

The Role of Episodic Memory and Autozoetic Thought in Upper Paleolithic Life

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ABSTRACT

Kuhn and Stiner (2006) have argued that the division of economic labor by age and gender is a salient feature of the recent human condition, that it emerged relatively late in human evolutionary history, and that it is not typical of Neandertals. Their provocative analysis of the archaeological signature of modern humans invites several alternative interpretations. In the present paper, we postulate that age and gender divisions of economic labor may have been a consequence of mental simulations enabled by an enhancement of working memory capacity that enabled true episodic memories and autozoetic thinking.

Kuhn and Stiner (2006) have proposed that the division of economic labor by age and gender is a salient feature of the recent human condition and that it emerged relatively late in human evolutionary history. They argue that one recent human type, Neandertals, exhibited little evidence for the kinds of distinct economic roles even as are often shown by contemporary hunter-gatherers. Their review of anthropological evidence suggests that Neandertals may have had more narrowly focused economies with women and juvenile activities more closely aligned with adult males. Kuhn and Stiner's analysis underlines a conclusion that has become increasingly clear over the last few decades—many aspects of Neandertal life differed from those of the modern humans who followed them. Neandertals were undoubtedly effective and successful; indeed, in many contexts they were probably more effective than modern humans. But their solutions to life's problems do appear to have been different. Kuhn and Stiner frame this difference in terms of demographic and social differences, with a specific account of division of labor. Their conclusion is controversial, even within this standard framework, and there are a range of alternative interpretations (see commentaries to their article). We would like to suggest that the framework itself may be inadequate for the task. It is more parsimonious, we contend, to explain the difference in modern human behavior within a framework of cognitive evolution. The differences in archaeological signatures may well reflect differences in ways of life, but the underpinnings of these differences are not some vague social/demographic dynamic, but a very real difference in how moderns and Neandertals thought about the world.

Kuhn and Stiner, and some of the commentaries, allude to a possible cognitive difference, so we are not alone in this suspicion. Kuhn and Stiner themselves recognized the possibility of a cognitive difference and noted that complementary economic roles and food sharing imply the ability to negotiate these roles and to penalize those who deviate

from these norms. However, they shy away from any sudden neurological shift as an explanation. Bocquet-Appel (2006) pondered whether Neandertals were incapable of transmitting factual memory across generations, although he noted that they have been accorded transition industries and the adoption of some technological innovations, while Hovers (2006) noted that Neandertals' technological knowledges "were not catching up," per penecontemporaneous *Homo sapiens*. Hovers (2006) also has expressed valid reservations about vague cognitive explanations. We would as well, if the explanation remained at some vague cognitive level (e.g., language) or vague neurological level (e.g., frontal lobe expansion) without reference to a more specific neural substrate, its clear and subsequent effects upon specific cognitive functions, and their implications for behaviors that might be reasonably assumed from the archaeological record. Elsewhere we have done just this, discussing the roles of enhanced working memory for moderns, and expertise for Neandertals (Coolidge & Wynn 2005; Wynn & Coolidge 2004). Here we would like to explore the likelihood that moderns relied heavily on episodic memory.

Our model was based on the original working memory model proposed by Baddeley and Hitch (1974) and subsequently modified and substantiated by three decades of empirical research (e.g., Baddeley 2000, 2001; Engle and Kane 2004; Hazy, Frank, and O'Reilly 2006; Miyake and Shah 1999; Shah and Miyake 2005). As currently conceived, working memory is a multi-component cognitive system reflecting a capacity to hold and manipulate information in active attention consistent with short- and long-term goals, in spite of task-irrelevant interference. Working memory consists of a central executive that manipulates two subsystems: (a) phonological storage with vocal and subvocal articulatory processors, and (b) a visuospatial sketchpad. Baddeley's most recent addition to working memory is an episodic buffer that integrates information from the two subsystems and serves as a temporary store for this

information and other material at the behest of the central executive. Baddeley currently views the episodic buffer as a storage system, which uses a multimodal code. It is episodic in the sense that it can hold integrated scenes, stories, or personal episodes in temporary consciousness. Baddeley also proposes that retrieval from the buffer is the nature of consciousness, and its binding functions are assumed to be the principal biological advantage of consciousness. Furthermore, because the episodic buffer allows multiple sources of information to be considered simultaneously, it may allow the creation of models of the environment that can be used to solve problems and to make plans for future behaviors. Recent work has delved into the nature of working memory capacity, which attempts to measure individual differences in working memory's capabilities. Working memory capacity has been empirically demonstrated to predict a broad range of higher order cognitive tasks, such as attention, language comprehension and production, reasoning, and general and fluid intelligence (novel problem solving abilities), e.g., Engle and Kane (2004) and Kane and Engle (2002).

As we noted earlier, we too would be leery of vague 'neural mutation' accounts for modern thinking as well as equally opaque cognitive claims that 'it must have been language.' In prior papers, we have already gone into some detail as to the nature of the neural mutation, its timing, and its possible effects upon specific cognitive processes (see Coolidge and Wynn 2005 for greater detail). In the present paper, however, we would like to confine ourselves specifically to the issue of a cognitive ability or trait that might have served as the foundation for not only age and gender based divisions of economic labor in Upper Paleolithic *Homo sapiens*, but many other aspects of the modern life-ways.

Psychologists and cognitive scientists have long distinguished between declarative memories like facts, details, strings of sounds and words, and procedural memories (motoric and visual-spatial) like stone-knapping and way-finding (Kolb and Whishaw 2001). Both types appear to use relatively independent neural pathways and selective types of brain damage may affect one type of memory but not the other. Interestingly, one type of declarative memory is *episodic memory*, defined as a coherent, story-like reminiscence for an event often with time, place, and feeling signatures. It also has been labeled *personal memory* or *autobiographical memory*. The other major type of declarative memory is semantic, often thought of as the memory for general facts. A reminiscence, of course, will include semantic details but its recall and subjective experience will be psychologically and neurologically different than the recall of the semantic components alone (e.g., Tulving 2002).

Many features of Upper Paleolithic life suggest longer reaches in time and space. In addition to the thought provoking argument for age and gender division of labor, Kuhn also has used raw material usage patterns to document a change in the landscape use over the course of the early Upper Paleolithic in Anatolia (Kuhn 2004). A pattern of short range foraging and 'provisioning of individuals' was

replaced by a larger scale system in which certain sites were provisioned for future use ("provisioning places"). Clive Gamble (various, e.g. 1999) has made a strong case that after 33 kyr, European societies included not only larger face-to-face groups, but also systematic social contacts over distances of hundreds of kilometers. Memory of exchange episodes almost certainly underpinned these long range social obligations. Such systems all imply that the phenomenological life-world of Upper Paleolithic people differed significantly from their predecessors, and was almost certainly based on episodic memory, and active engagement with past and future.

Recent empirical cognitive research into the nature of episodic memory may contribute to the understanding of differences between Neandertals and *Homo sapiens*. If 21st Century humans are asked to recall a list of thematically related words previously read to them, they generally will identify as part of the list, words that are related thematically but were not on the original list (false recognition) while correctly identifying words as not on the list, words that are not thematically related to the original list (true recognition). Neuroimaging studies have shown that both true and false recognition especially require hippocampal and parietal lobes functioning (e.g., Schacter 2001; Schacter and Addis 2007; Tulving 2002). People with hippocampal damage or an absence of a hippocampus, such as a patient known as H.M., have a complete inability to form long-term declarative memories. They can form and transmit procedural memories, although they cannot remember learning them verbally, but they can demonstrate the knowledge performance-wise (e.g., Gazzaniga et al. 2002). There are also examples of amnesic patients, such as patient K.C., who cannot remember their past very well (episodic memories) because the latter are recalled like a personal story, and as noted earlier, these memories have a time, place, and feeling associated with them that seems to escape amnesic patients. Very importantly, such patients often have problems imagining their future (Schacter and Addis 2007; Tulving 2002).

This confluence of memory and neuroimaging studies of healthy adults and brain-damaged patients suggests that the human memory system, rather than being seen as deficient or inexact, because of the false recognition problem noted earlier, is actually a constructive and adaptive system that can recall the essential gist, essence, or pattern of an experience at the apparent cost of unerring accuracy. However, there is another powerful advantage of this system and that is that people use their episodic memories to simulate future scenarios (e.g., Dudai and Carruthers 2005; Schacter and Addis 2007; Tulving 2002).

Interestingly, Tulving (2002) has proposed that the ability to simulate and contemplate future scenarios has been the driving force in the evolution of episodic memory. Tulving proposed the term *autonoesis* to refer to the ability, unique to humans, of a special kind of consciousness that allows individuals to become aware of the subjective time in which past events have happened. It is also this ability that allows humans to travel mentally in time. Tulving cites

neuroimaging studies that demonstrate an asymmetry in the encoding and retrieval of episodic memories—left prefrontal cortex is more involved in encoding episodic memories, and the right prefrontal cortex is more involved in retrieving them. Indeed, semantic memory retrieval more often involves the left hemisphere, thus, demonstrating a neurological distinction between episodic and semantic memories.

Tulving (2002) also offered one other provocative speculation on the nature of episodic memories. Mental time travel, by way of episodic processes, allows awareness of not only the past but of what may happen in the future. As Tulving (2002: 20) noted:

“This awareness allows autozoetic creatures to reflect on, worry about, and make plans for their own and their progeny’s future in a way that those without this capability possibly could not. *Homo sapiens*, taking full advantage of its awareness of its continued existence in time, has transformed the natural world into one of culture and civilization that our distant ancestors, let alone members of other species, possibly could not imagine.”

Interestingly, Baddeley (2001) viewed his own proposed episodic buffer in working memory as intimately tied to Tulving’s concept of episodic memory, although Baddeley sees the episodic buffer as strictly a temporary storage buffer, whereas he views Tulving’s episodic memory as primarily a system concerned with long-term storage. However, despite Baddeley’s differentiation, it appears obvious that Tulving’s concept of episodic memory has an important short-term component, albeit not stated explicitly.

Suddendorf and Corballis (2007) also have recently extended the metaphor of mental time travel, based on episodic memory processes, to hypothesize that the ability to generate, predict, plan, and shape future events has provided an intense selective advantage for future survival. They reason that present behavior can certainly influence an individual’s future survival chances, thus, there is the expectation that many species might evolve anticipatory capacities, although in some species, they argue, inflexible mechanisms to anticipate the future might suffice (like bears hibernating at the start of winter). They further propose that in modern humans this system is the most flexible. They speculate that the mental reconstruction of past and future events may have been responsible for the concept of time. Thus, having an appreciation for the continuity of time, that is, past and future on the same dimension, individuals become aware that the future often becomes the past. Thus, for them, mental time travel (episodic memory reconstruction) is a generative process, incorporating known elements arranged in unique ways that could have occurred in the past but did not, and may occur in the future but might not. They see the primary role of mental time travel as providing raw material from which to construct and innovate possible future scenarios.

Interestingly, Suddendorf and Corballis used a theatre metaphor with cognitive correlates and chief among them

was an executive producer. They noted that enacting a planned event requires executive functions such as the ability to select and inhibit competing responses, ultimately in favor of those that are thought to best suit various future scenarios. We see this role as particularly relevant to the development of age and gender based economic divisions of labor because episodic memory processes would require not only the innovation and active construction of such a system but also, as Shea (2006) noted, it requires the negotiation, disputation, and enforcement of differential economic roles. Even Kuhn and Stiner noted that complimentary economic roles and food sharing implies the ability to negotiate these roles and to penalize those who deviate from these norms. To us this clearly further suggests the important role of Baddeley’s central executive, its executive functions and two subsystems, and the episodic buffer in the life-ways of Upper Paleolithic *Homo sapiens* (see Coolidge and Wynn 2001, 2005).

Suddendorf and Corballis (2007) also noted that episodic memories and mental time travel induces a new kind of ‘mental stress,’ which is the anticipation of negative future outcomes, including death anxiety. Indeed, with burgeoning episodic memory capabilities, we might recall sorrowful past events, inducing depression and anticipate negative future outcomes, inducing anxiety. The subjective awareness (autozoesis) and feelings associated with these experiences and constructions might even serve as the inchoate beginnings of psychopathology. Given the great prevalence of these two disorders in present day psychopathology, depression and anxiety have been labeled the common colds of the variety of mental disturbances (e.g., Davidson et al. 2004).

Baddeley (2000, 2001) also proposed that greater working memory capacity would allow for the reflection and comparison of multiple past experiences. This might allow an individual to actively choose a future action or create an alternative action, rather than simply choosing the highest path of probable success. Although an individual would still be better off (compared to one without benefit of past experience) choosing alternatives simply based on the past (an example of an inflexible anticipatory process), Baddeley proposed that greater working memory capacity would allow for the formulation of mental models more likely to be successful as future behaviors.

Shepard (1997) postulated that natural selection favored a perceptual and representational system able to provide implicit knowledge (long-term memory) of the pervasive and enduring properties of the environment and that natural selection also favored a heightened degree of voluntary access to this representational system (created by working memory). This access, he proposed, facilitated the accurate mental simulation of varying actions, allowing the evaluation of the success or failure of these actions without taking a physical risk. Shepard thought that the mere accumulation of facts (as in Baddeley’s semantic memory or Mithen’s natural history intelligence or technical intelligence) would not result in advances in scientific human knowledge but its advancement would require “thought experiments.” He

also postulated that every real experiment might have been preceded by thought experiments that increased the probability of the success of the real experiment. Dawkins (1989) also proposed that natural selection would have favored the reproductive success of those individuals capable of simulation. He described systems highly similar to those of executive functions of the frontal lobes (see Coolidge and Wynn 2001 for our extended coverage of these functions) and replete with the executive functions metaphor. For example, he viewed consciousness as the culmination of an evolutionary trend where consciousness served as an executive decision-maker with an ability to predict the future and act in accordance with the predictions.

At this point it is well to return to archaeological record itself in order to make our general argument more specifically relevant. The European Upper Paleolithic presents a number of specific examples of activities that implicate episodic memories and/or an autozoetic life-world. We mention just a few of the more salient cases:

- The famous tableau at Lascaux that includes a bird-headed human figure, a wounded bison, a rhinoceros, and a bird on a shaft would appear to represent a scene of some sort. Whether mythological narrative, a hunting story, or a shamanistic performance, it was an episode that was remembered and painted, perhaps even celebrated. We imagine that few would want to deny the artist a rich set of episodic memories. Of course, Lascaux is relatively late in a chronological sense.
- The images at Chauvet, 17,000 years earlier (ca. 34 kyr [Clottes 2003]), are not as obviously episodic. However, the overlapping sequences of rhinoceros, and horse, and lion have a dynamic quality that may have been a convention to represent motion, and a particular episodic memory of the animal in question.
- The famous Sungir burial (ca. 28 kyr [White 2003]) of two juveniles is equally provocative. In addition to over 5,000 beads and other grave goods, the burial included spears carved entirely of ivory. Because ivory is soft, such spears were unlikely to have been intended for use. The ceremonial nature of such objects suggests that those who buried the juveniles may have perceived an afterlife in a manner phenomenologically different from real world. This is the stuff of autozoetic experience.
- The enigmatic engraved plaques from Aurignacian sites such as Blanchard and Lartet almost certainly represent external memory devices (d'Errico 2001) used to keep track of something. The most likely reason to do this would be to carry factual information from the past, through the present, into the future. These were truly autozoetic devices.

Using Donald's (1991) three stages for the evolution of culture and cognition, Hodgson and Helvenston (2006: 13) have recently proposed that the last stage, mythic culture, was characterized by "high-speed phonology, oral language and oral culture....[requiring] enhanced representational

abilities....[suggesting] enhanced cognitive capacities over that of the mimetic stage." To us, these 'enhanced representational abilities' are suggestive of episodic memories. Sugiyama (2001) has also argued that narratives, folklore, or story-telling (all of which may be clearly categorized as episodic memories) may have been naturally selected for because of their efficiency and safety in the acquisition of information. Verbal representations are substitutes for time-consuming and sometimes dangerous first-hand experience. She posited that fitness in varying habitats may have particularly aided foraging knowledge by transmitting information about geography, plants, fauna, weather, and other aspects. Arsuaga (2002) has also argued that the unique advantage of the Aurignacian culture, vis-à-vis the Mousterian, may have been the ability to verbally share myths. Although he does not add the advantage of recalling experiences in simulating the future per se, he does note that myth-sharing allows the ability to link past and present, and the use of wisdom from past experiences. Presumably, this wisdom confers its benefits primarily because it allows successful anticipation of future events.

We have previously written in much greater detail of the requirements of a fully functioning frontal lobe system, in particular prefrontal cortices, in the formation of short- and long-term goals and future plans (Coolidge and Wynn 2001, 2005). Recent neuroimaging studies not only continue to support the critical role of the prefrontal cortices in this regard but now appear to support their involvement in episodic memory recall as well. As noted earlier, when normal adults are asked to form episodic memories (through experimental manipulation), the left prefrontal cortices are differentially more involved than the right prefrontal cortices, whereas when they are asked to recall them, this pattern is reversed and right prefrontal cortices are more heavily involved (see Tulving 2002, for a review of these studies). It is important to note, however, that these episodic memory tests did not necessarily involve prospective episodic memories or mental time travel. Thus, mental time travel and episodic memory are not completely synonymous terms, and in our opinion, simulation and the formation of alternative future plans in all likelihood calls upon many other cortical regions.

At this point, we reiterate an argument by Trinkaus (2006)—it is modern humans who are more morphologically derived than Neandertals. His examination of 75 cranial, mandibular, dental, axial, and appendicular traits in Neandertals, early and middle Pleistocene *Homo*, and modern humans led him to the conclusion that about half of the traits were largely unique to modern humans. If modern humans are more morphologically derived than Neanderthal, is it not reasonable to at least examine the assumption that they may be more neurologically derived and may have some unique neurological features as well? Indeed, Bruner and his colleagues' (Bruner et al. 2003; Bruner 2004) work provides powerful empirical evidence that this may be the case. In their examination of two-dimensional and three-dimensional samples of a variety of *Homo* endocasts (including Neanderthal), they were able to conclude that

there is support for the hypothesis of a general evolutionary inertia of the frontal lobes. It does not appear, at least morphometrically (and verified statistically), that it is the frontal lobes that best distinguishes between Neandertals and their penecontemporaneous *Homo sapiens*, but the parietal lobes. Furthermore, whereas there has been a small shrinkage of the overall cranial volume from Neandertal to modern humans (about a 9% reduction), the parietal lobes appear to have expanded. This parietal lobe hypertrophy, coupled with a reduction of the occipital lobes and their movement to a more anterior position (under parietal lobe structures) has resulted in a more globular brain (reflected by klinorhynchy). Bruner further speculated that given a more globular brain, given that neocortical white matter has outpaced grey matter in anthropoid brain evolution, there may be greater corticocortical interconnectivity in the neural brain networks of modern humans.

Finally, Bruner hypothesized that this parietal lobe expansion was highly likely accompanied by a discrete cognitive shift. His best guess for the nature of this cognition comes from the elementary traditional bases of parietal lobe functions: visual-spatial integration, sensory integration, multimodal processing, and social communication. Bruner cited the work of Konrad Lorenz (1973) who postulated five variables critical to conceptual thinking: abstraction, curiosity, voluntary movement, imitation, and spatial orientation. Also important to Lorenz was the ability of conceptual thinking to create an imagined space interior to the central nervous system. Theoretically, Bruner reasoned, this space would work as a model to act 'virtually' within an environment by means of thought, and it serves as the basis for any conceptual operation. Thus, Bruner concluded that considering the known role of the parietal areas in its recognition and communication of the external environment, they may be directly related to the evolution of an accurate and ultimately highly adaptive 'inner reality.' This parietal lobe hypertrophy does not necessarily invalidate frontal lobe hypotheses that postulate their role as crucial to modern thinking, as Bruner's work does not measure anything but size and shape. That some critical rewiring or interconnectivity occurred within the frontal lobes or between the frontal lobes and other lobes as a result of hypertrophy still remains a very viable hypothesis.

In order to bring our argument for episodic memory functions full circle, we would add that Bruner did not mention two highly important structures to the creation of inner speech (subvocal articulation)— the supramarginal gyrus and the angular gyrus. Both of these structures largely constitute the inferior portion of the parietal lobes and both have been demonstrated to be crucial to phonological storage (e.g., Becker et al. 1999). Furthermore, Carruthers (2002) has hypothesized that inner speech (particularly generated by the left parietal lobe) is critical to intermodular and interhemispheric processing; that is, inner speech allows the left hemisphere access to non-verbal right hemisphere knowledge. We would also add that the creation of a better, more accurate, inner picture of the outer environment, perhaps as a function of the evolutionary expansion

of parietal lobe areas, undoubtedly resulted in enhanced episodic memory capabilities. Thus, it is possible that the inferior parietal lobes in particular may have served as a kind of bottleneck for the vocal or subvocal articulation and/or examination of these reminiscences.

As we have noted, with enhanced episodic memory capabilities, *Homo sapiens* may have been freer to call upon a vast array of prior experiences to simulate future options, thus, obviously enhancing overall reproductive fitness. We would postulate that age and gender divisions of economic labor may have been a direct consequence of these mental simulations of episodic memory. Kuhn and Stiner (2006: 973) have acknowledged that larger questions in archaeology should be explored in as many dimensions as possible. For them, the ability to conserve and transmit "long-term corporate memory" was fundamental to maintaining alliances and cooperatives networks. We think a cognitive ability is a logical place to begin.

AUTHORS' NOTE

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