paris.

Soressi Marie, et al.
2008 The Paleolithic societies in the vast southwestern France:New sites, new results, new methods (Translated from French).In *Société Préhistorique Française, Mémoire XLVII,* edited by J. Jaubert, J.-G. Bordes,and I. Ortega, pp. 95-132. Joué-Lès-Tours, France.

Smith, Eric P. and Gerald van Belle
1984 Nonparametric Estimation of Species Richness. *Biometrics* 40:119-129.

Sperber, Dan
1975 *Rethinking Symbolism*. Translated by Alice L. Morton. Cambridge University Press, Cambridge.

Sperber, Dan (editor)
2000 *Metarepresentations: A Multidisciplinary Perspectiv*e. Oxford University Press, Oxford.

Speth, John
2014 News Flash: Negative Evidence Convicts Neanderthals of Gross Mental Incompetence. *World Archaeology* 36(4):519-526.

Stoler, Ann
1989 Rethinking Colonial Categories: European Communities and the Boundaries of Rule. *Comparative Studies in Society and History* 31(1):134-161.

Stiner, Mary C.
2003 Standardization in Upper Paleolithic Ornaments at the Coastal Sites of Riparo Mochi and Ucagizli Cave. In *The Chronology of the Aurignacian and the Transitional Technocomplexes: Dating, Stratigraphies, Cultural Implications, Trabalhos de Arqueologia, No. 33.,* edited by J. Zilhao, J. and F. d'Errico, pp. 49-59. Istituto Protugues de Arqueologia, Lisbon.

Stringer, Christopher B.
2002 Modern Human Origins: Progress and Prospects. *Philosophical Transactions of the Royal Society of London*, Series B 357:563-579.

Takhtajan, Armen
1986 *Floristic Regions of the World*. Translated by T.J. Crovello and A. Cronquist. University of California Press, Berkeley.

Texier, Pierre-Jean, Guillaume Porraz, John Parkington, Jean-Philippe Rigaud, Cedric Poggenpoel, Christopher Miller, Chantal Tribolo, Caroline Cartwright, Aude Coudenneau, Richard Klein, Teresa Steele, and Christine Verna
2010 A Howiesons Poort Tradition of Engraving Ostrich Eggshell Containers Dated to 60,000 Years Ago at Diepkloof Rock Shelter, South Africa. *Proceedings of the National Academy of Sciences*107(14):6180-6185.

Thieme, Hartmut
1997 Lower Palaeolithic Hunting Spears from Germany. *Nature* 385:807-810. doi:10.1038/385807a0.

Tilley, Christopher
1991 *Material Culture and Text: The Art of Ambiguity*. Routledge, London.

Tomasello, Michael
2000 *The Cultural Origins of Human Cognition.* Harvard University Press, Cambridge.

Tostevin, Gilbert B.
2007 Social Intimacy, Artefact Visibility, and Acculturation Models of Neanderthal-Modern Human Interaction. *Rethinking the Human Revolution: New Behavioural and Biological Perspectives on the Origins and Dispersal of Modern Humans*: 341-357.

Tribolo, Chantal, Norbert Mercier, Hélène Valladas, J. L. Joron, Pierre Guibert, Y. Lefrais, M. Selo, Pierre-Jean Texier, Jean-Philipe Rigaud, Guillaume Porraz, Cedrik Poggenpoel, John Parkington, J-P. Texier, and Arnaud Lenoble.
2009 Thermolulminescence dating of a Stillbay-Howiesons Poort sequence at Diepkloof Rock Shelter (Western Cape, South Africa). *Journal of Archaeological Science* 36: 730-739.

Tribolo, Chantal, Norbert Mercier, Eric Douville, J.-L. Joron, J.-L. Reyss, Daniel Rufer, N. Cantin, Y. Lefrais, C.E. Miller, Guillaume Porraz, John Parkington, Jean-Philipe. Rigaud, and Pierre-Jean Texier
2013 OSL and TL dating of the Middle Stone Age sequence at Diepkloof Rock Shelter (South Africa): A clarification. *Journal of Archaeological Science* 40(9): 3401-3411.

Turner, Victor
1967 *The Forest of Symbols: Aspects of Ndembu Ritual*. Cornell University Press, Ithaca, New York.

Turville-Petre Francis
1932 Excavations in the Mugharet el Kebarah. *Journal of the Royal Anthropological Institute* 62:271-276.

Uexküll, Jakob von
1982 The Theory of Meaning. *Semiotica* 42:1-87.

Uexküll, Thure von
1987 Sign Theory of Jakob von Uexküll. In *Classics of Semiotics,* edited by Martin Krampen, Klaus Oehler, Roland Posner, Thomas A. Sebeok, and Thure von Uexküll, pp.147-179. Plenum Press, New York.

UNESCO
2009 Prehistoric Sites and Decorated Caves of the Vézère Valley. Electronic document, http://whc.unesco.org/en/list/85, accessed April 15, 2016.

Valladas, Hélène, Nadine Tisnérat-Laborde, Hélène Cachier, Maurice Arnold, Federico Bernaldo de Quirós,Victoria Cabrera-Valdés, Jean Clottes, Jean Courtin, J. J. Fortea-Pérez, C. Gonzáles-Sainz, A. Moure-Romanillo
2001 Radiocarbon AMS Dates for Paleolithic Cave Paintings. *Radiocarbon* 43(2B):977-986.

Vogelsang, Ralf, Jürgen Richter, Zenobia Jacobs, Barbara Eichhorn, Veerle Linseele, and Richard G. Roberts
2010 New Excavations of Middle Stone Age Deposits at Apollo 11 Rockshelter, Namibia: Stratigraphy, Archaeology, Chronology and Past Environments. *Journal of African Archaeology* 8(2):185-218.

Wadley, Lyn
2001 What is Cultural Modernity? A General View and a South African Perspective from Rose Cottage Cave. *Cambridge Archaeological Journal* 11(02): 201-221.

2013 Recognizing Complex Cognition through Innovative Technology in Stone Age and Palaeolithic Sites. *Cambridge Archaeological Journal* 23:163-183.

Walker, N.J.
1987 The Dating of Zimbabwean Rock Art. *Rock Art Research* 4:137-149.

Watts, Ian,
2010 The Pigments from Pinnacle Point Cave 13B, Western Cape, South Africa. *Journal of Human Evolution* 59(3): 392-411.

Weissbrod, Lior. and Yossi Zaidner
2014 Taphonomy and Paleoecological Implications of Fossorial Microvertebrates at the Middle Paleolithic Open-air site of Nesher Ramla, Israel. *Quaternary International* 331:115-127.

Wendt, W.E.
1976 Art Mobilier from the Apollo 11 Cave, South West Africa: Africa's Oldest Dated Works of Art. *African Archaeological Bulletin* 31:5-11.

White, Randall
1985 *Upper Paleolithic Land Use in the Perigord: A Topographic Approach to Subsistence and Settlement*. British Archaeological Reports International Series, Oxford.

2001 Personal Ornaments from the Grotte du Renne at Arcy-sur-Cure. *Athena Review* 2:41-46.

Whitley, David S.
1993 The Raw and the Half-Baked: Structuralism and Archaeological Interpretation. *Cambridge Archaeological Journal* 3(1):118-121.

Wiessner, Polly
1983 Style and Social Information in Kalahari San Projectile Points. *American Antiquity* 48(2):253-276.

1985 Style or Isochrestic Variation? A Reply to Sackett. *American Antiquity* 50(1):160-166.

1989 Style and Changing Relations Between the Individual and Society. In *The Meaning of Things: Material Culture and Symbolic Expression*, edited by Ian Hodder, pp. 56-63. University of Cambridge Press, Cambridge.

1990 Is There a Unity to Style? In *The Uses of Style in Archaeology*, edited by Margaret W. Conkey and Christine Hastorf, pp.105-112. Cambridge University Press, Cambridge.

Wilson, Robert A.
2000 The Mind Beyond Itself. In *Metarepresentation: A Multidisciplinary Perspective, Vancouver Studies in Cognitive Sciences 10*, edited by Daniel Sperber, pp.31-52. Oxford University Press, Oxford.

Wobst, Martin
1977 Stylistic Behavior and Information Exchange. In *For the Director: Research Essays in Honor of James B. Griffin*, edited by C.E. Cleland, pp. 317-342. Ann Arbor Museum of Anthropology Papers, No. 61. Ann Arbor Museum, Ann Arbor.

Wreschner, Ernst E.
1971 Prehistoric Rock-Engravings in Naḥal ha-Me'arot, Mount Carmel. *Israel Exploration Journal* 21(4):217-218.

Wynn, Thomas and Frederick L. Coolidge (editors)
2010 Working Memory: Beyond Language and Symbolism. *Current Anthropology* 51(S1). University of Chicago Press, Chicago.

Zaidner, Yossi, Amos Frumkin, Naomi Porat ,Alexander Tsatskin, Reuven Yeshurun, and Lior Weissbrod
2014 A Series of Mousterian Occupations in a New Type of Site: The Nesher Ramla Karst Depression, Israel. *Journal of Human Evolution* 66: 1-17.

APPENDIX A

AFRICAN ASSEMBLAGES BY CODE

[CONSULT ATTACHED FILES]

APPENDIX B

CLASS FREQUENCIES IN THE AFRICAN DATASET BY TIME PERIOD

[CONSULT ATTACHED FILES]

APPENDIX C

CLASS MEMBER FREQUENCIES IN THE AFRICAN DATASET

BY TIME PERIOD: ASSERTIVE ARTIFACTS

[CONSULT ATTACHED FILES]

APPENDIX D

CLASS MEMBER FREQUENCIES IN THE AFRICAN DATASET

BY TIME PERIOD: EXTRA-ASSERTIVE ARTIFACTS

[CONSULT ATTACHED FILES]

APPENDIX E

LEVANTINE ASSEMBLAGES BY CODE

[CONSULT ATTACHED FILES]

APPENDIX F

CLASS FREQUENCIES IN THE LEVANTINE DATASET BY TIME PERIOD

[CONSULT ATTACHED FILES]

APPENDIX G

CLASS MEMBER FREQUENCIES IN THE LEVANTINE DATASET BY TIME PERIOD: ASSERTIVE ARTIFACTS

[CONSULT ATTACHED FILES]

APPENDIX H

CLASS MEMBER FREQUENCIES IN THE LEVANTINE DATASET

BY TIME PERIOD: EXTRA ASSERTIVE ARTIFACTS

[CONSULT ATTACHED FILES]

APPENDIX I

CLASS MEMBER FREQUENCIES IN THE LEVANTINE DATASET

BY TIME PERIOD: EMBLEMIC ARTIFACTS

[CONSULT ATTACHED FILES]

APPENDIX J

EUROPEAN ASSEMBLAGES BY CODE

[CONSULT ATTACHED FILES]

APPENDIX K

CLASS FREQUENCIES IN THE EUROPEAN DATASET BY TIME PERIOD

[CONSULT ATTACHED FILES]

APPENDIX L

CLASS MEMBER FREQUENCIES IN THE EUROPEAN DATASET

BY TIME PERIOD: ASSERTIVE ARTIFACTS

[CONSULT ATTACHED FILES]

APPENDIX M

CLASS MEMBER FREQUENCIES IN THE EUROPEAN DATASET BY TIME PERIOD: EXTRA ASSERTIVE ARTIFACTS

[CONSULT ATTACHED FILES]

APPENDIX N

CLASS MEMBER FREQUENCIES IN THE EUROPEAN DATASET BY TIME PERIOD: EMBLEMIC ARTIFACTS

[CONSULT ATTACHED FILES]