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The Feminization of Prehistory: Evidence for the Emergence of Complex Modern Behaviors before c.70,000 Years Ago

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The FEMINIZATION of PREHISTORY: EVIDENCE for the EMERGENCE of COMPLEX MODERN BEHAVIORS BEFORE c.70,000 YEARS AGO.

by

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A master's thesis submitted to the Graduate Faculty in Liberal Studies in partial fulfillment of the requirements for the degree of Master of Arts, The City University of New York

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ABSTRACT

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Advisor: Anna Stetsenko

This thesis seeks to understand the relationship between environmental, genetic, and physiological changes that were concurrent with the emergence of complex modern behaviors and the morphing of archaic *Homo sapiens* into anatomically modern humans, between c. 190,000 years ago and c. 70,000 years ago. The thesis also focuses on how the unique survival needs of mothers and children contributed to the emergence of modern behaviors.

Archaic *Homo sapiens* have been dated to have emerged in history c. 318,000 years ago (Hublin, et al., 2017). The females of archaic *Homo sapiens* have been genetically dated to have morphed into anatomically modern humans c.160,000 years ago; considerably earlier, by tens of thousands of years, then the males of the species were genetically dated to have morphed into anatomically modern humans (Lippold, et al., 2014). Evidence from a variety of academic disciplines supports the emergence of complex modern behaviors concurrent with these dates, along with the strong possibility that these changes occurred when a small number of clans of archaic *Homo sapiens* occupied the paleo Cape Floral Region *refugium* in what is now South Africa during the periods of the Marine Isotope Stage 6 (MIS 6) deep glaciation and the Marine Isotope Stage 5 (MIS 5) interglacial period..

Evidence from the craniofacial feminization of paleoanthropological skeletal remains (Cieri,

et al, 2014) between c.318,000 and c.32,000 years ago, coupled with contemporary breeding studies and prehistoric anthropological artifacts, suggest that archaic *Homo sapiens* women had been able to self-tame themselves enough of their primitive agonistic behaviors to be able to provide and accept *mutual aid* between each other. The capacity for mutual aid and cooperation during the deep glaciation would have been foundational to the emergence of behavioral modernity (Donald, 2001) by c.70,000 years ago.

Though many anthropological, geographic, and genetic studies offer evidence of the emergence of modern behaviors during the period to be studied, they do not illuminate what developmental psychological changes had to evolve before archaic *Homo sapiens* could have morphed into anatomically modern humans. To address this shortcoming this thesis will focus on the artifacts which supported the use of affordances and cultural artifacts that could have become the grounding for modern behaviors in an isolated *refugium* (Marean, 2011) and which could have supported some of the neurological and behavioral changes of *Homo sapiens* that allowed for a plasticity of brains to emerge. Brain plasticity could have provided the flexibility for non-hierarchical, matrilineal, alloparent communities essential for small isolated clans of archaic *Homo sapiens* women to survive both the obstetric dilemma and the deep glaciation of MIS 6 and the glacial warming period of MIS 5. Further, the goal is to explore what psychological behavioral changes, ubiquitous to present day anatomically modern humans, could have evolved to support *cooperative cultural solutions to a biological problem* and the public suppression of archaic *Homo sapiens'* instinctive agonistic behaviors.

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This thesis has evolved over many years and I will undoubtedly leave out many deserving individuals from this list. To them I say your input has been greatly appreciated.

To my thesis advisor Anna Stetsenko, a challenging exuberant woman, thank you for stimulating my curiosity to seek ever newer sources of knowledge while at the same time pushing me to narrow my focus into a defensible thesis.

Though I acquired two degrees I had never had to argue an academic position using the written word, until I came to the Graduate Center. So, intermittently I have returned to a challenging class in effective academic writing taught by Maria Jerskey. Thank you, Maria, for helping me move through the academic maze.

To Susan Moritz without whose consistent copyediting of the multiple iterations of this work, it would never have become as congruent as it has. Since the final draft was always mine, I alone am responsible for errors and shortcomings.

To Al Tibbets and Larry Winter thanks for your support and patience putting up with thesis ideas as they emerged garbled and unformed during so many shared meals.

The writing of this thesis has, on a number of occasions made my wife of many years a “thesis widow” as I regressed into my single obsession and disappeared into my cubby hole with a book, a computer or a thought, often to emerge in foul moods, raving on evolutionary theory, coupled with bouts of forgetfulness. So, to Ginny without whom it would not have been possible, I’d liked to say it is finished, but most of all, I say thank you for your loving patience.

Overview

> "Although scientists are aware that humans share the same biological heritage as do all other organisms on the planet, the reliance of *Homo sapiens* on culture and cooperation has resulted in what can best be described as "a spectacular evolutionary anomaly."
>
> (Hill, Barton & Hurtado 2009, p.1).

Introduction

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Scope of Literature Review

This thesis documents from peer-reviewed literature and publications the impetuses for the emerging attributes of complex modern behaviors as defined above, during a prehistoric period

(c.185,000 to c.70,000 years ago) selected and preserved by evolution (Darwin, 1861) in present day anatomically modern humans.

The thesis research will focus on a number of areas: natural affordances (Clark, 2016; Costall,1995; Gibson, 1977) available in a specific *refugia*, over different climatic periods of glaciation (especially MIS 6 and MIS 5); technological affordances (Brown, 2009; Malafouris, 2013; Marean, 2011); and social affordances and cultural artifacts (Costall, 1995; Henshilwood, 2003; Vygotsky, 1978; Winnicott, 1971) which can possibly be substantiated by various kinds of anthropological evidence and the remnants of cultural artifacts unique to the paleo Cape Floral Region *refugium* located in present day South Africa.

The thesis will also address specifically the natural and technological affordances offered by the *refugium* (Marean, 2011) which could have supported some of the neurological and behavioral changes of *Homo sapiens* brains that allowed for a more flexibly wired mind to emerge (Braun, 2010; Donald, 2001; Malafouris, 2013; Roizman, 2014) and which might have enabled women to survive, day to day, during periods of intense glaciations—because ingrained habits learned from cultural artifacts (which have a designed objective built into them by humans to maintain the status quo) allow humans and their brains to be more energy efficient yet are flexible enough, over time, to allow for incremental changes—a feat no other upright, bi-pedal *Homo* species had ever been ever able to achieve and selected for by evolution to the present day (Walter, 2010).

Beyond *Homo sapiens*' reliance on various kinds of affordances and cultural artifacts to survive glaciation the thesis will also draw from the findings of various contemporary studies, (Cieri, Churchill, Franciscus, Tan, & Hare, 2014; Darwin, 1868; Laland, Odling-Smee, & Myles, 2010) which support a link between reduced aggression and craniofacial feminization

found in breeding experiments conducted with silver foxes and mice (Trut, 2001; Trut, Pliusnina & Oskina, 2004), along with field and laboratory research that allows comparisons of physical morphological changes between archaic *Homo sapiens* c.315,000 years ago (Hublin, Ben-Ncer, Bailey, Freidline, & Skinner 2017), an intermediate Levantine cranium from Manot Cave, Israel (Hershkovitz, Marder, Ayalon, Bar-Matthews, … & Barzilai, 2015), and anatomically modern humans c. 32,000 to c. 30,000, also known as Cro-Magnon (Smithsonian, 2016). These comparisons will be done to explore if there were any possible modern behavioral changes—particularly a willingness of archaic *Homo sapiens* to participate in cooperative behaviors, because, even when individuals feel themselves alone they are not. Humans are a symbiotic relationship of body, mind, and culture (Donald, 2001) and mutual aid (Kropotkin, 1902)—before c. 70,000 years ago. These attributes would have been essential to facilitate a unique cultural solution selected by evolution for the biological obstetric dilemma ubiquitous to anatomically modern humans (Buck, 2011; Dunsworth, 2015; Rosenberg, 2015). Proof to substantiate the emergence of cooperative behavior can also be found in the documented existence of alloparenting and the need for matrilineal communities (Aiello, 2002; Barrickman, 2007; Burkart, 2009; Dunsworthy & Eccleston 2015; Hrdy, 2009; Power, 2013; Robson, 2008; van Schaik, 2006), coupled with a belief in partible paternity and the acceptance of polyandry in prehistoric clans (Beckerman & Valentine, 2002; Starkweather, & Hames, 2011; Walker, 2010).

According to Linda Owens, it has normally been assumed that in prehistoric hunter-gatherer clans, men did the "hunting" and women did the supposedly less important "gathering" (Owens, 2005). However, Curtis Marean, an anthropologist known for his work in the Cape Floral Region of South Africa, tells us that during deep glaciation women could obtain both nutritional plants and high protein shell fish on their own, "freeing them from relying on men to

provision them and their children with high-quality food" (Marean, 2010). This was especially true during the MIS 6 glaciation (c.191,000 to c.123,000 years ago) in the paleo Cape Floral Region *refugium*. But the women's ability to gather their own food did not lessen the drive of men to copulate with them as often as possible, regardless of how many dependent children the women had to provide for. The thesis must go deeper and seek out the affordances which might have existed in the *refugium* beyond their food- gathering capacity, which would have allowed the females of the species to create cultural artifacts that would improve their survival and that of their children.

Secondary Altriciality

According to Karen Rosenberg and Wenda Trevathan, "Human babies are born in an unusually helpless condition that Portmann called 'secondary altriciality'…Scholars…have emphasized the helplessness of our newborns and the resulting needs that they have for intensive care by parents and alloparents" (Rosenberg & Trevathan, 2015). The human infant that evolved to accommodate the obstetrical, locomotor and energetic constraints imposed by encephalization was a costly creature to birth, carry around and parent (Rosenberg & Trevathan, 2015). These constraints necessitated that children be born earlier and less developed than other newborn animals, except elephants.

Chris Knight, in his article "Early Human Kinship Was Matrilineal," states: "If *Homo sapiens* mothers proved able to afford to raise such extraordinarily slow maturing, ultra-dependent offspring, this fact alone testifies to the success of their alliance building and reproductive strategies. The question arises: what new source of energy were they exploiting?" (Knight, 2008, p. 81).

The thesis will demonstrate that one of the new energies these women found emerged out of an ability to self-tame both themselves (Cieri, Churchill, Franciscus, Tan, & Hare 2014) and their male mates (Wilkins, 2014). And that self-taming can be known by comparing the craniofacial feminization of fossils (Cieri, et.al, 2014) of archaic *Homo sapiens* and anatomically modern humans.

Defining Behavioral Modernity

Often debated in its details, most scholars agree that modern human behavior can be characterized by symbolic behavior (von Petzinger, 2016), and/or planning, blade technology, ornamentation, and art, among other attributes *(*Henshilwood, 2003). D'Errico and Henshilwood (2011) go a step further and date the origin of symbolic material culture, not in the Europe, and much earlier than c.40,000 years ago, as originally thought. Rather they contend that *Homo sapiens* ability to create symbolism (which demonstrates the ability for sharing, storing and transmitting coded information within and across groups) gradually emerged in Africa, in conjunction with the origin of our species (d' Errico, & Henshilwood, 2011, Introduction to Chapter 3).

Underlying these modern behaviors and technological innovations are cognitive and cultural foundations that have been documented experimentally and ethnographically; for example, by Sarah Blaffer Hrdy in her study *Mothers and Others*, of the hunter-gatherer Hadza people (Hrdy, 2009). Some of these human universal patterns are "ratcheted" (Tennie, Call, &Tomasello, 2005), cumulative cultural adaptations such as matrilineal clans, self-taming, alloparent care, communal midwifery, cooperative breeding, use of technological affordances as cultural artifacts, and social norms, which will be discussed throughout the thesis.

Henshilwood and d'Errico, in a book chapter "Middle Stone Age Engravings and Their Significance to the Debate on Emergence of Symbolic Material Culture", define symbolically mediated culture or modern behavior from an archeological point of view as "*one in which individuals understand that artifacts are imbued with meaning and that these meanings are construed and depend on collectively shared beliefs.*" (Henshilwood & d'Errico, 2011, p.76). They go on to say that this definition is important in that it "explains how human norms and conventions differ from ritualized behaviors of other none human primates." (p.75). However, they do not explain what developmental psychological changes had to emerge before this could happen.

According to Texier, Porraz, Parkington, Rigaud, Poggenpoel, and Verna (2010), symbolically mediated behavior has emerged as one of the few universally accepted markers of behavioral modernity. They go onto say:

> Symbolic practices are defined by socially constructed conventions…and may take various archaeological forms, varying in the nature of the material used or the kind of transformation performed. In all cases these practices require adherence to collective rules. Repetitiveness and patterning of practices are key elements for the emergence of a tradition mediating behavior through the involvement of artifacts (Texier, et al.,2010, p. 9964)

Again however, these anthropologists leave out the psychological components that had to evolve for symbolic practices to emerge.

Knauff and Wolf at the outset of their literature review offer a more complex psychological definition by breaking modern behaviors into smaller components starting with decision-making, which falls back on other cognitive processes such as perception, working memory, long-term

memory, executive processes, or when the cognitive processes are in close connection with other processes such as emotion and motivation. They go on to write, "The complexity also results from an interaction from a multitude of processes that occur simultaneously or at different points in time and can be realized in different cognitive and/or neuronal structures" (Knauff & Wolf, 2010, p. 99).

Merlin Donald in his book *A Mind So Rare* describes what this thesis takes as an *a priori* for modern behaviors to have emerged: "The first priority [of *Homo sapiens*] was not to speak, use words, or develop grammars. It was to bond as a group, to learn to share attention and set up social patterns that would sustain such sharing and bonding in the species" (Donald, 2001, p. 253).

Restraining Agonistic Behaviors

To bond in groups archaic *Homo sapiens* had to continuously learn to repress the primitive parts of their brain's instinctive reliance on agonistic behaviors in response to internal feelings to fight, flee, or freeze when stressed, especially when in the presence of their own kind. J.J. McGlone defined agonistic behaviors as:

> …behaviors which cause, threaten to cause or seek to reduce physical damage. Agonistic behavior is comprised of threats, aggression and submission. While any one of these divisions of agonistic behavior may be observed alone, they usually are found, in sequence, from the start to the end of an interaction (McGlone, 1986, p.1130).

Contemporary examples of agonistic behaviors would be: a great ape pounding his chest and then charging to scare off an opponent, followed by one or the other running away or submitting; or the MAD (Mutually Assured Destruction) military buildup between the US and Russia during the cold war.

Individual prehistoric minds contaminated by agonistic behaviors needed a time and a place to evolve from a purely individualistic perspective implied in the phrase "survival of the fittest" (Darwin, 1889) to sensing oneself as part of a community "struggling for life" (Darwin, 1859) and curious and needful enough to experiment with behaviors less reliant on coercive cooperation (Kropotkin, 1902).

Genesis of archaic *Homo sapiens* and Anatomically Modern Humans

New fossil discoveries and re-dating of key specimens, combined with analyses of variation in female mitochondria (mtDNA) and male Y chromosomes in living humans, strongly suggest that the earliest members of our species appeared in Africa about c. 318,000 years ago (Henn, Gignoux, Jobin, Granka, … & Fledman, 2011; Hublin, et al., 2017; Schlebusch, 2017).

The dating of anatomically modern humans and modern behaviors is less certain. This lack of physical evidence (such as a cave painting) is often referred to as the "problem of behavioral modernity" and "has generated heated debate about the cognitive and cultural capacities of the earliest modern humans" (Cieri, et al. 2014, p.419). However, there is evidence of symbolical artifacts which reflect the existence of modern behaviors as early as c. 100,000 to c. 70,000 years ago in the Cape Floral Region of South Africa: beads made from shells; thousands of pieces of ochre used for body decoration found in multiple geological strata; two pieces of ochre used for mark making; and a few pieces of ostrich egg shells with rectangular markings (Bouzouggar, 2007; d'Errico, Henshilwood, & Watts, 2009, d'Errico, Salomon, Vignaud, & Stringer 2010; Henshilwood, d'Errico, F. von Niekerk, K.L. Coquinot, Y. Jacobs, Z.… & Garcia-Moreno, 2011a; Texier, et.al. 2010). There is no evidence found on cave walls and no sculpted figures or representations of multiple symbols or complex drawings, like those

found in European caves between c. 45,000 and c 35,000 that without a doubt say humans with a capacity for modern behaviors created them (von Petzinger, 2016). However, the paleo Cape Floral Region *refugium* does offer sporadic evidence that people with cognitive skills did exist; especially when connections are made to diet, craniofacial feminization, and the kinds of behaviors and skills required to create various technological affordances and to use ochre and beads as cultural artifacts, including increased flexibility in understanding the minds of others as intentional (Dunbar, 2003; Tomasello, 2005), abstract thinking (Donald, 2001; Lewis-Williams, 2002), and linguistic and symbolic capacities (Bouzouggar, 2007; d'Errico, et al, 2009; Henshilwood, et al.,2011; Texier, Porraz, Parkington, Rigaud, Poggenpoel, …Verna, 2010).

Genetics, Geographic Resources, and Anthropological Time Frames

Multiple clans of archaic *Homo sapiens* in any isolated *refugium* had to consist of at least 100 plus women (and male counterparts) to be genetically detectable (Laland et al., 2010). One Eve was not enough. The *refugium* also needed to be able to offer archaic *Homo sapiens* the right combination of accessible physical resources to survive (Baraban, Mensch & Lyons 2016; Marean, 2011, 2011a; Proche, Cowling & du Preez, 2005)—including fish and shellfish which were essential to support the development of post-myelinating rewireable brains after birth (Bergles, & Richardson, 2015; Malafouris, 2013).

Next, in order to have survived through natural selection this isolated band of archaic *Homo sapiens* had to develop communal midwifery (Buck, 2011; Dunsworth & Eccleston, 2015; Gruss, & Schmitt, 2015; Rosenberg & Trevathan, 2002), and matrilineal alloparent support (Hrdy, 2005; 2009). The movement toward matrilineal cooperation (Opie & Powers, 2008) allowed for the selection of tamer and more supportive males (Hawkes & Bird, 2002) and more dependable resources for rearing children (Crittenden & Frank, 2008). This eventually resulted in

an evolutionary population explosion (Hawkes & Bird, 2002), which in turn necessitated a second Out of Africa migration into the world c. 55,000 years ago to support their hunter-gatherer way of life.

Dating evidence of Physical Evolution of *Homo sapiens*

Anatomically modern humans are members of the archaic species *Homo sapiens* that themselves came into being c. 318,000 years ago (Hublin, et.al 2017). Archaic *Homo sapiens* looked similar but not identical to anatomically modern humans.

This thesis follows the hypothesis established in the literature that over the course of the Middle Paleolithic (spanning from c. 300,000 to c. 30,000 years ago) there was a physical and cultural morphing from one species—archaic *Homo sapiens*—into another distinctly different species called anatomically modern humans, or earlier referred to as Cro-Magnon (Smithsonian, 2016).

One recently published genetic paper dealing with ancestors of the Khoisan people of South Africa dates archaic *Homo sapiens*, with the caveat of a "wide range spectrum,"back to c. 300,000 years ago (Schlebusch, Malmstrom, Gunther, Sjodin, Coutinho, …& Jakobsson, 2017,

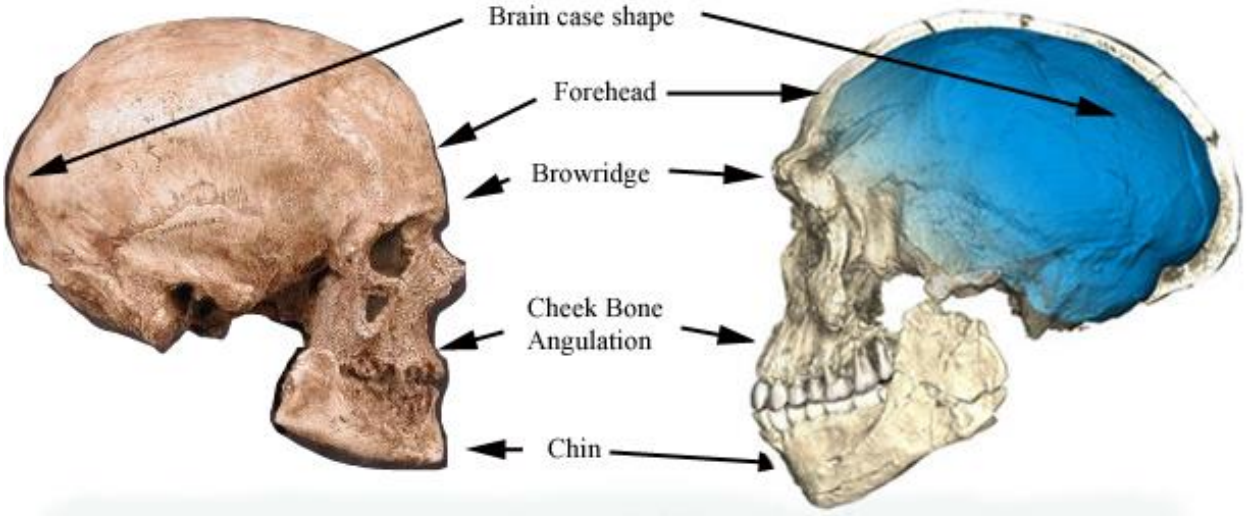

Figure 1. Comparison of Craniofacial Feminization of Cro-Magnon from c. 32,000 years ago (left side) to archaic *Homo sapiens* c.318,000 years ago (right side). Image on right taken from a computer reconstruction of fossils from Jebel Irhoud. © Philipp Gunz, Mpi Eva Leipzig. Vreeland, J. 2017.

p. 1126). A second paper published in *Nature* in August of 2017, by Jean-Jacques Hublin (currently a Professor at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany) dates another group of earlier archaic *Homo sapiens* to c. 318,000 years ago. The paper refers to this group as "fossils found in Northern Africa near Jebel Irhoud, Morocco" (Hublin, et al., 2017), and used the radiation level of lithic Stone Age tools to date actual paleoanthropic bones at the site. The first paper used genetic mtDNA studies to date the ancestors of sub-Saharan tribes and Khoisan people's ancestors, while the second used the dating of physical evidence found at the site. Until these studies were published, the consensus in most media and anthropological papers was that *Homo sapiens* had not emerged in Africa before c. 200,000 years ago. As recently as 4/28/2018, the Smithsonian National Museum of Natural History website still states, "The species that you and all other living human beings on this planet belong to is *Homo sapiens*. During a time of dramatic climate change 200,000 years ago, *Homo sapiens* evolved in Africa" (Smithsonian, 2018). This erroneous dating for the origins of *Homo sapiens* was based in part on the accepted archeological fossils Omo 1 and Omo II, which were re-dated to c.195,000 years ago because of re-dating of the geological strata in which the fossil where found (McDougall, Brown & Fleagle,2005), coupled with genetic estimates derived from women's mitochondria DNA (Cann, Stoneking, & Wilson 1987; Wallace, Brown & Lot 1999).

Genetic Bottlenecks

Genetic bottlenecks or near-species extinctions are correlated by analyzing different DNA samples of living humans and comparing them with mitochondria DNA (mtDNA) of fossils. A very low number in an earlier population—a genetic bottleneck— was noted by Cann, Stoneking, & Wilson (1987). However, such bottlenecks could also be confused with the emergence of a potentially new species, such as anatomically modern humans, because of neural

cell expressions due to self-taming (Engelhaupt, 2017; Wilkins, 2014) when neither environmental stresses (Cordero, Rodríguez, Davies, Peddie, Sandi & Stewart, 2005) nor epigenetic expressions are known. Normally such bottlenecks are attributed to factors such as disease; major climatic events, such as glaciation, which radically changes the environment over long periods of time; or shorter intense events, such as the super volcanic eruption Toba c. 75,000 years ago (Ambrose, 1998).

Glaciation had a great impact on the environment of Africa during the evolution of anatomically modern humans. Deep cold and glaciers in the northern hemisphere locked in moisture, creating deserts and savannas where trees once grew, and dropping and raising sea levels around the continent by more than 439 feet (Lambeck, Rouby, Purcell, Sun & Sambridge, 2014). This thesis will discuss in the section "Natural Affordance of Shellfish" (p 21) why

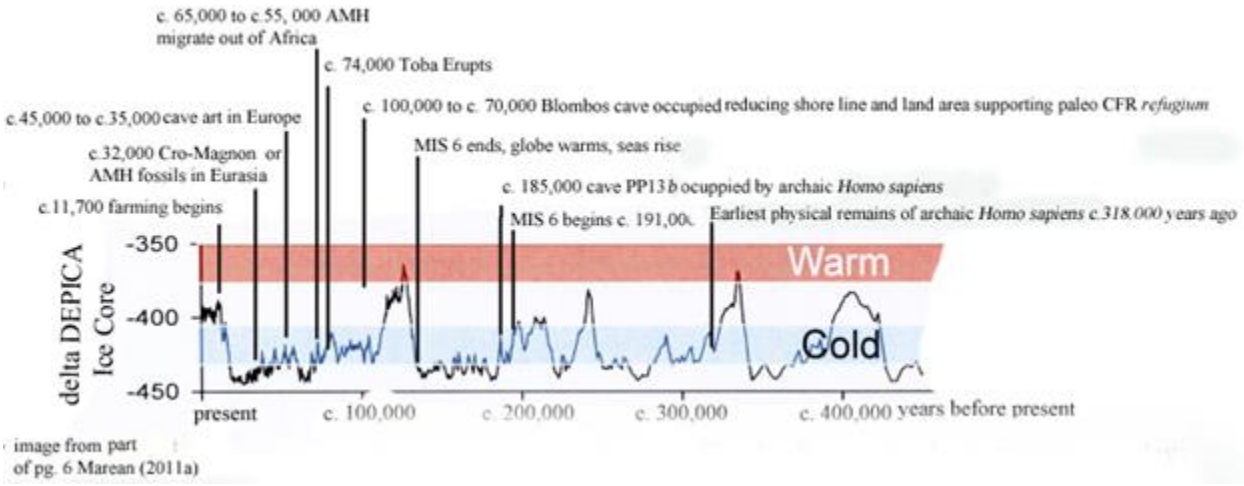

Figure 2. "Physical Timeline of Emerging Archaic. *Homo sapiens.*" Vreeland, J. (2018)

accessibility to the sea with a sloping shoreline (provided by the Agulhas Bank) along the paleo Cape Floral region was important—as coastal regions were a major protein source of fish and shellfish, which were an essential catalyst for brain development (Baraban, Mensch & Lyons, 2016).

According to Rose and Chester, "the Toba caldera, located in northern Sumatra…was the site of the largest Quaternary volcanic eruption on Earth (Rose & Chester, 1987). Toba was a short-acting phenomenon in terms of geological time, but it left huge ash deposits in parts of Africa and Asia (Lane & Johnson, 2013). This eruption occurred after the cusp of the of intergalactic MIS 5a period (c. 84,740 years ago) and the beginning of glaciation MIS 4 period (c.71, 000 years ago) (Lisiecki & Raymo, 2005); it did not create the glaciation, though it might have given it a push after it started and created a wide variety of species genetic bottlenecks and extinctions in Asia and Africa.

The enormous Toba ash cloud spread as far as the middle of Africa and along the shores of the Mediterranean, but it had little to no impact on the southern tip of Africa (Lane & Johnson, 2013). According to Rose and Chester the "description of such tephra dispersal is relevant when considering the effects on the human population of an eruption of this magnitude" (Rose & Chester, 1987, p.7), even though the "residence time of volcanic aerosols in the stratosphere is only of the order of a few years" (Rampino, Self, & Stothers, 1987, p.2). What concerns the thesis' hypothesis regarding the availability of the South Africa *refugium* for the emergence of behavioral modernity is that Toba had little or no effect on the southern tip of Africa. However, it might have negatively affected other *refugia* in northern or central Africa. A few years of little or no sun and of microscopic glass (ash) in drinking water or covering the plants that supported animals that other *Homo sapiens* in other *refugia* would need to survive could have led to a weakening and reduction of populations of archaic *Homo sapiens* and then to extinction. The Toba eruption could be one of the reasons why there is no evidence of archaic *Homo sapiens* as opposed to anatomically modern humans participating in the Out of Africa 2 exodus.

Geneticists have used DNA to trace back to the theoretical genesis of what some have referred to as the Mitochondrial "Eve" and the Y chromosome "Adam." Mitochondrial Eve debuted in January 1988, when *Newsweek*'s cover depicted "The Search for Adam and Eve" (Tierney, 1988), while reporting on a peer reviewed paper entitled "Mitochondrial DNA and Human Evolution" (Cann, Stoneking, & Wilson ,1987). Geneticists do this tracking back by correlating a wide variety of anthropological data with the largest genome base possible of anatomically modern humans from a variety of present-day areas such as Africa, Oceanica, and Europe, and working genetically backwards.

In 2014, Lippold, Xu, Ko, Li, and Stoneking (2014), sampled both the NRY (Non-recombining Y chromosome) from the males of a large study group, and the mtDNA (mitochondrial DNA) from the females of the same group. The "age of the mtDNA ancestor is estimated to be about c.160,000 years ago," and "the ages of the non-African mtDNA lineages M and N [Mediterranean and North Africa] are about 65 to 70 [thousand years ago] which was in good agreement with previous estimates." However, what is important to this thesis is that their estimate for the age of the NRY (male) ancestor is c. 103,000 years ago (Lippold, Xu, Ko, Li, and Stoneking, 2014). This date is based on the what is known as the "fast rate," after having discounted the "slow rate" as being incongruent with known anthropological dating (Lippold, et al., 2014). What is being said here is that the females of the species were genetically recognizable as anatomically modern humans tens of thousands of years before the males of the species could be genetically identified as anatomically modern humans. Another study (Poznik, Henn, Yee, Sliwerska, Euskirchen, Lin, Snyder, Quintana-Murci, Kidd, Underhill & Bustamante, 2013) corroborates the findings that anatomically modern human females came into existence

before anatomically modern human males, though with a much smaller cohort and a wider range of numbers.

Research by E. Heyer Chaix, Pavard & Austerlitz has shown that sex-specific demographic behaviors can shape human genomic variation (Heyer, et al. 2011). This could in part explain the differential between when anatomically modern human females emerged and were identifiable versus their male counterpart. However, it does require us to accept the possibility of strong matrilineal groups in the paleo Cape Floral region. Heyer et al., used the Island South-East Asia area to demonstrate how local processes may affect large-scale human genomic variation:

> In the human species, the two uniparental genetic systems (mitochondrial DNA and Y chromosome) exhibit contrasting diversity patterns. It has been proposed that sex-specific behaviours, and in particular differences in migration rate between men and women, may explain these differences… Austronesian women married with non-Austronesian men. The children of such matings have the Y chromosome of their non-Austronesian father, the mtDNA of the Austronesian mother, and as the result of the dominant matrilocality *practised* by most Austronesian societies in the past (Jordan, 2009), the children of such matings would have been incorporated into the Austronesian communities. Thus, it was shown that a simple model of just 2% marriage of Austronesian women with non-Austronesian men over a period of 50 generations, in the context of matrilocality, could explain the pattern of sex-specific diversity. This example demonstrates how a local process of low intensity, adhering to the residence rule, but maintained over a large number of generations, may impact human genomic variation at large geographic scales (Heyer, Chaix, Pavard & Austerlitz, 2011, p. 1365)

Genetics and a number of physical artifacts suggest that the emergence of anatomically modern humans happened between c. 195,000 and at least by c.70,000 years ago in southern Africa. To date, the earliest artifacts reflecting modern behaviors have been found in the caves of the Cape Floral Region of South Africa. This region was isolated from the rest of Africa during periods of deep glaciation by deserts to the north but had continuous access to the sea because of the Agulhas Bank, especially during the MIS 6 period. Therefore, its occupants would have had tens of thousands of years to evolve as separate species.

The Cape Floral Region *Refugium*

The Cape Floral Region was inscribed on the UNESCO World Heritage List in 2004, because it is one of the world's great centers of terrestrial biodiversity representing ongoing ecological and biological processes associated with the evolution of the unique Fynbos biome. Of particular scientific interest are the adaptations of the plants to fire and other natural disturbances; seed dispersal by ants and termites; the very high level of plant pollination by insects, mainly beetles and flies, birds and mammals; and high levels of adaptive radiation and speciation (Cape, 2018, Criterion (xi) & (x)). Although the entire floral region is only 90,000 km^2 in extent, it is home to 8,996 plant species and 988 genera, with 32% of its species found nowhere else in the world (Snijman, 2013).

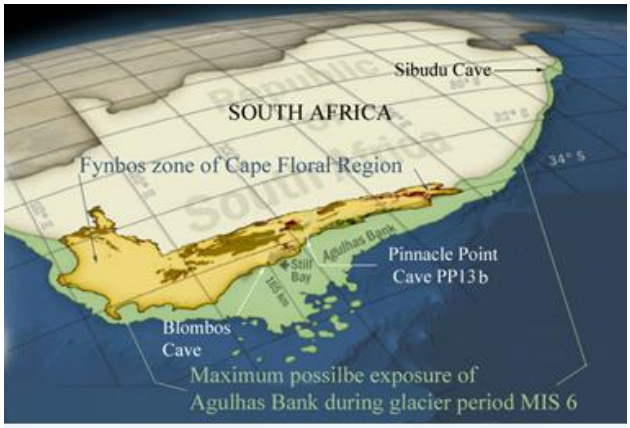

Figure 3. Map of paleo Cape Floral Region *refugium* in what is now present day South Africa, Vreeland, J. (2018).

The paleo *refugium* in the Cape Floral Region was unique it its ability to provide access to a "combination of calorically dense, nutrient-rich protein from the shellfish and low-fiber,

energy-laden carbs from the geophytes," so "the southern coast would have provided an ideal diet for early modern humans during glacial MIS 6" (Marean, 2010). The Marine Isotope Stage 6—lasted from c. 191,000 years ago, when oceans and temperatures started to fall, and ended c. 123,000 years ago, when temperatures and oceans started to rise. (See Figure 2 . Timeline pg.13) There is evidence that shellfish were being eaten in Cape Floral Region caves as early as c. 185,000 years ago (Henshilwood, 2009; Henshilwood, 2003; Marean, 2011).

Because the region abuts the Agulhas Bank, which slopes gradually rather than sharply falling off to deep ocean, the rich source of protein was always available as the ocean dropped and rose nearly 440 feet between periods of glaciation and interglaciation. Changes in the location of the shoreline which is presently quite near the Blombos, PP13B, and Sibubu caves to upward of 165 kilometers away over periods of tens of thousands of years would have meant that the inhabitants lived in areas now buried by the sea as they followed their source of protein. The need to follow their food supply accounts for the intermittent use (Marean, 2011a, slide 13) of the caves from the end of interglaciation MIS 7 and then again toward the warmest part of the interglaciation MIS 5. Periods of deep glaciation were a time when most of the rest of Africa had become dry, arid, and uninhabitable (Marean, 2010). However, during MIS 5 there are signs of trees growing and occupation of the Sibudu Cave, a rock shelter in a sandstone cliff in northern KwaZulu-Natal, South Africa as late as c. 77,000 years ago to c. 38,000 years ago. The evidence includes some of the earliest examples of modern human technology: the earliest bone arrow (61,000 years old), the earliest needle (61,000 years old), the earliest use of heat-treated mixed compound gluing (72,000 years ago), and the earliest example of the use of bedding (77,000 years ago) (Blackwell, d'Errico & Wadley, 2018; Wadley, Hodgskiss & Grant, 2009; Wadley, Sievers, Bamford, Goldberg, Berna & Miller, 2011)

Changing Population Densities Affect Expression of Modern Behaviors

According to Cieri, Churchill, Franciscus, Tan, and Hare (2014), demographic expansion and population density are increasingly being seen as critical components in the expression of behavioral modernity. Jacobs & Roberts (2009) and Boyd & Richardson (2009) also substantiate the claims by Cieri, Churchill, Franciscus, Tan, & Hare (2014).

Population density pressures would have emerged in the paleo Cape Floral Region *refugium* at the Eemian, or last major interglaciation between MIS 6 and periods of MIS 5, (c. 130,000 years ago to c. 115,000 years ago). The warmest peak of the Eemian was around c.113,000 years ago when sea levels are estimated to have been 20 to 30 feet higher than today. At the peak of the Eemian warming period the land area of the *refugium* was drastically reduced, making the area difficult for hunter-gathering subsistence living, pushing people closer together, and reducing the land mass available for vegetable carbs and the length of seashore line available for scavenging for shellfish, injured animals, or even dead fish.

Emergence of Modern Behaviors from Affordances to Cultural Artifacts

Learned Behaviors

Anatomically modern humans are not born with modern behaviors. These have to be learned. What follows are some of the steps that had to happen psychologically and neurologically for archaic *Homo sapiens* to become behaviorally modern, coupled with some of the prehistorical sources of enculturation ubiquitous to anatomically modern human culture.

Natural Affordances

James J. Gibson first introduced the idea of affordances in *The Theory of Affordances* (Gibson,1977) and explored it in more detail in *The Ecological Approach to Visual Perception* (1979). Gibson defined affordances as all "action possibilities" latent in the environment,

independent of an individual's ability to recognize them, but always in relation to agents (people or animals) and therefore dependent on their capabilities. Affordances are not limited to humans. Apes have been observed using sticks to get termites out of their mounds to eat them. Chimpanzees have been observed using rocks to break nuts, and their young learning how to do it by observing their mother (De Waal, 2016). However, chimps only do this in areas where the stones and nuts seem to exist together. Gibson also insisted that affordances involve more than mere "interaction" between an animal and its environment:

> The relation between the animal and its environment is not one of interaction in any sense of that word that I understand…it's one of, well, reciprocity's not too bad. A term like "affordance" that bridges the gap points both ways… Affordances are both objective and persisting and, at the same time, subjective, because they relate to the species or individual for whom something is afforded (Gibson, 1982b, pp. 234, 237).

Another way of saying this according to Alan Costall, a professor of theoretical psychology, is that "meaning is not a 'psychic addition' but exists within the animal- environment relation. What we attend to in our surroundings are not the shapes, colors and orientations of surfaces in our surroundings, but rather the useful meaning of things for action" (Costall,1995, p. 470).

The spacing and size of the limbs of a tree make it climbable for the adult viewer, but not for a toddler; stones in a stream allow us to cross it without getting wet depending on how far the stones are from each other and on the length of the legs of the human trying to cross the stream. In the *refugium* it is very possible that our ancestors could see that it was safer and more productive to try to get shellfish when the tide was at its lowest, better still when there was a spring tide but not a neap tide (Marean, 2011a). It probably took a while for them to learn that tides changed every day, even twice a day, and eventually how to time their arrival to the low

tides, without clocks or calendars and only the moon to assist them, and then rationalize this information and pass it on. Marean tells us that there seems to have been structured use of this natural affordance: remains of different kinds of shellfish found only during certain kinds of tides were left in caves in the area (Marean, 2011a. slides 21 & 22).

Andy Clark, the author of a number of books built around the ideas of man's quest for artificial intelligence, talks often about the power of affordances:

> …the world thus revealed is a world tailored for human needs, tasks, and actions. It is a world built around affordances—opportunities for action and intervention. And it is a world that is exploited, time and time again, to reduce the complexities of neural processing by means of canny action routines that alter the problem-space for embodied, predictive brains (Clark, 2016, p. xv).

Clark does not know when humans eventually figured out the problem of tides but has faith in the predictive brain, as an "action-oriented engagement machine" (Clark, 2016, p.1). It's not known when archaic *Homo sapiens* in the Cape Floral region figured out tides. However, to become anatomically modern humans they would need a continuous supply of shellfish to support the emerging viability of smaller, more plastic brain structures. (see Natural Affordance of Shellfish, p. 21, this thesis)

We also don't really know what the etchings on the ochre found in the Blombos cave meant, but maybe they were a primitive attempt to keep track of tides (see Figure 4., p.28). Clark would say the predictive brain was not an "insulated inference machine" but rather at that stage of human development it was probably capable of selecting frugal, "action based routines" (such as etching into a piece of ochre) that would "reduce the demands on neural processing and deliver fast, fluent forms of adaptive success" (Clark, 2016, p. 1).

Natural Affordance of Shellfish

Seafood as a protein source was a natural affordance of the paleo Cape Floral Region *refugium* (Marean, 2011). It was a supply of protein that women could gather themselves without reliance on male hunters. More important to the development of anatomically modern human behaviors, their daily or frequent dependence on this resource also supplied DHA (Docosahexaenoic acid), which is essential for the development of the brains of archaic *Homo sapiens* and anatomically modern humans.

A recent study in in *Proceedings of the National Academy of Science* found a site in Africa which provided:

> the oldest in situ evidence that hominins, predating Homo erectus, enjoyed access to carcasses of terrestrial and aquatic animals that they butchered in a well-watered habitat. It also provides the earliest definitive evidence of the incorporation into the hominin diet of various aquatic animals including turtles, crocodiles, and fish, which are rich sources of specific nutrients needed in human brain growth. The evidence here shows that these critical brain-growth compounds were part of the diets of hominins before the appearance of Homo ergaster/erectus and could have played an important role in the evolution of larger brains in the early history of our lineage. seafood played an important role in human brain evolution even before archaic *Homo sapiens* appeared on our planet. (Braun, Harris, Levin, McCoy, Herries, Bamford, Bishop, Richmond & Kibunjia, 2010, p.10002).

Myelin underlies the development of large complex nervous systems of all hinged-jaw vertebrates. It promotes rapid, efficient nerve conduction, and besides increasing the speed of nerve conduction, “myelination has emerged as a source plasticity in neural circuits that is

crucial for proper timing and function" (Salzar & Zalc, 2016, p. 975). Myelin constitutes around 50% of the human brain. "Myelin is not just present in white matter. "Myelin is not just present in white matter but is additionally an important component in the cortex and deep grey nuclei, in agreement with its role in more complex neural functions" (Salzer & Zale 2016, p. 975). Myelin underlies conduction speeds in the brain and provides a substrate for additional control of the timing of inputs during human development. Exacting control of timing is essential not only for motor skills and sensory processing but also for higher integrative functions, including cognition. McKenzie, et al. in their paper "Motor skill learning requires active central myelination," provided experimental evidence that "OL [Oligodendrocyte] genesis and myelin formation are important for motor learning and, therefore, are likely to contribute to the changes observed by MRI" (McKenzie, Ohayon, Li, de Faria, Emery, Tohyama, & Richardson, 2014, p. 321).

Johanna Bradbury's work reinforces the importance in a staple source of "preformed docosahexaenoic acid (DHA) in the diet. An important turning point in human evolution was the "discovery of high-quality, easily digested nutrients from coastal seafood and inland freshwater sources. Multigenerational exploitation of seafood by shore-based dwellers coincided with the rapid expansion of grey matter in the cerebral cortex, which characterizes the modern human Brain." (Bradbury, 2011, p. 522)

According to Horrocks and Yeo, "DHA is essential for the growth and functional development of the brain in infants…DHA is also required for maintenance of normal brain function in adults. "The inclusion of plentiful DHA in the diet improves learning ability, whereas deficiencies of DHA are associated with deficits in learning" (Horrocks & Yea, 1999. p.1). DHA is involved in cell signaling. DHA is the predominant structural fatty acid in the grey matter of the brain and retinal tissues in humans and other mammals. Humans obtain DHA primarily from

their diets because they are capable of synthesizing only small amounts of DHA. Infants acquire DHA initially in utero during pregnancy, and from their diet via their mother's milk. (Kuratko, Barrett, Nelson, & Norman, 2016)

The period from birth to 2 years of age is considered the primary growth phase for the human brain when measured in terms of brain weight. However, certain areas of the brain are not fully developed by the age of 2 years, and development as well as growth continues throughout childhood and adolescence. Myelination of brain frontal lobes begins as early as 6 months of age and continues throughout childhood and adolescence with spurts of development identified at 2 years of age, 7–9 years of age, and during mid-adolescence (Horrocks,1999).

Being in a *refugium* surrounded by an ocean of shellfish gave archaic *Homo sapiens* a crucial neurological foundation for their brains to develop complex modern behaviors.

Ratchet Effect

Michael Tomasello, a psychologist who spent many years studying other primates, is credited with developing the concept of the "ratchet effect" described in a paper by Tennie, Call and Tomasello:

> …from the point of view of process, a key feature of uniquely human cultural products and practices is that they are cumulative. One generation does things in a certain way, and the next generation then does them in that same way—except that perhaps they add some modification or improvement. The generation after that then learns the modified or improved version, which then persists across generations until further changes are made (Tennie, Call, &Tomasello, 2009, p.2405).

The improvements can be in natural or technological affordances, but it is cultural artifacts that allow for the ratchet effect to be transmitted from generation to generation. The

ratchet effect allows for modifications and improvements to stay in a tribe or clan with little loss or backward slippage, until new changes to how things can be done ratchet things up again. According to the authors of the study, and particularly Tomasello who developed the conceptof the "ratchet":

> This process obviously relies both on inventiveness, for the cultural novelties, and on faithful transmission across generations to keep the novelties in place until other novelties come along. The claim in the original paper was that while inventiveness is fairly widespread among primates, humans transmit cultural items across generations much more faithfully, and it is this faithful transmission (the ratchet) that explains why human culture accumulates modifications over time in a way that chimpanzee and other animal cultures do not (Tennie, Call, &Tomasello, 2009, p.2406).

Technological Affordances

Technological affordances are tools made from natural affordances that help us interact with our environment but *not necessarily with each other*. There is no question that humans have been able to create technological affordances from a diversity of natural products far in excess of any other animal: fire made from grasses, peat, wood, fish oil; clothes made from the fur of other animals, snake skins, silk woven from the cocoons of silk worms; homes made from trees, stone, sod, mud, and straw; pots made from ostrich shells, clay, stone, wood, glass from silica (sand); weapons from stone, wood, iron, copper, and uranium. However, the skills to utilize the natural affordances are self-taught, shared, and incrementally added to over generations—transmitted not through genetics but through culture.

The Wonderwerk Cave in the North Cape Region of South Africa, not far from the paleo Cape Floral Region *refugium,* has a number of artifacts, including the evidence of fire making

going back possibly a million years. Although this use of a technological affordance predates *Homo sapiens* and the emergence of anatomically modern humans, the dating of fires made with intentionality, surrounded by stones to contain it, is not evident before the advent of *Homo sapiens.*

Fire is a natural affordance of nature, but at some point it started to become a technological affordance. *Homo erectus'* use of fire to cook food might have evolved when it was a natural affordance—when *Homo erectus*, like other animals before them, first discovered tasty, good smelling, easy to chew dead animals after fires started by an electrical storm had passed over an area. Animals still do this today. However, learning with intentionality how to keep a fire alive after a storm was another evolutionary advance. Learning how to carry the embers of a dying fire from one place, possibly in seashells, to another place and bringing them back to life was yet another step. And, finally, learning how to bring one stick to another stick, and rubbing them in a sawing motion, really hard, near the finest of combustible grasses, as I have seen Maasai warriors do in Kenya, is another. Each step took observation (seeing what nature afforded) and experimenting with different materials not always readily at hand. Of course, the *Homo erectus* species had tens of thousands of years to observe and experiment, but this information was not stored in their genes for use by the next generation. It had to be saved in brains and taught from generation to generation for the information to be kept alive. The learning could be lost in a small isolated clan if those responsible for the keeping of the memories were lost.

Flint blades burned in fires roughly 300,000 years ago were found near fossils of archaic *Homo sapiens* in Morocco (Zimmer, 2017). Evidence of widespread control of fire by anatomically modern humans dates to approximately 125,000 years ago (at the apex of the

interglacial warming at the end of the MIS 6 period). There is not yet enough prehistoric information to say that the active use of fire was limited to *Homo sapiens*; we only know that they actively used it.

The controlled use of fire was a breakthrough adaptation in human evolution. In terms of technological affordances, Kyle Brown with Curtis W. Marean and others, in an interesting but very technical article, "Fire as an Engineering Tool of Early Modern Humans" tells us that fire as an affordance allowed prehistoric anatomically modern humans to alter the physical properties of materials. Specifically, the analysis of tools at multiple sites in the Cape Floral Region:

shows that the source stone materials were systematically manipulated with fire to improve their flaking properties. Heat treatment predominates among silcrete tools at ~72 thousand years ago (ka) and appears as early as 164 ka at Pinnacle Point, on the south coast of South Africa. Heat treatment demands a sophisticated knowledge of fire and an elevated cognitive ability and appears at roughly the same time as widespread evidence for symbolic behavior (Brown, Marean, Herries, Jacobs, Tribolo, Braun, Roberts, Meyer & Bernatchez, 2009, p. 859).

There is considerable evidence from both Pinnacle Point and the Blombos cave in the *refugium* that *Homo sapiens* in the area as far back as c.164,000 years ago had developed some rather sophisticated technological affordances.

According to Marean (2011), among the stone tools found in PP13B were a significant number of "bladelets"—tiny flakes twice as long as they are wide—that are too small to wield by hand (Marean, 2011). Marean assumes they must have been attached to shafts of wood and used as projectile weapons. Composite toolmaking is indicative of considerable technological know-how, and the bladelets at PP13B seem to be among the oldest examples of it. Marean goes on to

say that "intentional heat treatment was a dominant technology at Pinnacle Point by 72,000 years ago" (Marean, 2011, under heading "Survival Skills).

There were other artifacts found in these caves that we know were made by hominoids, because they required a certain skill to do so, but that seem to have no practical use from a biological survival perspective: pieces of deep red ochre buried in many geographical strata (Henshilwood, d'Errico & Watts, 2009) which require heating in a fire to create the color, and thousands of shell beads with little holes drilled in the shells, and pieces of ostrich egg shells with geometric patterns on them, and the crown jewels of them all, pieces of ochre which had been ground smooth on one face with etched markings on them. All these artifacts are dated before c. 70,000 years ago. Because they have been worked on by humans, they are not just affordances of nature; they are definitely technological affordances. Even though we may sometimes be unable to discern the purpose of an object, we can usually tell whether it is a human product with some intended purpose.

How the Creating of Technological Affordances Shaped Physical Brains.

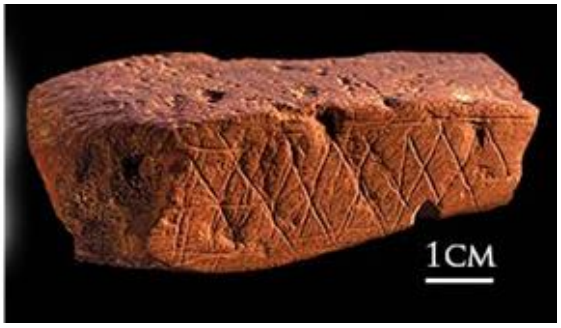

Figure 4. A cross-hatch design, scratched into a piece of ochre.c. 70,000 years ago. Blombos Cave, South Africa Copyright C. Henshelwood

Lambros Malafouris, in a wonderful book, *How things shape the mind: A theory of material engagement* (Malafouris, 2013), patiently explains in great detail how early prehistoric human brains were adapted to wire and rewire themselves because of their interaction in the tool-making process itself. Regarding the etched ochre found in the Blombos cave, Malafouris is not so much interested in the ochre as a cultural artifact or in its symbolic or representational intent (p.186) as he is in the activity of mark

making, itself, and what it did to help wire and rewire the ancient mind (p.179). For Malafouris, "the mark-making action and the thinking are the same" (p.189). Malafouris writes that the "Incise lines on ochre requires focused attention, with both hands working together to stabilize the piece, apply the right pressure, and keep the depth of incision constant"(p.186). Tool making, according to Malafouris, is a "species-unique and self-terraforming human predisposition that leaves very little space for valid relational comparisons with other animals" (p.154). Even the most highly trained nonhuman nut crackers couldn't equal the abilities seen in the earliest hominin maker of tools. For Malafouris, the capacity of our brains to wire and rewire themselves arises from the profound complexity of our engagement with tools and technologies. It is the interaction in the making and shaping that initially started to stimulate the unique wiring and rewiring of anatomically modern human brains. *Homo sapiens* first and, later, anatomically modern humans "define and shape ourselves by the tools we make and use" (p. 154). Like a child using hands to find the right words (Vygotsky, 1978), Malafouris sees the power of freeing the hands and the importance of gesture and toolmaking as central to forming the human mind (p.154).

Malafouris' ideas, offer insights into the origins of the brain's plasticity. However, his ideas walk close to the edge of the theory called Technological Determinism. This thesis argues throughout that it is cultural artifacts, created by humans, that allowed anatomically modern humans to emerge out of prehistory with an internal mind and a capacity for the external storage of information in cultural artifacts in the real world. The thesis accepts the premise that the extension of human senses and the physical body's ability to interact in the real world via technological affordances is important in the struggle for life. It concurs with Malafouris ascertain that the making of technological affordances, helps to prepare *Homo sapiens* and

anatomically modern human's brains with the flexibility to accommodate mind. However, technological affordances in themselves do not create mind or culture— people do.

Socializing Affordances: Moving Toward Cultural Artifacts.

I was, at various times in my life, both a professional architect and a professional oil painter, with academic degrees in both endeavors, which meant a lot of years studying art and architectural history where I learned a very famous saying: "Art and architecture reflect the culture that creates it."

Different styles of paintings or buildings— the mere existence of painting as an art form, done in a specific time, in a specific place, in a specific way—reflect the culture of the people who lived in that place during a specific time. The cultural artifacts found in the Blombos and PP13B caves at the edge of the paleo Cape Floral Region include burnt ochre, engraved ochre, beads, etched ostrich eggs. The thesis contends these cultural artifacts are enough to substantiate the emergence of modern behavior before c. 70,000 years ago.

Alan Costall goes to great lengths in an attempt to socialize the idea of affordances developed by J.J. Gibson:

> Objects have been shaped, even deliberately designed, through the intentioned activities of others; they have a "place" in relation to definite cultural practices and "represent" various human purposes; their reliable and safe functioning depends on a social system of mutual responsibilities and obligations (1995, p.479-480).

He then goes on to quote Gibson's assertion that the artificial and cultural are part of what nature has become:

> It is a mistake to separate the natural from the artificial as if there were two environments; artifacts have to be manufactured from natural substances. It is also a

> mistake to separate the cultural environment from the natural environment, as if there were a world of mental products distinct from the world of material products. There is only one world, however diverse, and all animals live in it, although we human animals have altered it to suit ourselves (Gibson, 1979, p.130).

Costall and Gibson are trying to direct their readers to think of culture and nature as affordances. But for the hypothesis being developed in this thesis there is a fine line between "social affordances" described here and "cultural artifacts" described by L.S. Vygotsky in *Mind and Culture*, in the section: Internalization of Higher Psychological Functions. A social affordance can be found in the phrase "It's not what you know, but who you know." People using other people to acquire information about how to survive in the world are interacting with other people as if they were an affordance, similar to the natural affordance of using a stick to get termites out of nest. However, social affordances require a higher level of brain functioning because to communicate intentions to another person—to query another human—there has to be a capacity to externalize intention as information in an external object, whether the external object is a gesture, grunt, or word that both objects (people) can agree on. Each and every one of these mutual agreements of understanding is foundational to a clan's distinct externalized culture, which allows people to interact with each other.

Every time we network on the internet we are looking to get information about our environment. Every time we look at any technological affordance we assume it was made by a human and has a purpose. There is a whole school of design predicated on instructing people how to respond to signs and symbols connected with words or without words. In Western culture buttons invite us to push them, levers on doors invite us to twist them, signs that have red circles with a cross bar warn us not to enter. Steps too high to climb are not an affordance to a toddler.

For social affordances to be meaningful a person must have been enculturated into the culture that created them. To a hunter-gatherer walking down a path a do-not-enter sign or a poison sign might be a meaningless anomaly; a number of decaying human carcasses hanging from trees might be more meaningful as a warning.

Some natural affordances can to be used as symbols or signs, but are only meaningful to an individual who was enculturated to their use. For example, Lewis and Clark set off in 1804 on a two-year expedition to explore the northwest of the United States. Most of their journey passed through the central plains and a wide variety of Indian nations and tribes. In retrospect, one of the keys to their safe passage was an Indian by the name of Sacagawea, a Shoshone woman who ended up accompanying the expedition. A few weeks after encountering the expedition she went into a slow and painful labor, which was eased after Clark, instructed by another Shoshone, gave her some rattlesnake tail, which immediately eased her delivery (Clark, 1983).

Common sayings such as “mind over matter” or “the placebo is part of the cure” offer credence that a rattlesnake tail might be capable of reducing pain in childbirth if Sacagawea had been culturally conditioned to believe in the power of such a cultural artifact, even though it existed in nature as an affordance.

"Sacagawea...was not the guide for the Expedition, she was important to them as an interpreter and in other ways” (Clark, 1983, p.16). The sight of a woman and her infant son would have been reassuring to some indigenous nations— a good example of a social affordance. Sacagawea also played an important role in diplomatic relations by communication—only made meaningful because of the cultural artifacts of grunts, signing, or words—with chiefs, easing tensions, and giving the impression of a peaceful mission (Clark, 1983).

This would support Gibson's statement that "other people are in themselves an important source of affordances" (Gibson, 1979, p. 135). Here being an interpreter is an obvious affordance to the expedition.

Sacagawea's knowledge of the cultural artifact of signing was one of her greatest assets to the expedition. Hand Talk, the American Indian Sign Language website hosted at the University of Tennessee with support from the National Science Foundation, states that:

> American Indian Sign Language is currently endangered, but prior to the cultural disruption caused by European colonization, it was commonly used across a large swath of North America from the Gulf of Mexico to Calgary, Canada, an area of over 1 million square miles. It spread so far because it was used as a lingua franca between Native American nations speaking at least 40 different languages, but it was also used within native communities as an alternative to their spoken languages..." (Davis, 2018, Hand Talk).

Many people seem not able to talk without using their hands. Lev Vygotsky notes that "the child embellishes their first words with very expressive gestures which compensate for their difficulties in communicating meaningfully through language" (Cole, John-Steiner, Scribner, S. & Souberman (eds) 1978, p. 32).

Winnicott: Trust Before Intentionality

D.W. Winnicott, in *Playing and Reality*, gives us an idea of how a "good-enough-mother" (a phrase he coined) might have prepared early humans to be capable of imbuing external objects, such as cultural artifacts, with trust. A good-enough-mother starts off, like most mammals, with an almost complete adaptation to her infant's needs, but "as time proceeds she adapts less and less completely, gradually, according to the infant's growing ability to deal with

her failure of not being available all the time" (Winnicott, 1971, p.10). One of the things this good-enough-mother or good-enough-alloparent does which is distinctive to anatomically modern humans is placate a child's fussiness or teething not with food from her breast, or with grooming like other primates, but rather with attempts to calm the infant by allowing it to suck on something other than its thumb or fist. Possibly in a cave 75,000 years ago a mother continued to let her child nibble on the leather sling she used to carry the child when it was fussy; then in more recent times a blanket or a teddy imbued with a continuous scent; and then more contemporarily the binky pacifier. Winnicott called this object the "first not-me-possession" (Winnicott, 1973). No daughter would leave her infant with its grandparents even for a few hours without leaving its first not-me-possession. Along the way this object facilitates adaptive behavior on the child's part, so the child learns delayed gratification and that frustration is a time-limited sense process. More important for the idea of "meaning making," the object gives the illusion that the child's first not-me-transitional object has an affordance to represent something other than what it is. Tomasello's (2001) and Vygotsky's (Cole et al,1978) observations of the development of children confirm that the externalization of trust into objects such as a child's first not-me-transitional object does happen. What is important to the hypothesis of this thesis is that Winnicott's description demonstrates that mothers and alloparents of infant archaic *Homo sapiens* would have been capable of investing trust into external objects.

Learning Intentionality is the Genesis of Cultural Artifacts

Cultural artifacts are not affordances of nature or technological affordances though they can be built from affordances of nature such as stone or wood or the tools we use to make marks or words on wet clay. Creating any cultural artifact requires work on behalf of human beings: for example, interacting in the physical world to create a pyramid, write a law, paint a picture,

teach words to a child, or trying to agree on the meaning of a grunt, a hand sign, a gesture, or a word.

Humans also instill cultural artifacts with meaning and values by linking mind to how they interact with the objects. Do they bother to keep a house clean? Is it important to wash a car? Read the books on the shelf? Adult's and children's minds do not exist independent of the cultural artifacts that help form them. Alan Costall, in discussing Gibson's social affordance, writes:

> People are (like other animals) animate: they are active in the world, not just in their heads, and it is through their activities that they primarily come to know their world. Indeed, many of the relevant informative structures which support perception, and thereby action, become available only through our movements and activities. For Gibson's claim was that meaning is not a psychic addition but exists within the animal–environment relationship (Costall, 1995, p.470).

How do two or more people come to understand that an externalized action can have a common meaning? How, for example, does a child learn that the word "tree" represents the trees in its yard and not the grass or the bushes? Lev Vygotsky is credited with developing the idea of cultural artifacts as part of his theory of how children learn. He saw cultural artifacts as the sources that allowed the child to internalize external information that resides in the people around him or her. Individual cultural artifacts can contain a single bit of information such as 0 and 1 in a computer code. If I point my finger even without saying anything to you, you will more likely look in the direction I'm pointing. In *Mind in Society: The Development of Higher Psychological Processes,* Vygotsky explains how a child can learn to interpret its grasping movement toward an object or a person by *internalizing* the "pointing gesture" itself as

containing information.

> We call the internal reconstruction of an external operation *internalization*. A good example of this process may be found in the development of pointing. Initially, the gesture is nothing more than an unsuccessful attempt to grasp something, a movement aimed at a certain object which designates forthcoming activity. The child attempts to grasp an object placed beyond its reach: his hands, stretched toward that object, remaining poised in the air. His fingers make grasping movements. At this initial stage pointing is represented by the child's movement, which seems to be pointing to an object—that and nothing more (Cole et.al (eds),1978, p. 56).

If during these movements the mother comes to the child's aid and "realizes his movement as indicating something, the situation changes fundamentally" (p.56). His grasping toward a stone, or a fire can become a "gesture" for others. His grasping for an object is responded to not by the object itself but by another human being. Vygotsky concludes this point with:

> …the primary meaning of that unsuccessful grasping movement is established by others. Only later, when a child can link his unsuccessful grasping movement to the objective situation as a whole, does he begin to understand this movement as pointing. At this time juncture there occurs a change in that movement's function: from an object-oriented movement it becomes a movement aimed at another person, a means of establishing relations. The *grasping movement changes to the act of pointing* (p.56).

According to Vygotsky, eventually the child physically simplifies its grasping to pointing and what can be called a true gesture. However, this happens only after the child has mastered the use of the gesture, like pronouncing a new word, and after the child and those around him or her can mutually agree on the meaning for the gesture or the word. The meaning and function of

the word or gesture are created at first by an objective situation (grasping, for example), which is responded to by a caregiver. It is the response to the child's gesturing that gives it meaning. Gestures, grunts, words are meaningless if they are not responded to by others.

Vygotsky then tells us about the process of internalization, or how children and adult learns about the world around them. First, there must be a transposition where "*an operation that initially represents an external activity is reconstructed and begins to occur internally*" (p. 57), such as a child practicing copying letters and numbers and later visualizing them internally while using them to make words. Second, the learner must then be capable of another transformation: converting the "*interpersonal process into an intrapersonal one*" by using what is internalized to interact with others, or objects that others have made (p. 57). Having accomplished this transformation of internalizing that a particular gesture or action can have meaning, and then in trying the gesture or word out in the real world and finding out that others concur with that meaning, the action can then become the child's own—in the form of memories about how to use an affordance of nature, or the sequencing of how to structure an argument. Finally, it must be understood that the process of "*transformation of an interpersonal process into an intrapersonal one is the result of a long series of development events*" (p. 57). It takes a long time to internalize the culture we are raised in, and even longer if the rules keep changing because a member of the anatomically modern human species has bad parenting, or is forced to integrate into a new culture, such as the army or prison, or must immigrate to a foreign land.

Cultural Artifacts Make Anatomically Modern Human More Energy Efficient

Biologically it makes sense for our bodies to interact with cultural artifacts; they make us more energy efficient (one of the benefits of symbiotic relationships). In our day-to-day life, cultural artifacts create energy-efficient shortcuts because they require fewer conscious decisions

on our part; they give us cues as to how to move effectively in the natural or the made world. Kurt Lewin's description of people's learned habits supports this idea. In *Field Theory of Social Science*: Lewin discusses "how to change" people's behavior, he notes that the problem is that people are born into culture and "indoctrinated and habituated at childhood in ways that keep their habits strong enough for the rest of their lives" (p. 290). Ingrained habits learned from cultural artifacts allow humans and their brains to be more energy efficient yet are flexible enough, over time, to allow for incremental changes.

Evidence for Matriarchal Cooperation as Grounding for Modern Behavior

Cooperation

Orson Wells' contention that "We're born alone, we live alone, we die alone" (Wells, 2015) is erroneous. Even when individuals feel themselves alone they are not. Humans are a symbiotic relationship of body, mind, and culture. From birth it is anatomically modern human culture that forms human minds. A primitive culture yields a primitive mind. Alexei Leont'ev, a Soviet developmental psychologist who worked closely with Zev Vygotsky, said that we do not merely encounter things in our natural and manmade world; we are introduced to them:

> [The] notion of an individual, a child, who is all by itself with the world…is a completely artificial abstraction. The individual is not simply thrown into the human world; it is introduced into this world by the people around it; and they guide it in that world (Leont'ev, 1981).

Cooperation, the giving and accepting of "mutual aid" (Kropotkin, 1902) or mutualistic symbiotic relationships, is the par-excellence survival skill for any species from bacteria to humans. Your very own body depends on it. The body of an anatomically modern human is made up of about 37.2 trillion cells (Eveleth, 2013) of all kinds and purposes: kidney cells, nerve

cells, blood cells, muscle cells, stem cells, and even hair follicle cells. If these cells stopped cooperating with each other, you would biologically cease to exist. If the genetic instruction set in one individual cell mutates enough times and starts to uncontrollably make more sister cells, regardless of its neighbor's needs—you have cancer. Our bodies exist because cells have evolved to cooperate and not compete in some abstract "survival of the fittest" competition (Darwin, 1859). Darwin and his contemporaries were able to scale up the idea of cooperation to higher level animals as essential in a species' struggle to survive based on their observation of animals in nature. But more so than Darwin, one contemporary, Peter Kropotkin (1842–1921), wrote a great work on evolution called *Mutual Aid*, based on five years of field research as a military officer in Siberia, where he participated in several geological expeditions. He interpreted the world he observed differently than Darwin envisioned the world he saw:

> We saw how few are the animal species which live an isolated life, and how numberless are those which live in societies, either for mutual defense, or for hunting and storing up food, or for rearing their offspring, or simply for enjoying life in common. We also saw that, though a good deal of warfare goes on between different classes of animals, or different species, or even different tribes of the same species, peace and mutual support are the rule within the tribe or the species; and that those species which best know how to combine, and to avoid competition, have the best chances of survival and of a further progressive development. They prosper, while the unsociable species decay (Kropotkin, 1902, p.45).

Relationship Between Cooperation and Tameness

Tameness is of interest to this thesis because its presence in a species can be determined in the evolutionary physiological changes in the craniofacial feminization of skeletal remains

(Cieri, 2014). Note the differences in Figure 1. on pg.11 between archaic *Homo sapiens* on the right, c.318,000 years ago (Hublin, 2017), and an anatomically modern human or Cro-Magnon on the left c. 32,000 years ago (Smithsonian, 2016). According to the Smithsonian web site,"The skull of Cro-Magnon does show traits that are unique to modern humans, including the tall, rounded skull with a near vertical forehead. A large brow ridge no longer tops the eye sockets and there is no prominent prognathism of the face and jaw" (Smithsonian, 2016). Some of these refinements can be seen in earlier intermediate fossils found in Africa (Hershkovitz, 2015).

A number of genetic, breeding, and animal studies demonstrate and explain the genetic expression or mutations of genes that reflect the tameness we see in contemporary anatomically modern humans that evolved from archaic *Homo sapiens* (Cieri, 2014; Wilkens, 2014). The Cieri (2014) team postulated that the reduction of average androgen reactivity (lower levels of adult circulating testosterone or reduced androgen receptor densities) is due to tameness. Wilkens, Wrangham, and Tecumseh Fitch (2014) explain Darwin's "domestication syndrome" in mammals as being an expression of neural crest cell behavior and genetics. However, neither of these two studies can help identify changes in prehistoric skeleton remains. For that kind of help the thesis must turn to the Russian geneticist Dmitry K. Belyaev who successfully tamed a silver fox population (Trut 2001) over fifty generations starting in the late 1950's by selecting for tameability, or amenability to domestication. Trut, Oskina, and Kharlamova (2001) studied changes in behavior, morphology, and physiology compared to traits observed in the domestic dog. Darwin's encyclopedic investigation of domesticated species, which he described in *The Variation of Plants and Animals under Domestication* (Darwin, 1868), revealed an intriguing phenomenon that relates to both studies, according to Wilkins, Wrangham, Tecumseh, and Fitch:

> From his [Darwin's] survey of the animal breeding work, he found that domesticated mammals in general exhibit a suite of behavioral, physiological, and morphological traits not observed in their wild forebears. Today, the full set of these characteristics is known to include: *increased docility and tameness*, coat color changes, reductions in tooth size, changes in craniofacial morphology, alterations in ear and tail form (e.g., floppy ears), more frequent and nonseasonal estrus cycles, alterations in adrenocorticotropic hormone levels, changed concentrations of several neurotransmitters, prolongations in juvenile behavior, and reductions in both total brain size and of particular brain regions (Wilkins, 2014, p. 795)

The Cierei et.al (2014) study also tells us that, "high levels of social tolerance, as seen among living humans, are a necessary prerequisite to life at higher population densities [which would have occurred during the interglacial period between MIS 6 and MIS 4 in the paleo Cape Floral Region *refugium*] and to the kinds of cooperative cultural behaviors essential to these demographic models" (Cieri, et al., 2014). However, the paper does not explain how archaic *Homo sapiens* achieved high levels of social tolerance, though it does confirm the "craniofacial feminization (reduction in average brow ridge projection and shortening of the upper facial skeleton) in *Homo sapiens* from the Middle Pleistocene to recent times" (p.419).

These changes should not be surprising. Anatomically modern human biological genes are no different from other mammals' when it comes to expressing genes according to Laland, Odling-Smee, and Myles:

> Researchers from diverse backgrounds are converging on the view that human evolution has been shaped by gene–culture interactions. Theoretical biologists have used population genetic models to demonstrate that cultural processes can have a profound

> effect on human evolution, and anthropologists are investigating cultural practices that modify current selection. These findings are supported by recent analyses of human genetic variation, which reveal that hundreds of genes have been subject to recent positive selection, often in response to human activities (Laland, et al., 2010, p.137).

Admittedly, the experimental breeding studies by Trut, Oskina, and Kharlamova (2001) and Darwin (1868) were directed by humans. After each generation animals were selected for the most tameness and bred with each other, generation after generation. Humans become the force of "natural selection" in Darwin's evolutionary model. Therefore, the thesis cannot attribute the fore knowledge acquired over thousands of years of domesticating animals to archaic *Homo sapiens* without violating the basic tenants of evolution. Any forethought on the part of the evidence used in this thesis has to be limited to the assumed immediate needs of an archaic *Homo sapiens'* or clan's life span. However, this does not eliminate the probability that day-by-day decisions were attempted by clans to limit or encourage when and which females and males could mate, as long as this immediacy of decision making is demonstrable in prehistoric artifacts and/or ethnographic data of contemporary hunter- gather clans. Within these constraints it is possible that comparing skeletal remains of archaic *Homo sapiens* to remains of the Levantine cranium from Manot Cave (Israel) which foreshadows the first European modern humans (Hershkovitz, Marder, Ayalon, Bar-Matthews, … & Barzilai, 2015) to Cro-Magnon c. 30,000 years ago does suggest that craniofacial feminization has taken place—demonstrating that humans were capable of self-taming themselves.

The comparison raises questions. What cultural changes did archaic *Homo sapiens* make that stimulated neural crest cells to activate physiological changes? What biological physical problems could have necessitated a new way for women to relate to each other, including the

necessity to create new cultural artifacts as Vygotsky would have defined them, and possibly necessitated matrilineal culture as opposed to other possible group arrangements?

Anatomically modern humans don't walk down the street snapping and growling at every human they meet (some of their dogs might, but the majority of humans don't). The questions the thesis must answer is why and how did matrilineal clans form, and how did they suppress their instincts for impulsive agonistic responses to other individuals? Tameness emerges as a spiral pattern interwoven with other behaviors. Tameness allows one animal to approach another with increasingly less and less fear, like an unknown dog approaching a human for the first time, each looking for primal instinctual signs of aggression.

How Tameness Might Have Emerged in the Paleo Cape Floral Region *Refugium*

One notable ratchetable modern behavior that has been faithfully transmitted via cultural artifacts from generation to generation is the resolution of the prehistoric obstetric dilemma unique to archaic *Homo sapiens*. The resolution of the *obstetric dilemma was a cultural solution to a biological problem selected and preserved in evolution to survive from generation to generation to the present day.*

Sharon Buck writes, in her paper "The Evolutionary History of the Modern Birth Mechanism: Looking at Skeletal and Cultural Adaptations," that the development of "bipedalism had many effects on human evolution" but "one of the more significant impacts was on the birth process." She then outlines the array of skeletal adaptations that had to take place to accommodate bipedal upright walking and running and how the consequent process of encephalization placed "conflicting pressures on the birth process and the continuation of the species" (Buck, 2011 p. 81). This is often referred to as the obstetric dilemma.

Buck offers a good description of how the delivery process and prenatal growth compromise the female body and have resulted in a unique human birth mechanism referred to as rotational delivery (Buck, 2011; Gruss & Schmitt, 2015; Rosenberg & Trevathan, 2002). Buck concludes her paper with a statement of the link between birth and species extinction applicable to small clans in an isolated *refugium*:

> The evolution of birth is critical because it has the first and most direct impact on natural selection as any serious complications may result in death for mother and fetus. Due to this immediate effect on the gene pool, it has shaped human evolution more than any other skeletal or cultural adaptation (Buck, 2011, p. 91).

Simply put, we are the only species that is known for its ubiquitous communal birthing habits. Midwifery is a cultural solution to biological problem. Midwifery is not a genetic change to a biological body. It is a cultural change based on a new kind of trusting relationship. This idea is reinforced by Karen Rosenberg and Wenda Trevathan in their detailed paper "Birth Obstetrics and Human Evolution." Around the world in the vast majority of anatomically modern human cultures, positions of delivery might change but women ubiquitously seek midwifery assistance:

> So, while there may be rare exceptions, assisted birth is a phenomenon that comes close to being universal in our species. At some point in the evolutionary past of humans, the advantages of assistance during birth out-weighed the disadvantages (e.g. infection or *stress resulting from contact with others*), so that the species-typical pattern of "obligate midwifery" emerged. Human birth is a social, rather than a solitary event. (Rosenberg & Trevathan 2002, p.10, emphasis added).

One of the reasons women seek this help is that the human fetus emerges from the birth canal facing in the opposite direction from the mother. Whatever a woman's delivery position—standing, kneeling, squatting, or lying—the mother must be able to reach down "as non-human primate mothers often do, to clear a breathing passage for the infant or to remove the umbilical cord from around the neck" (Rosenber & Trevathan, 2002, p.10). This is done by drawing the primate infant toward the mother's breast area. This would be almost physically impossible with a *Homo sapiens* child delivered facing the opposite way, since it would risk breaking the child's neck or back.

Rosenberg & Trevathan (2002) compare *Homo sapiens* to our nearest *Homo* ancestors the Neandertal. This comparison is also made by Bruner, Manzi, & Arsuaga in their paper "Encephalization and allometric trajectories in the genus Homo: Evidence from the Neandertal and modern lineages" (Bruner, et al., 2003). Robert G. Franciscus argues that Middle Pleistocene encephalization trends increased obstetric constraints in both the Neandertal and modern human lineages with divergent results:

> Neandertals continued to expand transverse pelvic outlet dimensions (the primitive condition), commensurate with large bi-iliac breadths and cold adaptation, with secondary consequences such as more or less equal pubic bone lengths in both Neandertal sexes. Modern humans, in contrast, underwent anteroposterior expansion of the birth outlet, since the African ancestors of modern humans were built on a transversely narrow pelvis baupan related to warmer climate (Franciscus, 2009, p.9126).

This argument is also supported by L. T. Gruss and D. Schmitt in their article "The evolution of the human pelvis" (2015) which contended that the *Homo sapiens'* body configuration was an imperfect, but remarkable solution to three problems (bipedalism, obstetrics

and thermal regulation) which was finally resolved with the advent of *Homo sapiens* (Gruss & Schmitt, 2015, p.1).

Intermittent deaths of mother or child or both, beyond being painful and heartbreaking, also reduce the survival potential of a species, and could constitute an existential threat to a small clan, if women were unable to overcome their primate instincts to give birth alone and in hiding.

There are endless possibilities that could be pursued regarding the issue of how the *Homo sapiens* female's narrow pelvic area evolved. For example, the need for survival hunting strategies that necessitated thermoregulation. However, Rosenberg and Trevathan demonstrate that a key to modern behavior and the emergence of anatomically modern humans is the importance of midwifery as a cultural solution to the obstetric dilemma: "Human birth occurs in a social context with others in attendance" (Rosenberg & Trevathan, 2002, p.1206).

The Need and Advantages of Alloparent Care in Hunter-Gather Groupings.

According to Holly Dunsworth and Leah Eccleseston in their detailed paper exploring "The Evolution of Difficult Childbirth and Helpless Hominin Infants":

> Bearing and rearing human infants involve processes that appear to be different from those that perpetuate other lineages. Among primates and across mammals, humans seem to have exceptionally protracted and painful labor, with a surprisingly high injury and failure rate, and remarkably helpless babies. Furthermore, a woman's pregnancy, labor, parturition, and infant care are nearly always assisted, suggesting that cooperative breeding (Clutton-Brock, 2002; Kramer, 2005; Hrdy, 2009) is adaptive in the human species because of its direct contribution to the reproductive success of the maternal and paternal lines and its major contribution to that of the offspring (Dunsworth & Eccleseston 2015, p. 56).

Rosenburg & Trevanthan also emphasize that the helplessness of human babies results in the need for intensive care by parents or alloparents (Rosenberg & Trevanthan, 2015). Rosenberg et al., called this condition "secondary altriciality." However, these infants are completely unlike other animals who are born helpless. The terms *precocial* and *altricial* describe a continuum of developmental states in birds and mammals, but according to Rosenberg & Trevanthan it is difficult to place humans on this continuum:

> Humans have relatively long gestation lengths similar to the precocial great apes (e.g., averaging 268 days for *Homo*, 232 days for *Pan*, 257 days for *Gorilla*), but our babies are relatively larger than theirs (6.1% of maternal weight compared to about 3% in African apes) with relatively small brains (29% of adult brain size compared to 40-45% in African apes) (Rosenberg, & Trevanthan, 2015, p.1).

Humans would need to "gestate about seven more months to be born with the same proportion of brain growth accomplished by that of a chimpanzee at birth (Gould, 1977; Leutenegger,1982; DeSilva & Lesnik, 2006)." (Rosenberg, & Trevanthan, 2015, p.1).

It's possible that evolution selected for truncated in-utero premature birth as a partial biological resolution of the obstetric dilemma, but it could not have done so to accommodate Portmann's (1969) "extrauterine spring" hypothesis, according to Dunsworth & Eccleston (2015) which proposes that infants are born early to experience enriching stimulation outside the womb while their brains develop. Though infants do experience enriching stimulation outside the womb, regrettably Portmann's idea suggests that a random evolutionary process foresaw a possibility and designed itself to achieve the possibility. It puts the cart before the horse regarding the evolutionary process.

Sarah Blaffer Hrdy offers a wonderful introduction to the emergence of alloparent care in social-science literature along with her own authoritative take on the issue. Quoting John Bowlby, with whom for the most part she disagrees, Hrdy concedes that his statement "Infant survival in nomadic, foraging context required close physical contact with someone" was a profound insight concerning the human infant's need for a "secure base" and has become widely accepted; it "remains one of the greatest contributions to human well-being ever made by an evolutionary theorist" (Hrdy, 2005, p. 66). She then proceeds to list the names of other famous evolutionary theorists, along with anthropologically oriented psychologists such as Michael Lamb, who expanded the role of "someone" to include alloparents in hunter-gather societies, as groups made up of:

> members other than the parents, who might also care for infants (especially older infants) and help provision both children and their mothers. Mothers were embedded in a wider social network, and family compositions were less stable, more variable, and dynamic than previously assumed. Within such flexible arrangements it is *not always possible to identify the genetic father,* so it may be more precise to refer to helpers other than the mother, or allomothers (Hrdy, 2005, p. 66, emphasis added).

In such a culture, a child could have many mothers, such as older siblings, aunts, grandmothers, or uncles. Hrdy then concurs with human behavioral ecologists who dismantle support for the main alternative "sex contract" hypothesis. Support for her argument comes from K. Hawkes, and R. Bird, (2002), as well as K. Hawkes, J.F. O'Connell, and J.E. Coxworth (2010), among others who disagree with the presumption that prolonged childhood evolved in the context of mated pairs with labor clearly divided between nurturing mothers and provisioning by hunter-fathers Hrdy (2005). Hrdy then goes on the summarize the present generally accepted

understanding that long childhoods were required for the extended development of large brains—requiring prolonged socialization and learning, the use of cultural artifacts, along with mastering tool-based "subsistence technologies that characterized our species." Learning these skills more than "offset the costs of large brains and slow growth (with the attendant risk of dying before maturity and any chance at all to reproduce)" (Hrdy, 2005, p 68).

Ethnographic data collected on the Hadza people in Tanzania by such notables in the field as Hawkes and R. Bird (2002) proposed that obtaining meat by the males of the species had more to do with "showing off" so as to increase sexual access to women than with provisioning progeny. Pursuing the logic that sociobiology used to explain the evolution of nuptial gifts in animals, Hrdy suggests that Hawkes and Bird (2002) hypothesized that males used meat to advertise their hunting skill and worth in order "to compete for access to mates." The strength of these arguments indicates that earlier *Homo sapiens* women did not necessarily live in a patriarchal relationship and the payoff for men was not supporting children they *might* have sired but more sex as we will see in the next sections.

Matrilineal Groupings

Father-as-hunter-and-sole-provider might have characterized Neandertal hunters from northern latitudes as well as the patriarchal families of Victorian society more familiar to Charles Darwin. However, as this section will demonstrate, father as sole provider is a poor explanation for how mothers and children survived in the Cape Floral Region *refugium* in South Africa from c.185,000 until present day hunter-gathers such as the Hadza people (Crittenden & Frank, 2008).

According to Camilla Powers, Volker Sommer, and Ian Watts (2013) there is a growing consensus that evolving *Homo* mothers relied on cooperative breeding to raise larger-bodied, larger-brained offspring. This reliance on matrilineal child support coupled with strategies to

mobilize men's hunting skills is also supported by Aiello & Key, (2002), Barrickman, Bastiana, Islerb, Carel, & van Schaik (2007), Burkart, Hrdy & Van Schaik (2009), Hrdy (2009) , and van Schaik, Pandit, & Vogel (2006).

C. Power, and C. Aiello (1997), in their work "Female proto-symbolic strategies" contend that pair-bonding was inherently less stable for African *Homo sapiens* and go on to state the female of the species developed symbolic counter-strategies using red ochre (See Red Ochre as a Cultural Artifact, p. 53, this Thesis) to resist male philanderers and mobilized men's hunting as mating effort rather than relying on their parental effort (Power & Aiello, 1997).

Genetic studies already referenced substantiate the possibility of matrilineal groupings; for example, Heyer, et al. (2011); Lippold, et al. (2014); and Poznik, et al. 2013). More specific to this section is a genetic study by Behar et al.(2008) that focused on the Khoi and San (Khoisan) people of South Africa. The Kohisan "are considered to be a unique relic of hunter-gatherer lifestyle and to carry paternal and maternal lineages belonging to the deepest clades known among modern humans" (Behar, Villems, Soodyall, Blue-Smith, Pereira,… Rosset 2008, p.1130). The authors wrote:

> Both the tree phylogeny and coalescence calculations suggest that Khoisan matrilineal ancestry diverged from the rest of the human mtDNA pool 90,000-150,000 years before present (ybp) and that at least five additional, currently extant maternal lineages existed during this period in parallel…Our results suggest that the early settlement of humans in Africa was already matrilineally structured and involved small, separately evolving isolated populations (Behar, et al., 2008, p. 1130).

The above dates conform with the study by Lippold et al, (2014).

Geographically, the paleo Cape Floral Region *refugium* could have supported separately evolving, isolated matrilineal clans during the MIS 6 period, which relied on their gathering skills to obtain protein.

Chris Knight in his article "Early Human Kinship Was Matrilineal," states: "If *Homo sapiens* mothers proved able to afford to raise such extraordinarily slow maturing, ultra-dependent offspring, this fact alone testifies to the success of their alliance building and reproductive strategies." (Knight, 2008, p. 81). The following are some of the strategies they were using.

Polyandry and Partial Paternity

One of the ways the females of the species could obtain more protein food for the child beyond their normal diet of shellfish and other costal resources was to practice polyandry. Katherine E. Starkweather and R. Hames define informal polyandry as: "…when two men are socially recognized as sires and provide some investment to the same woman and her child. In general, we define polyandrous unions as a bond of one woman to more than one man" (Starkweather & Hames, 2011p.150). Informal polyandry is the reverse of present-day patrilocal polygamy arrangements found in the African Maasai tribes, in the early Mormon Church, or among the great apes.

Starkweather and Hames write that the practice of polyandry is not as rare as commonly thought: "it is found world wide" and it likely existed during early human history. Their research led them to conclude that "it may be a predictable response to a high operational sex ratio favoring males and may also be a response to high rates of male mortality and, possibly, *male absenteeism*" (Starkweather & Hanes, 2011, p. 149, emphasis added). However, the adult sex ratio of males to females could also be interpreted as there being fewer biologically reproductive

women *available* for sexual intercourse to unrelated males outside a matrilineal clan regardless of the number of women in a clan.

Starkweather and Hames also introduce the concept of *partible paternity* or the belief that a child could have more than one biological father— a concept supported in research done by Walker, Flinn, and Hill (2010) and Beckerman and Valentine (2002). Belief in partible paternity allowed multiple males of the species to believe they along with other males were the fathers of a specific woman's child. Beckerman and Valentine (2002) offers many examples of this kind of believing that is still held by tribes in parts of South America. In Brazil, for example, the records of Eduardo Viveiros de Castro stated that among the Tupi-Guaraní-speaking Araweté "it is difficult to find someone who has only one recognized 'genitor' because more than one inseminator can cooperate...or take turns in producing a child...The ideal number of genitors seems to be two or three (1992, 142, 180)" (Beckerman, & Valentine, 2002, p. 5).

Acceptance of the practice of polyandry in a matrilineal clan, possibly coupled with the belief in partible paternity (Beckerman & Valentine, 2002; Walker, Flinn, & Hill, 2010) on the part of both males and females, offered two options to enhance the survivability of mothers with children and the matrilineal clan as a whole. First, polyandry is believed to enhance a child's survivability and is often found to be prevalent in "smaller, low-density, and often-isolated groups that tend to be egalitarian" (Starkweather & Hames, 2011, p.165). Second, polyandry would have made it acceptable to allow many males to access a limited number of women— those without nursing children— provided these hunters were willing to provision the whole clan by providing larger game such as ungulates, which were seasonally prevalent in areas of the paleo Cape Floral Region *refugium.*

Red Ochre as a Cultural Artifact

According to d'Errico and Banks (2013) "modern behavior" must have developed gradually in Africa as a consequence of the origin of our species there and would have been expressed by a process of gradual accretion of innovations observed in the African archaeological records over the past 300 kyr." (d'Errico & Banks 2013)

Grinding or scraping ochre to produce a powder for use as a pigment was a common practice in Africa and the Near East after c. 100,000 years ago (D'Errico & Banks 2013); Henshilwood, et al.,2009; Rosso, Pitarch, & d'Errico, 2016; Wadley, 2010). The use of ochre applied to the body is a strong indication of symbolic behavior (Hovers, Bar-Yosef, & Vandermeersch, 2003), though ochre has been shown to have other uses, such as making a glue to haft stone to wood (a process that in itself indicates complex thought) (Wadley, Sievers, Bamford, Goldberg, Berna, & Miller, 2009). Two deliberately engraved ochre pieces (Figure 4., p.38) from a c.75,000 years old level at Blombos Cave, in the Cape Floral Region, are indicative of the first known externalization of information by an anatomically modern human and is considered evidence for symbolically mediated behavior (Henshilwood, et al. 2009). Henshilwood states: "The conceptual ability to source, combine, and store substances that enhance technology or social practices represents a benchmark in the evolution of complex human cognition" (Henshilwood, et al., 2011. p.221).

According to archeologists, deposits in caves in the region include "hundreds to thousands of pieces of worked and unworked ochre at sites dating as far back as 120,000 years ago" (Marean, 2010, p.53). This ochre from caves such as Pinnacle Point and the Blombos tends to be a deep red in color. Yet local sources of the mineral exhibit a range of hues, suggesting that humans were preferentially harboring the red pieces because of the association of the color with menstruation and fertility (Powers 2013). "According to Jocelyn A. Bernatchez, many of

these ochre pieces may have been yellow originally and then heat-treated to turn them red" (Marean, 2010, in section, "Smart from the Start"). Fire-treated ochre is one of the earliest examples of using technological affordances (controlled fire + yellow ochre) to create a cultural artifact.

C. Power, V. Sommer, and I. Watts, contend that "under pressure of encephalization, modern human female ancestors, less seasonally constrained, pursued a strategy of cosmeticization of menstrual signals" (Power, Sommer & Watts, 2013, p.33).The ochre was possible mixed with animal fat or urine and spread over the vaginal area of the woman's body as a way to communicate an idea relating to "menstruation and fertility" (Powers, Sommer, & Watts 2013, p. 54). In an earlier paper Power and Aiello (1997) outlined the necessity of this deception on the part of women:

> First, they would do best if they could avoid attempts at being held separate, in harem like arrangements typical of great apes, and away from any potential matrilineal support system (which could include brothers and uncles) able to collectively resist dominant males. Second, no female needs a partner who will get her pregnant only to abandon her in favor of a new sexual partner (Power, & Aiello, 1997, p. 60).

Samuel Bowles reinforces this idea: "To any local group of females, the more such philandering can be successfully resisted—and the greater the proportion of previously excluded males who can be included in the breeding system and persuaded to invest effort—the better" (Bowles, 2006, p. 1570). By evolving concealed ovulation and continuous receptivity, females force males into longer periods of courtship if they are to have a good chance of achieving impregnation (Bowles 2006).

To local groups of females in the paleo Cape Floral Region *refugium* even during times when food might have been reasonably plentiful from the sea or from plant carbohydrates it might still have been advantageous to induce as many males as possible (but not kin) into thinking each male was the father of the same child for a variety of reasons. For example, they would be less likely to eat the infant and they would be more likely to provide protection and food for the support of the mother and infant (Bowles, 2006).

According to K. Hawkes and R. Bird, (2002), "Showing off, handicap signaling, and the evolution of men's work," reinforces the idea that by using concealed ovulation and continuous receptivity through the use of red ochre, females could possibly entice males into longer periods of courtship, inducing the show-off displays of hunting prowess with a food gift that would benefit the entire clan if they were to have a good chance of achieving impregnation (Hawkes & Bird, 2002). K. Hawkes, J.F. O'Connell, J.F. and J. E. Coxworth, expand this idea:

> Males of other primate species do not contribute any significant fraction of the food consumed by females and juveniles. Our own species is different. When people live on wild foods, hunting is usually a specialty of men, and meat is commonly a substantial component of everyone's diet…This unique male subsistence contribution may have evolved as hunting large animals became a focus of competitive display (Hawkes, et al., 2010, p.58).

So even though women were living in matrilineal communities, in a *refugium* which offered plenty of protein from the sea (at least until the end of the MIS 6 glaciation), there were good reasons to confuse males with red ochre. Showing or hiding the potential fertility of a female makes red ochre one of the earliest known use of a physical cultural artifact capable of externalizing information— a sign of anatomically modern human behavior.

Birth of the Memes, the Gesture, and the Clan

This thesis has already addressed the developmental psychological importance of cultural artifacts as intermediaries between mind and culture—a symbiotic, interdependent, evolving dialogue between mind and culture—mediated by cultural artifacts.

Merlin Donald in his majestic work to explain human consciousness (Donald, 2001) saw early *Homo* species as being capable of a "culture of public action, without language, or symbols but equipped with mimetic expressive skills" (Donald, 200, p. 263). Given early *Homo sapiens'* evolutionary proximity to primate social styles such as agonistic behaviors, "the control of emotions by public action and gesture would have been one of [archaic *Homo sapiens*] priorities" (p.2630. Thus, contrived public displays, public competition for control, and *a great deal of deception* would have been the rule." (p. 263, emphasis added) According to Donald, anatomically modern humans use gestures, body language, and mime even today as very effective cultural artifacts for communicating intention effectively without the use of language.

A Cultural Externalized Solution to an Interior Biological Problem

This thesis has been presenting evidence that a band of archaic *Homo sapiens* occupied a cave, now referred to as PP13B (Marean, 2011) in what is now the Cape Floral Region of South Africa c. 185,000 years ago at the beginning of a new ice age designated as MIS 6. The thesis has been using the phrase archaic *Homo sapiens* to set them apart from future generations that

many thousands of years later, but at least by c. 70,000 years ago, are emerging as anatomically modern humans. D.E. Lieberman, B.M. McBratney, and K. Krovitz, with their research support the idea of anatomically modern humans as "a distinct species from taxa of "archaic" *Homo"* (Lieberman, et.al.,2002, p.1134). Unlike their northern Neandertal fellow *Homo* species who left Africa c. 500,000 years ago in an earlier out of Africa migration and physiologically acclimated to a colder northern climate, the males of *Homo sapiens* were hairless, clawless, and largely weaponless, but had learned how to use their sweatiness and relentlessness to gain an upper hand over faster, stronger, and often more dangerous animals, by running ungulates and others to exhaustion (Bramble, Daniel, & Lieberman, 2004). However, the use of sweaty thermoregulation to maintain the homeostasis of archaic *Homo sapiens* (Gruss & Schmitt, 2015) had a drawback for the female of the species and how their children were born. The archaic *Homo sapiens* female's narrow pelvis evolved with a more circular birth canal—reflecting selective pressures for both further increases in neonatal brain size and for a narrow body shape associated with heat dissipation in warm environments (Gruss & Schmitt 2015). What is fascinating is that to resolve the problem that arose from the obstetric dilemma, evolution selected, down through the ages, a culturally modern human behavior—communal birth or obligate midwifery—over a biological genetic solution to help maintain the survival of the species during the birthing process. It is still very normal for other female mammals to go off,

Figure 5. Visual Comparison of Body Differences Between Neandertal and Anatomically Modern Humans. Vreeland, J. (2018)

hide in the bushes, or a tree, or the dark warm corner of a basement to give birth. They do not normally need or desire assistance during birth.

Extinction was a strong possibility for isolated archaic *Homo sapiens* clans that might have been structured hierarchically like baboons or might have supported women's primate instinct to give birth alone. Evolution does not seem to have selected for this kind of behavior in anatomically modern humans as a species. However, the animal kingdom does offer rare examples of an alternative model. One such is a videotaped incident of a langur monkey during her first birth being assisted by an older langur female who had earlier the same day just delivered her fifth birth (Pan, Gu, Pan, Y., Feng, Long, Yi, Meng, Liang & Yao, 2014). In an interview with M. Walker (2014), Professor Yao, of the Pan team, observes that, "Midwifery is a common practice in almost all human societies. But it has been believed to be a unique human behaviour". She then states that, although assisted birth might be more common among other primates than supposed, " it is only likely to occur in primate species where females do not form hierarchies or compete with each other": "Macaques and baboons for example, are more likely to kidnap each other's infants than help another mother give birth" (Walker, 2014).

Conclusion

Matrilineal Clans and the Cape Floral Region *refugium* supported the Evolution of Anatomically Modern Humans Behaviors Before c.70,000 years ago.

Many isolated minority groups of individuals and families of the present Anthropocene era are being driven to migrate because of drought and erratic weather patterns, just as small remnants of paleo archaic *Homo sapiens* were driven southward to the tip of African in their unrelenting search for their daily meal. Evidence discussed throughout this thesis supports the dating of these earlier migrations to the paleo Cape Floral Region by at least c.185,000 years ago

as the MIS 6 glaciers in the northern hemisphere sucked moisture from the planet's atmosphere while drying up its oceans. Anthropological evidence found in many geological strata of PP13B and other caves in the paleo Cape Floral Region *refugium* confirm that archaic *Homo sapiens* found shelter in the area; even as the glacier age deepened, the seas receded, leaving an expanded dry landmass on the Agulhas Bank, and offering more food sources for the survivors (see Figure.3 p. 16). Not all these climate refugees survived. Those that did survive morphed into anatomically modern humans, leaving behind fossil evidence of craniofacial feminizations similar to animals bred for tameness.

The thesis then focused on how the female "gatherers" of the species learned over tens of thousands of years to survive by "gathering" an important source of protein from the oceans (critical to brain development) instead of relying solely on the erratic supply of "show off displays" by male hunters made to a clan for female sexual favors.

The thesis documents the benefits of suppressing instinctive genetic public displays of agonistic behaviors first between women of the species by self-taming themselves long enough to offer mutual aid to each other (as Kropotkin described it), and concurrently using a culturally supported midwifery to assist each other in giving birth and alloparenting each other's children—behaviors ubiquitous to anatomically modern humans even to this day, which matrilineal clans learned to ratchet-up and pass on from generation to generation. Such modern behaviors are not transmitted genetically. Anatomically modern humans are not born with modern behaviors already in their brains. Modern behaviors that allowed anatomically modern humans to live more cooperatively were imbedded in cultural artifacts (external to the brain) and transferred from generation to generation—as defined earlier by Vygotsky—with grunts, gestures, and artifacts. More specific to the hypothesis of this thesis, artifacts such as red ochre

heated in a fire to get the right degree of redness and then ground to use on the body, or shells drilled with holes in them so they could be worn or given as gifts, or two pieces of etched ochre from the Blombos cave all represent physical cultural artifacts that demonstrate modern behaviors long before c.70,000 years ago.

A genetically viable number of anatomically modern human women had to survive and multiply beyond the geographically shrinking paleo Cape Floral region *refugium* during the global warming MIS 5 period or anatomically modern humans would not exist today. Geographic diminishment of a glacially confined land area forced an ever-increasing closeness. This closeness necessitated creating and evolving new modern behaviors to support ever larger cooperating circles of individuals and clannish cultures, without which at least a hundred childbearing females would not have been able to maintain their numbers and multiply beyond c. 70,000 years ago. Without a willingness and the creativity to find ways to accommodate intergroup cooperation through new cultural artifacts there probably would have been an active regression toward public agonistic displays which have plagued anatomically modern humans since the advent of agriculture c.11,000 years ago, possibly or probably leading to some extinctions even in the Cape Floral Region. However, anatomically modern humans did not go extinct. They became more behaviorally modern. To survive during intergroup pressures, emerging anatomically modern humans would have had to develop some form of rudimentary sign language (as the northern plains Indians did) that could facilitate intergroup communications, if for no other reason than to negotiate territorial disputes within their shrinking *refugium*, rather than regressing to agonistic behaviors leading to death. All of the above contributed to the emergence of anatomically modern behaviors before c.70,000 years ago.

As the *refugium's* available living space shrank from global warming during the interglacial MIS 5 period (a microcosm of our earthly home's overpopulation and erratic weather problems today) the females of the species still had to attend to their daily struggle to feed themselves and their children while unknowingly evolving from generation to generation. One important evolutionary step was the resolution of the *obstetric dilemma*—a cultural solution to a biological problem selected and preserved in evolution to survive from generation to generation to the present day. Even in their micro *refugium* they had to learn, as we will have to in the present day, to incorporate newer cultural artifacts that can be trusted as a child learns to trust a "good-enough-mother" and its "first not-me-possession" (Winnicott, 1971). Even when individuals feel themselves alone they are not.

This thesis has documented that humans are a symbiotic relationship of body, mind, and culture, with ingrained habits transmitted through cultural artifacts (which have a designed objective built into them by humans to maintain the status quo). These cultural artifacts further allow humans and their brains to be more energy efficient yet flexible enough, over time, to allow for incremental changes. It was these advantages which started to emerge in matrilineal communities before c.70,000 years ago that allowed the first anatomically modern humans to have been selected and preserved by evolution in their Darwinian struggle to survive.

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