

The Role of Memory in the Evolution of Human Cognition

David L. Alles

Western Washington University

e-mail: alles@biol.wwu.edu

The purpose of this essay is to question the current received view on the evolution of human cognition (1, 2). To do so I will take a fresh look at the question of what cognitive trait or traits were being selected for that caused the three-fold increase in brain size that occurred during the last 2.5 million years of our evolutionary history. The current candidates for what drove this increase in brain size include tool making, complex social interactions, and language ability (1, 2). My first point is to argue that all of these candidates involve the combined functioning of more fundamental cognitive traits. The position I will defend is that our cognitive evolution was not driven by selection for tool making, or complex social interactions, or language ability. I view each of these as epiphenomenon arising from the selection for more basic cognitive traits. I submit that memory capacity, causal awareness, and reasoning are the fundamental cognitive traits that we must look at to understand our cognitive evolution. My contention is that selection for one or a combination of these basic traits caused the observed increase in hominid brain size. It is not enough, however, to offer an explanation for the encephalization we observe in our fossil record. We must also explain the paradox of increasing brain size occurring along side an archeological record of punctuated technological innovation (1, 2, 3, 4). My hypothesis is that memory capacity, alone, can give us the answer to both of these questions.

The idea that our ability to remember is what started our hominid ancestors down the evolutionary path of increasing cranial capacity is straight forward. After all, increased memory capacity should logically come before the capacity to process that memory. Two million years ago our ancestor, *Homo habilis*, may have already started down the road, suggested by Jared Diamond, where our brain "was performing tasks qualitatively similar to a chimpanzee's but smarter." (3). That smarter brain required more memory. And as you increase memory capacity you create the raw material that allows for the evolution of more sophisticated cognitive processes. But there are better reasons for believing that memory is the pivotal trait in the evolution of our cognition.

Two and a half million years ago in the fossil record of our ancestors, we find a completely bipedal ape with a brain approximately the size of a modern chimpanzee (5). This organism was surely adapted to a life of terrestrial foraging in a relatively open habitat. This period of time also corresponds to a period of climate change where the East African rift valley was drying out (6, 7). My hypothesis is that with the drying of their habitat, early hominids were forced to increase their foraging range in order to find adequate food. Selection in this case was operating on the substrate equivalent of a very

mobile bipedal chimpanzee. And if you start with the cognitive landscape of this mobile chimp and apply the environmental pressure to increase foraging range, this gives you the necessary conditions to make increased memory capacity an adaptive trait. But there is an addition aspect to this picture.

The seasonal availability of a wide variety of food items, spread over a large area, could have led to a foraging pattern of seasonal migration over tens to hundreds of kilometers. This could only be adaptive if our hominid ancestors could remember where to find different food items over a large area at different times of the year. Increased memory, itself, would be an adaptive trait and, given the environmental conditions I've described, would increase the fitness of those individuals in whom it occurred. If you have a good memory and are mobile, you will be able to find food consistently over a large area when times are bad. You need the addition of none of the other cognitive traits I've listed in order for this scenario to be plausible. Language ability is not necessary in this case, as visual memories of your habitat would suffice, along with the associated memory of appropriate seasonal cues. The key concept in this picture is that memory capacity and foraging strategies are intimately linked together.

The reason this connection between memory capacity and foraging strategies is so important is in answering the question of what *initiated* the selection for increased brain size? Our cognitive evolution can not be the result of a completely self-referential system. To start the process of encephalization something in the environment must have placed a selective pressure on our cognitive abilities. The idea that climate change forced our ancestors to increase their foraging range, which, in turn, provided the selective pressure for increased memory capacity is just such a relationship. Therefore, the selection for memory capacity, alone, out of all the cognitive traits our ancestors possessed, can account for the initiation of increasing cranial capacity in our evolution. This is the scenario that I believe "got the ball rolling" in our cognition evolution. But once the ball was rolling, what could be expected next?

Increased memory would allow for the storing of memories of the outcome of unconscious trial and error experiences. These memories of outcomes could be about social interactions just as well as interactions with the environment. This points up that social interactions were probably only secondary causal factors in the evolution of our cognition. But once you have memories enough, you can then begin to be aware of causal chains of events. And with its arrival, causal awareness would provide the last needed element for the evolution of rational thought. I am proposing that there was an evolutionary cascade of cognitive functions, one leading to another, in the order of increasing memory, leading to causal awareness, and on to rational thought.

But as I stated in my introduction, one of the aspects that must be accounted for in any scenario about our cognitive evolution is the apparent punctuated nature of that evolution (1, 2, 3, 4). Why wasn't there a steady increase in the sophistication of our

ancestors' tool kit that correlates to the steady increase in brain size we see in the fossil record? If you accept the assumption that technological innovation correlates with encephalization, then why would a new innovation arise, such as the Acheulean hand ax, only to remain static over hundreds of thousands of years (4)? But if memory capacity was the primary trait being selected for during the two million years of evolution from *Homo habilis* to archaic modern humans, then this stasis in tool kits makes sense. If our ancestors were creatures that relied on memorizing cultural traditions, then it makes sense that innovations would be rare but, once they occurred, would remain constant over time.

This does not imply that there was complete stasis in the evolution of our ability to reason or to communicate. The punctuated innovations in our technological evolution may have been the result of reaching threshold levels in the synergistic product of a steadily increasing memory capacity combining with an increasing causal awareness. I believe that rational thought is this synergistic product. And it seems obvious that it required rational thought by some individual at some point in time to develop the innovations that did occur in stone tools. The same is true of language ability. Chimpanzees do communicate with each other, and there is every reason to believe that our ancestors became increasingly sophisticated in communicating with each other whether it was verbally or not (1).

Therefore, it is conceivable that all of this—increased memory capacity, increased causal awareness, rational thought, and expressive, but not necessarily verbal, communication—was fully in place by 50,000 years ago waiting only for the evolution of a cognitive ability that would break the punctuated pattern of our technological innovations. It is important to note that all of the above cognitive traits are necessary prerequisites for modern spoken language ability. And indeed, it is the evolution of the capacity for modern spoken language that many feel (3, 4) is the key that opened the flood of cultural innovations that began 50,000 years ago. But the central point to take from this account is that the evolution of more fundamental cognitive traits, such as memory capacity and awareness of causality, must have preceded the evolution of modern spoken language. And, in closing, I offer two passages from the work of John Maynard Smith and Eörs Szathmáry in support of this conclusion.

"It is hard to suppose, therefore, that the increase in brain size, by a factor of almost three, could have been a response to selection for improved technical skill. What selective force did lead to our larger brains? It is conceivable that the relevant factor was the evolution of language. It seems more likely, however, that language as we now know it evolved rather recently, and that it was responsible for the dramatic changes that have occurred in the past 100,000 years, not for the increase in brain size that took place earlier." (4).
"We suggest, therefore, that the ability to form concepts and to manipulate them evolved because thinking helped survival, independently of whether the thought could be communicated." (8).

References

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