Did Meditating Make Us Human?

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Campfire rituals of focused attention created Baldwinian selection for enhanced working memory among our Homo sapiens *ancestors. This model is grounded in five propositions: the emergence of symbolism occurred late in the archaeological record; this emergence was caused by a fortuitous genetic mutation that enhanced working memory capacity; a Baldwinian process where genetic adaptation follows somatic adaptation was the mechanism for this emergence; meditation directly affects brain areas critical to attention and working memory; and shamanistic healing rituals were fitness-enhancing in our ancestral past. Each proposition is discussed and defended. Supporting evidence and potential future tests are presented.*

Steven Mithen (2003, 130–31) envisions a late Palaeolithic shamanistic ritual:

> Night descends, the meat is eaten and candles are lit. One of the men appears older than the others and wears a necklace of pierced fox teeth around his neck. Throughout the evening he has been lowering his face close to the smoldering herbs and inhaling deeply. He now takes a flat slab of slate and draws upon the surface, cutting into it with a flint point. As he does so the other people gently chant. Within a few minutes he is finished, and the engraved slate is passed around the circle. He has drawn a horse; it has been carefully depicted and proportioned quite correctly. This slate is placed to one side. The old man — a shaman — starts again: a deep intake of the intoxicating smoke, a few minutes of intense concentration amid more chanting, another slate to pass around the circle. That too has the figure of a horse. And so this continues ...

... and continues ...

Imagine you travelled back in time 100,000 years and happened upon a group of our ancestors gathered around an evening fire. Would anyone be surprised to find them chanting, clapping, dancing in unison, or maybe just sitting mesmerized before the flickering flame? The thesis of this article is that this commonplace activity, which I will call campfire rituals of focused attention, created an important selective pressure in the evolution of the modern human mind. Ritualized gatherings before an open fire — repeated night after night, generation after generation for thousands of years — contributed significantly, though not necessarily exclusively, to the evolution of the enhanced working memory capacity required for symbolic thinking.

The scenario for which I will argue can be summarized as follows. Anatomically modern humans emerged between 200,000 and 150,000 years before present (bp), initially differing little from other hominin forms. Consciousness-altering rituals, often taking the form of shamanistic healing rituals, constituted an important and unique aspect of the human selective environment. This environment targeted those areas of the brain involved in focused attention and working memory, and, in time, facilitated the genetic mutation or mutations that ultimately fixed enhanced working memory and symbolic function in the human population.

The scenario is grounded in the following five propositions.

1. Convincing evidence of symbolism in the form of ceremonial tools, artwork and grave goods appears late in the archaeological record (largely after 50,000 bp) and post-dates the emergence of anatomically modern humans.
2. Recent work combining cognitive science and archaeology has built a compelling case for explaining the late emergence of symbolism as the result of a fortuitous genetic mutation (or combination of mutations) that enhanced human working memory capacity.
3. Evolutionary developmental biology indicates that genetic adaptation can sometimes follow somatic adaptation (the Baldwin effect). Put another way,

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environmental conditions that require bodily adaptation (such as high-altitude conditions which require the production of more red blood cells) simultaneously create selection pressure for genetic mutations that more permanently establish the adaptive phenotypic state.

4. Neuroscience studies indicate that meditation produces short-term and long-term effects on both the structure and function of those areas of the brain closely associated with working memory and focused attention such as the dorsolateral pre-frontal cortex.
5. Hypnotizability, or the ability to achieve a ritually induced, health-enhancing, suggestibility-prone conscious state, is individually variable and heritable; and would have been fitness-enhancing in our ancestral past.

The present article discusses and defends each of these propositions. The bottom-line conclusion can be stated straightforwardly and succinctly: campfire rituals disproportionally enhanced the health of those whose brains permitted the deepest immersion in the rituals; and this, in turn, selected for brains with enhanced working memory capacity.

Late emergence of symbolism

Bar-Yosef (2000, 14) has characterized Late Mousterian hominins as possessing a 'low level of symbolic behavior', while Wadley (2001, 208) has suggested that Palaeolithic image making varies in 'symbolic complexity'. Comments such as these acknowledge that symbolism may not be as unitary a phenomenon as is often portrayed. Indeed, the philosopher C.S. Peirce described referential thinking as existing in three forms: iconic, indexical, and symbolic (see Hawkes 1932 for a good discussion). Iconic referents are ones that bear a perceptual or physical resemblance to the things they signify, such as using a round pebble to represent a soccer ball. Indexical referents indicate the presence of what they signify based on a temporal or spatial association. For example, a weather vane indicates the wind (when the wind blows the vane moves), tears indicate sadness, smoke indicates fire. While both iconic and indexical referents can be thought of as 'symbolic' in that one thing stands for another, Peirce reserves the term 'symbol' for those occasions where the relationship between signifier and signified is arbitrary. For example, the '$' is symbolic because its relationship to money is based solely on convention.

Deacon (1997, 75–92) provides a detailed discussion of the hierarchical relationships among these levels of reference. He shows how indexical referents are 'built up' from iconic ones and symbolic referents are 'built up' from indexical ones, with each level placing increasing cognitive demands on the organism. Acquired symbolic reference can be especially memory-intensive.

> To learn the first symbolic relationship requires holding a lot of associations in mind at once while at the same time mentally sampling the potential combinatorial patterns hidden in their higher-order relationships. Even with a very small set of symbols the number of possible combinations is immense, and so sorting out which combinations work and which don't requires sampling and remembering a large number of possibilities (Deacon 1997, 93).

In this article, 'symbolism' is Peirce's definition, arbitrary referents based on cultural convention. As discussed shortly, evidence from the Middle Palaeolithic of such things as the ritualistic use of mineral pigments (e.g. red ochre) and beads probably used as personal ornamentation may very well represent iconic or indexical referents and, as such, qualify as Bar-Yosef's 'low level' of symbolism (Wadley 2001). Higher level or Peircian symbolism is what appears to have arrived late in the archaeological record and it is this that required enhanced working memory.

Genetic and fossil evidence points to the emergence of anatomically modern humans (*Homo sapiens sapiens)* somewhere between 200,000 and 150,000 years bp in Africa (Deacon 1989; Ingman *et al*. 2000; Ke *et al*. 2001; McDermott *et al*. 1996; McDougall *et al*. 2005; Stringer 1996; Underhill *et al*. 2001; White *et al*. 2003). Controversy surrounds the issue of exactly when modern human behaviour emerged (Henshilwood & Marean 2003; McBrearty & Brooks 2000; Wadley 2001). Some have argued that the relatively sudden appearance of sophisticated tools, burial with grave goods, and image making in the European Upper Palaeolithic signifies a 'revolution' in human thought and behaviour (Klein & Edgar 2002; Mellars 1996; Stringer & Gamble 1993).

This 'Upper Palaeolithic revolution' model has been challenged by those who see evidence of an incremental accumulation of modern behaviours in the African archaeological record (e.g. McBrearty & Brooks 2000). For example, evidence of blade production, seasonal mobility, use of grindstones, and barbed points date to 100,000 bp or more. Many of these finds, however, do not necessarily imply symbolic thinking (Henshilwood & Marean 2003; Wadley 2001). More compelling evidence of Middle Palaeolithic symbolism can be found in the form of perforated beads apparently used as personal ornamentation and the ritual use of mineral pigments (e.g. red ochre), both of which appear before 50,000 bp (Barham 2002; Henshilwood *et al*. 2002; 2004; Vanhaeren *et al*. 2006).

Beads and pigments, however, may represent a 'lower level' form of symbolism that provides the foundation for the arbitrary, culturally constructed symbols typical of modern human societies. Red pigment bears an iconic connection to blood, one of its most common ritual referents (Knight *et al*. 1995). Likewise, beads can be thought of as indicators (indexical referents) of clan affiliation or marital status (Wadley 2001). The fact that evidence of ritual use of red ochre is more widespread and ancient (by 200,000 bp) compared to the first scattered evidence of perforated beads (around 100,000–70,000 bp) supports this interpretation. Peircian symbolism most likely did not occur until the Upper Palaeolithic, when grave goods, sophisticated tools, image making and what appear to be purely ceremonial artefacts arrive on the archaeological scene. For the purposes of the current model, what is pivotal is that the evidence for this 'higher-level' symbolism emerges late and post-dates the arrival of anatomically modern humans.

Fortuitous mutation(s)

Many of the same explanations that have been used to account for the emergence of modernity in general, such as fully recursive language, technological innovations, population pressures and competition with Neanderthals, could be more narrowly applied just to symbolism (Bar-Yosef 1998; Gamble 1999, 381–7; Davidson & Noble 1989). However, as Klein & Edgar (2002, 214–15, 268–9) point out, these explanations almost inevitably beg questions about deeper sources of causation (e.g. what caused the population pressures or what produced fully recursive language?). For Klein, the ultimate mechanism must come down to a fortuitous genetic mutation that reorganized brain structure and function, thus giving *Homo sapiens* a cognitive advantage over other archaic hominin forms (Klein 1995; Klein & Edgar 2002). While Klein typically talks in terms of a single genetic mutation (terminology, which for simplicity's sake, I will retain), this change could have involved a series of mutations that affected the interaction of genes and, or, their manner of expression.

Coolidge & Wynn (2001; 2005; Wynn & Coolidge 2003; 2004) have elaborated on Klein's proposal, arguing that the most likely target of this mutation would have been an enhancement of working memory capacity. In this context, working memory capacity refers to the ability to hold information in mind, especially information about behavioural procedures and intended goals, in spite of interfering stimuli or response competition (Kane & Engle 2002). According to Coolidge & Wynn, enhanced working memory capacity was essential for cognitive innovation, experimentation and ultimately, symbolism.

Their proposal echoes that of others such as David Lewis-Williams (2002, 93–4, 189–90), Merlin Donald (2002, 263–7, 271–2) and Roger Shepard (1997), all of whom argue that a key to human consciousness and cognition was the evolution of the ability to hold and manipulate information in working memory. For Lewis-Williams, it is the ability to voluntarily recall and manipulate the experiences of altered states of consciousness[1] (as in dreams or fantasies) and use these images as a basis for art and religion. For Donald, it is the ability to hold movement templates in mind and use them as a basis for directing, executing and refining motor sequences — providing the foundation for the mimetic skills of pantomime, imitation, and role play. For Shepard, it is holding mental simulations of actions in mind and evaluating and selecting from among potential plans. For all of these theorists, enhanced working memory capacity, however functionally envisioned, is a prerequisite to the emergence of symbolism.

The common theme among all these proposals is that our ancestors had an enhanced capacity to recall, consciously retain and manipulate information. This enhanced working memory capacity was essential to crossing the threshold to purely arbitrary or convention-based symbolism (Deacon 1997). Unlike iconic or indexical referents, purely arbitrary symbols have little to no external cues or supports to aid in processing. The $ sign does not look like money (in the way red pigment looks like blood) nor is its presence consistently associated either spatially or temporally with real currency (as tears are to sadness). To understand this level of purely arbitrary reference, one must be able to hold in mind both what the signifying image is perceptually and what it means conceptually, while at the same time understanding that these two are not the same (Russell 1996). Thus, the Holenstein-Stadel lion-headed man is perceptually a miniature lion's head upon a miniature man's body while, at the same time, it is not that at all but (presumably) a powerful animal spirit worthy of reverence.

Coolidge & Wynn set a broad time frame for the emergence of the genetic change that produced enhanced working memory. It could have accompanied the arrival of anatomically modern humans (200,000 to 150,000 bp) or it could have emerged much later (closer to, say, 70,000 bp). For purposes of this proposal, the exact time of emergence is less important than when this change became widespread, which, I would argue, was not until around 50,000 bp, immediately prior to the emergence of symbolism.

As an explanatory mechanism, a fortuitous mutation would seem to require no deeper causal force. Mutations, it has generally been thought, are more or less inevitable and largely random. However, recent work in evolutionary developmental biology has provided a clearer framework for understanding how 'random' genetic mutations are translated into non-random phenotypic variations (Kirschner & Gerhart 2005; Jablonka & Lamb 1995; West-Eberhard 2003). This work shows that mutations may be far less random than originally thought and that evolved developmental processes place constraints on how genetic mutations get expressed in the phenotype.

The Baldwin effect updated

The Baldwin effect — independently proposed in 1896 by James Mark Baldwin, C.L. Morgan and H.F. Osborn — provided a non-Lamarckian way for environmentally induced somatic modifications (resulting from either learning or physiological adaptation) to become heritable changes (Jablonka & Lamb 1995; Simpson 1953). According to this principle, acquired traits do not directly affect genes but these traits could create or importantly contribute to selective conditions that would, in time, genetically establish them in the population.

The classic example of this was provided by Waddington (1975), who exposed pupal fruit flies to heat shock. Some of the pupae later developed into flies without the typical cross-vein pattern on their wings. Waddington bred the no-cross-vein flies and once again exposed their pupal offspring to heat shock. After successive breedings, Waddington found that the no-cross-vein trait would emerge in nearly 100 per cent of the offspring even in the absence of heat shock. In other words, an initially environmentally induced trait eventually became encoded and transmitted genetically. In this example, the target trait, the absence of cross-veins, was only adaptive in that Waddington consciously selected for it. However, in later studies, he showed that a naturally adaptive trait, the ability to expel sodium in a sodium-saturated environment, could also be first somatically acquired and then genetically fixed. Studies with laboratory rats have shown that this effect can also be found in mammals (Denenberg & Rosenberg 1967; Ressler 1966).

Bjorklund & Rosenberg (2005) provide a related example with clear implications for human evolution. They showed how chimpanzees, raised in a species-atypical environment (human-raised 'encultured' apes), acquired a cognitive capacity, deferred imitation, that is generally not found among wild apes. This finding coincides with others that have shown more sophisticated cognitive skills in captive or human-raised apes compared with wild apes in such areas as tool use, imitative learning and, most famously, language (see Tomasello & Call 1997, 390–95 for a summary). This could provide a model for how hominins acquired increasingly complex cognitive skills. These skills may first have appeared as novel acquired traits induced by atypical environmental demands. Then, as those demands persisted, a Baldwinian process could have led to the traits becoming genetically heritable and stabilized. Over the course of hominin evolution, the atypical environmental demands were increasingly products of hominins themselves.

A number of mechanisms have been proposed to account for the Baldwin effect. Waddington originally explained the effect as resulting from the slow accumulation of the various alleles necessary for the expression of the trait. Others, however, posit a more directed process in that environmental stress may actually affect the rate and character of mutations (see Jablonka & Lamb 1995, 54–78; or Wright 2004 for reviews and discussions).

It has been Darwinian dogma for over a century that genetic mutations are 'random' either with regard to selection pressures or in terms of predictability (see Dawkins 1986, for example). However, studies questioning this have a long history and have recently been gaining greater legitimacy. Both Jollos (1934) and Plough & Ives (1935) found that mutation rates increased in heat-treated fruit fly larvae and that the resulting mutations were specific to certain loci and related to the heat-induced somatic modifications. Similar evidence of 'environmentally directed mutations' has been reported in the bacterium *E. coli* (Wright 1997). Wright (2004) has recently reviewed a range of studies providing support for the process of 'stress-directed mutagensis', where feedback mechanisms within the organism allow environmental stressors to target specific genes that must mutate in order to surmount the stress. Though a great deal is still to be learned about how mutations arise, it is becoming increasingly clear that dismissing them as simply random is too simple.

Kirschner & Gerhart (2005) have proposed another possible mechanism, 'facilitated variation', where directed evolutionary change is facilitated by the organism itself. In this view, genetic mutations are still largely random but developmental constraints bias which mutations are passed along as phenotypic modifications. Modifications are more likely to arise in those systems that are under selection pressure — where the adaptive range of a physiological system is under stress.

Any mutation or genetic reassortment that resets the range of a physiological system to a more adaptive level would then be positively selected by environmental conditions. Thus, a population of humans relocated to higher altitudes is biased toward the expression of any mutation that permanently resets their baseline levels of red blood cell production.

The course of human evolution seems to provide numerous examples of this process. For example, hominin locomotor, social, and digestive systems appear to have been far more prone to adaptation than the sensory systems, especially vision. In response to hotter, drier, patchier woodland environments, our ancestors might have adapted by becoming more nocturnal. Primate visual systems, though, appear highly conserved. Instead, our ancestors had a wider adaptive range in terms of locomotor movement (where, among extant apes we find knuckle-walking, orthograde clambering, brachiating and bipedialism), social systems (monogamy, fission-fusion societies, harems) and diet (apes are notorious omnivores). Hence, physiological constraints biased our evolution toward bipedal meat-sharers rather than solitary nocturnal bug eaters.

Over the course of hominin evolution, the brain changed significantly in both size and structure, suggesting that it too was one of those systems prone to adapt under changing environmental conditions (Falk *et al*. 2000; Holloway 1973; 1981; Wood & Collard 1999). If one of these adaptations was, in fact, Klein's fortuitous-working-memory-enhancing-mutation, then two important questions emerge: what were the conditions that prompted its emergence and spread, and, even more importantly, why did those conditions only affect *Homo sapiens* and not other archaic hominins?

Meditation and the brain

Recent brain-imaging and EEG studies have shown that areas in the frontal lobe of the brain associated with working memory and focused attention, especially the dorsolateral prefrontal cortex and the anterior cingulate, are activated during meditation (Lazar *et al*. 2000; 2005; Lutz *et al*. 2004; Lou *et al*. 1999; Newberg *et al*. 2001; Wallace *et al*. 1971). Using functional MRI (fMRI), Lazar *et al*. (2000) found that subjects practising Kundalini meditation, where attention is focused on breathing and silent mantra recitation, had significant metabolic increases in many brain structures including the dorsolateral prefrontal cortex and anterior cingulate. Similarly, using single photon emission tomography (SPECT), Newberg *et al*. (2001) found increased activation in the dorsolateral and orbital prefrontal cortices, anterior cingulate cortex, and the sensorimotor cortices of the brains of eight meditating subjects. In both of these studies, experienced mediators served as their own controls, thus eliminating the possibility that pre-existing sample differences could explain the results.

Lutz *et al*. (2004) used EEG measures to assess brain activity in practitioners experienced with 'compassionate' meditation (where one is to cultivate compassion for all things). Compared to novices, they found that the experienced meditators generated high-amplitude gamma wave synchrony over the frontoparietal regions of the brain, indicating that neural assemblies widely distributed across these areas were synchronizing activation. In some of the subjects, the level of synchrony was 'the highest reported in the literature in a nonpathological context' (Lutz *et al*. 2004, 16,372). Furthermore, the ratio of gamma band activity (25–42 Hz) to slow wave oscillation (4–13 Hz) at resting level was higher in meditators compared to controls, suggesting that meditative practice had affected long-term base-line brain activity. Given that this study compared experience meditators with naive controls, pre-existing sample differences cannot be entirely ruled out as an explanation for the results. However, Davidson (Davidson *et al*. 2003) found a similar significant increase in EEG activity in the left frontal lobe of naive subjects randomly assigned to an eight-week meditation training programme, suggesting that training effectively alters specific forms of brain function.

That meditation might have long-term effects on brain structure and function has been supported in at least two other recent studies. Lazar *et al*. (2005) measured cortical thickness in meditators experienced with 'mindfulness' meditation (where the goal is to increase non-judgmental awareness of present stimuli). They found that, relative to controls, meditators had significantly thicker regions of the prefrontal cortex, including the right anterior insula and the right middle and superior frontal sulci. As hypothesized, these areas are ones associated with attention and sensory processing. Some of the largest differences between groups were found among the older subjects, prompting the authors to speculate that meditation may work to reverse age-related thinning of the prefrontal cortex.

Finally, Carter *et al*. (2005) found that Tibetan monks experienced at one-point meditation (a type that involves focused attention on a single object) were able to exert conscious control over a typically automatic phenomenon of attention, binocular rivalry. Binocular rivalry occurs when each eye's fovea is presented with a different image. Usually this results in switching attention as perception changes back and forth between the competing images. Over half of the one-point meditators were able to significantly slow the switching rate, while three of them were able to achieve complete image stabilization during the five-minute testing period. This result shows that individuals trained in meditation can exert voluntary control over what are normally involuntary fluctuations. As the researchers point out, these results contrast dramatically with results reported from numerous previous studies involving over 1000 meditation-naive subjects.

This accumulating body of research indicates that meditation produces long-term changes in those areas of the brain involved in attention and working memory. These areas are critical for the enhancement of working memory capacity. This enhancement may have given *Homo sapiens* a competitive edge over other hominins and produced the emergence of symbolism about 50,000 bp. However, it can rightly be pointed out that it seems quite unlikely that our ancestors of 100,000 years ago or more were engaging in one-point or compassionate meditation. While true, numerous other studies have shown that far more mundane memory and attention tasks also activate the same brain areas.

The very reason we know that the dorsolateral prefrontal cortex is important in working memory and attention is because of a variety of neuroscience studies where memory and attention tasks, not involving specific meditative practices, have been used. For example, Smith & Jonides (1994) tested subjects on a spatial judgment task that began with subjects viewing a display containing three dots. After a three-second delay, they saw another display with a circle and were required to indicate if the circle encircled one of the previous dots. PET (positron emission tomography) scans showed a significant increase of activation in the right prefrontal cortex. A similar object matching test was done where subjects judged whether a pattern presented later matched an earlier one. In this instance, the left prefrontal cortex was significantly activated.

Thus, using a relatively simple task, Smith & Jonides showed the involvement of the prefrontal cortex in working memory, with the right more important for spatial memory and the left for form recognition. Numerous other studies with similarly simple cognitive demands have indicated the dorsolateral prefrontal cortex to be an important high-level filter of attention, sustaining cognitive energy on relevant information while suppressing the processing of and responding to irrelevant signals (Duncan 2001; Heinze *et al*. 1994: Kane & Engle 2002; Wheeler *et al*. 1997; Geary 2005, 211–20).

Campfire rituals practised by our hominin ancestors need not have been as disciplined as those of Tibetan monks to have activated the brain regions important for attention and memory. However, they were probably more intensive than the tests used in typical neuroscience studies. Furthermore, unlike tool making, hunting and other routine activities that also require focused attention and working memory, these rituals could easily have included children, thus opening up the possibility for adaptive modifications of brain ontogeny. Environmentally induced changes in brain structure and function could, over time, have become genetically heritable as a result of the selective pressure of the rituals themselves. Those most susceptible to the rituals' physical and psychological healing effects reaped the greatest survival and reproductive advantage — a Baldwinian process. Finally, there is evidence to suggest that these conditions were unique to *Homo sapiens* and not a regular part of the social worlds of Neanderthals and other archaic hominins.

Shamanistic healing rituals

Strictly speaking, shamanism is a practice confined to cultures of the higher latitudes of Eurasia where the term originated. More broadly, however, the shaman is anyone who uses consciousness-altering ritual as a means of connecting with the spiritual world for the purpose of individual or community healing (Hultkrantz 1973; Townsend 1999). This includes not only traditional shamans, but also shaman-healers, healers, mediums and other magico-religious healers (Winkelman 1990).

There is considerable evidence that shamanism (broadly defined) is humanity's oldest form of religion (Guenther 1999; Lee & Daly 1999; Winkelman 1990). It is found in nearly all traditional societies (Townsend 1999; Vitebsky 2000). An increasing number of scholars agree that some of the Upper Palaeolithic cave art and artefacts reflect shamanistic rituals and, or, experiences (Dowson & Porr 1999; Eliade 1972; Hayden 2003; Lewis-Williams 2002; Lommel 1967; Winkelman 2002). Ubiquity and antiquity suggest that the roots of shamanism run deep in human history. Indeed, a recent find from the Fumane cave in Italy seems to confirm this. Stone slabs dated to around 35,000 bp recovered from this cave depict images of a human form with the antlered headgear typical of a shaman (Balter 2000). These images could represent the oldest evidence of shamanistic rituals. If so, they also suggest that shamanism predates the Upper Palaeolithic, since the depiction reflects an already present system.

The positive physical and psychological effects of healing rituals documented among extant hunter-gatherers supports the notion that shamanistic healing served an important adaptive function in our ancestral past (Katz 1982, 49–55). Among the Kalahari !Kung, healing dances play a central role in the life, health and vitality of individuals and the community. Dances, held about every two weeks, are eagerly anticipated events (Katz 1982, 34–6).

McClenon (1997; 2002) has marshalled considerable evidence indicating that those of our ancestors who were most susceptible to the beneficial physical and psychological effects of shamanistic rituals had a selective advantage over others in surviving illness or injury, overcoming debilitating emotional states and enduring the rigours of childbirth. This 'ritual healing' theory is based on a number of converging lines of evidence: ritual healing practices are universal or near universal across traditional societies (Winkelman 1990; McClenon 2002, 67); ritual healing always involves hypnosis and altered states of consciousness (McClenon 2002, 67–71); hypnotizability or the ability to achieve a mental state highly prone to suggestion is measurable, variable and has heritable components (Katz 1982, 138; Morgan 1973; Wilson & Barber 1978; McClenon 2002, 93–6); ritual healing is often highly effective for a range of maladies where psychological factors are involved, such as chronic pain, burns, bleeding, headaches, skin disorders, gastrointestinal disorders, and the discomforts and complications of childbirth (Katz 1982, 49–55; McClenon 2002, 46–67); comparative and archaeological studies indicate the presence of ritual, altered states of consciousness and care of the sick among our primate cousins and hominin ancestors[2] (Goodall 1986; Hayden 2003; Jolly & White 1995, 345; Lewis-Williams 2002; Trinkaus 1983, 409–11); the earliest medical texts (from Mesopotamia and Egypt) closely connect healing with religious ritual (McClenon 2002, 39–43); and anomalous events associated with ritual, such as 'miraculous' healing, are effective in inducing beliefs in the supernatural (McClenon 2002, 70, 132–5, 150–51).

The potential antiquity of shamanistic healing rituals is further strengthened by evidence that neither sophisticated linguistic skills nor ideologies are needed for the rituals to be efficacious. It is the compelling nature of the ritual experience and not belief in a specific theology that is critical (e.g. a Muslim may find relief in a Christian-based healing practice so long as he or she accepts the power of the ritual itself: McClenon 2002, 10, 79–83). Furthermore, only minimal verbal expression is required (if any at all) to add to the persuasive impact of the ritual ('relax', 'heal' etc.). Indeed, part of the power of spiritual healing is that it is something beyond words and logic. Among the !Kung, ritual healing is caused by a powerful, but mysterious spiritual energy, *n/um* (Katz 1982, 34). Thus, what is required for spiritual healing appears to be well within the behavioural and cognitive repertoire of our hominin ancestors: a belief in a healing spiritual power accessible through consciousness-altering ritual.

It is not hard to imagine that our ancestors were engaging in campfire rituals of focused attention. At times, these rituals may only have involved group chanting, dancing or hypnotic silence before the flames (the benefits of which should not be casually dismissed). At other times, these rituals may have involved intensely dramatic shamanistic rituals where soul flight, supernatural encounters and 'miraculous' healings took place. More than likely, it was the immediate positive psychological (ecstatic emotions/social bonding) and physical (placebo benefits, 'miracles') effects of these rituals that provided the motivation for enactment. What is critical is that these rituals required focused attention which activated those areas of the brain associated with attention and working memory. Those whose brains were most 'ritually capable' would also have been the ones to reap the greatest fitness. Enhanced working memory capacity was a byproduct of brain changes resulting from ritually induced health benefits.

What made humans different?

Among our ancestors, campfire rituals were certainly not the only regular activities that taxed attention and working memory. However, these rituals may have been one of the few activities that consistently differentiated *Homo sapiens* from other contemporary hominins.

Prior to 50,000 bp, there is very little evidence that anatomically modern humans differed in any significant way from their archaic hominin counterparts. In fact, tens of thousands of years before the Neanderthals were displaced by Cro-Magnons in Europe, *Homo sapiens* and Neanderthals shared space in the Levant (Shea 2003; Tchernov 1994); but the Levant 100,000 years ago was not Upper Palaeolithic Europe. As Neanderthals moved in, *Homo sapiens* moved out. It is unclear whether there was direct competition or sequential habitation based on changing climates. In either case, at this point in history, *Homo sapiens* were no match for either Neanderthals or for increasing cold (conditions obviously not too difficult for Neanderthals); but, over the next 50,000 years or so, something changed. When *Homo sapiens* moved into Europe around 40,000 bp, it was for good. Neither Neanderthals nor cold conditions stopped them from laying claim to the entire continent. Whatever it was that changed them did not similarly affect Neanderthals. So what was the difference?

Both groups made tools. As Klein & Edgar point out (2002, 230) both Neanderthals and *Homo sapiens* 'commonly struck flake-blades from carefully prepared cores'. A recent analysis demonstrates that Neanderthal manufacturing required a degree of expertise on par with blacksmithing (Wynn & Coolidge 2004). Both groups collected natural pigments, built fires and hunted large mammals. Neanderthals were highly skilled hunters and foragers whose abilities compared favourably with Cro-Magnons and contemporary hunter-gatherers (d'Errico 2003; Grayson & Delpech 2003; Sorensen & Leonard 2001). Thus, it is hard to argue that the cognitive demands of hunting, making tools or surviving harsh climates differentiated *Homo sapiens* from Neanderthals. If these activities created selection pressures for enhanced working memory and symbolism, then these traits would have arisen in Neanderthals as well as anatomically modern humans.

Paradoxically, however, some scattered evidence indicates that Neanderthals were not entirely devoid of symbolic abilities. A few artefacts have been recovered from Neanderthal sites that appear to qualify as 'art' (e.g. Marquet & Lorblanchet 2003). Chatelperronian Neanderthals manufactured beads, pendants and other adornments along with sophisticated tools and other artefacts that appear to have symbolic significance (Hublin *et al*. 1996). Finally, evidence exists that Neanderthals, like Cro-Magnons, explored deep caves and may have used them as ritual sites (Hayden 2003, 108–15). Collectively, this evidence suggests that a capacity for symbolism was present in some nascent or measured form in Neanderthals and, under certain environmental conditions (such as close contact with Cro-Magnons), this capacity flowered; but apparently those conditions were not a regular aspect of the Neanderthal world prior to the Upper Palaeolithic. This again emphasizes the fact that something was different about the *Homo sapiens* world, something generally not present in that of other hominins.

Why Neanderthals did not meditate

If the critical difference between *Homo sapiens* and other hominins was campfire rituals of focused attention, then why did Neanderthals not engage in this activity? Were they and other archaic hominins not just as likely to have been singing, chanting and encountering healing spirits around their campfires? Odd as it may seem, the answer to this seems to be no. Evidence suggests that Neanderthals had neither the time nor the energy to engage in such activities. They lived hard lives — harder, apparently, than Cro-Magnons' (Stringer & Gamble 1993, 94–5).

Neanderthal habitations (consistent with Middle Palaeolithic or Middle Stone Age habitation sites in general) show less evidence of spatial structure and generally lack the well-built, stone-lined hearths of Cro-Magons (Bar-Yosef 2000; Bar-Yosef *et al*. 1992; Hoffecker 2002, 129, 136; Rigaud *et al*. 1995; Wadley 2001). The generally smaller and more transitory nature of Neanderthal sites suggests that, by and large, they did not invest as much as Cro-Magnons in home bases and the activities associated with them, including (and especially) communal ones involving a central fire.

The hardships entailed by constant movement are further reflected in studies of Neanderthal bones. Berger & Trinkaus (1995) have documented evidence of extensive head, neck and upper body trauma in Neanderthal skeletons. Extensive wear and tear and degenerative bone disease was also commonplace. Tellingly, Trinkaus (1995) failed to uncover a single instance of a healed immobilizing lower limb injury among Neanderthals, suggesting that constant mobility was essential to their life-style and that those unable to keep up simply did not survive. Nutritional stress also seems to have afflicted Neanderthals more than Cro-Magnons (Soffer 1994; Stiner 1991; Stringer & Gamble 1993, 166). Evidence of cannibalism owing to nutritional stress is present from Neanderthal sites (Defleur *et al*. 1993; 1999). Cro-Magnon sites, however, have yet to reveal any similar evidence (Klein & Edgar 2002, 198). To some degree then, *Homo sapiens*' advanced cognitive faculties may be attributable to the 'dumb luck' of having evolved in the tropics of Africa rather than the harsh cold of Europe.

Summary and testing

Between the Levant and Upper Palaeolithic Europe, something happened — symbolism and all that goes with it emerged. Klein (1995; Klein & Edgar 2002) makes a cogent argument that the ultimate explanation for this must come down to some genetically heritable change. It is unclear as to precisely when this change occurred but it is clear that by 100,000 bp it was not widespread enough to be of any consequence. Nor was the potential for this change necessarily confined to *Homo sapiens*. Neanderthals may very well have had it too; only too little, too late. A plausible explanation for how this genetic change emerged and became widespread in the human population is a Baldwinian process, where an environmentally induced trait, over time, becomes genetically heritable.

There are two relevant examples that provide potential models for how this might have occurred, at least in its initial stages. First, the archaeological record indicates a very brief and fleeting emergence of symbolism in the last days of the Neanderthals. Secondly, studies with human-encultured apes demonstrate that they can acquire cognitive capacities unprecedented among wild apes. In both these cases, human culture appears to have played a key role in producing new cognitive capacities. If culture can affect other species, it seems reasonable that it might have affected our ancestors.

One aspect of human culture that is universal and ancient is shamanistic healing. Campfire healing rituals were not only potentially fitness-enhancing but they also directly targeted those areas of the brain critical for enhanced working memory and symbolism. Furthermore, unlike making tools, hunting and other activities that require focused attention, campfire rituals were probably unique to *Homo sapiens*, and youngsters could have participated as well as adults. Generation after generation of our ancestors grew up chanting before the flame and, as they did, they changed their brains into human brains.

All theoretical models pertaining to human prehistory involve some speculation and the current model is no exception. The current model, however, strives to remain grounded in evidence and therefore open to testing and falsification. Each of the five propositions on which it is based is falsifiable. Their fate reflects on the plausibility of the over-all theory. For example, if archaeological evidence accumulates that contradicts the assumption of the late emergence of symbolism, then this model would be in jeopardy. Or if Baldwinian mechanisms for translating an environmentally induced change into a genetic one are found too weak to be of any consequence in the evolution of complex traits (such as intelligence or memory capacity), then again this model would suffer.

Along with negative evidence arising from the weakening of the model's founding assumptions, positive evidence is also predicted. For example, this model would predict that research would continue to deepen the physiological and psychological connections between attention and working memory, on the one hand, and ritual and meditation on the other. For example, preliminary data from O'Hara (Motluk 2005) indicate that meditation improves performance on tasks requiring constant focused attention even among sleep-deprived subjects. Another recent study has shown that spiritual meditation is more effective than secular meditation in reducing anxiety and increasing tolerance of pain (Wachholtz & Pargament 2005). This supports the notion that, in our past, meditative rituals that called upon healing spirits could have had tangible emotional and physical benefits that increased fitness.

This model would predict that archaeological research would continue to uncover evidence of the ancientness of shamanism and religious rituals associated with shamanism, continually pushing back in time the potential emergence of this religious form. Furthermore, it is predicted that evidence of behavioural and cognitive similarity among hominin species, prior to 50,000 bp, will continue to accumulate. This will be true especially for tool making and hunting and, increasingly, it will be compelling evidence of symbolism alone that will distinguish anatomically modern humans.

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Notes

1. Altered states of consciousness is a notoriously vague term. In this context, I follow Lewis-Williams (2002, 121–30) who describes a spectrum of consciousness ranging from typical wakeful consciousness to increasingly intensified states. Typical wakeful (base-line) consciousness is characterized by a problem-solving orientation and rational processing of external signals. Intensified or altered states are characterized by increasingly non-rational processing and internally directed focus ranging from fantasy to hypnagogic imagery to sensory hallucinations.
2. While it is impossible to know another species' subjective conscious experience, there is evidence that indicates that some non-human primate ritual behaviours affect conscious states. For example, Keverne *et al*. (1989) have shown that, during grooming, endogenous brain opiates are released in macaques. Goodall (1971, 112–14) describes how a young male chimpanzee, challenging for ascendancy in the social hierarchy, ritualistically 'rocked' himself into an agitated state (the equivalent of a pre-game 'psych-up') and then displayed with abandon. Similarly, Samorini (2002, 58) describes how male mandrills will often consume the iboga root, which appears to excite them powerfully, in preparation for conflict with other males.

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