The Cognitive Revolution

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A response to "Is AI Our Tool or Are We Its Tool?" by Dr. Daniel Schultz, DSPE and Philosopher, ISPE Trustee Chair Emeritus (*Telicom* 38, no. 3, pages 58–59)

Cave to Cognition
(Image by Wayne Smith, created with AI)

This essay is a response to the article that appeared in *Telicom* 38, no. 3, "Is AI Our Tool or Are We Its Tool?" by Dr. Daniel Schultz, DSPE and Philosopher. In a creative and engaging way, Dr. Schultz spoke about the rise of humanity as a thinking species. Here in my essay, I will talk about the way in which *Homo sapiens* started to use recursive language 50,000 years ago to awaken its cognitive potential.

Three hundred thousand years ago, our ancestors looked like us. They had brains of the same size, the same vocal cords, and the same kind of hands. Mentally, though, they were living only in their present—in a world of immediate sensation and reaction. And then, 50,000 years ago, they became conscious beings.

Homo sapiens has existed for 300,000 years. We survived ice ages, migrated across continents, and encountered the Neanderthals. We made tools, controlled fire, and hunted cooperatively. We were successful, without being any more special than the other animals. Then, suddenly, all over the planet, human creativity exploded. In the caves of Spain and France, people started painting,[1] not just simple scratches but animals in motion, handprints, and abstract symbols that clearly meant something to the people who made them.

In Africa, humans began creating complex tools and weapons with multiple parts that required planning days in advance. In the Middle East, people started burying their dead, placing flowers and ornaments in the graves. Humans kept

moving around the Earth, migrating across entire continents, not just wandering to the next valley. Crossing into Australia 70,000 years ago required building boats and navigating an open ocean to a land that couldn't be seen from shore. Someone had to convince a group of people to get into a wooden craft and paddle hundreds of miles toward a place that might not even exist.

Prior to 50,000 years ago, humans had made very few tools: stone hand axes, scrapers, and some wooden spears. These were simple tools that hadn't changed design in hundreds of thousands of years. After 50,000 years ago, a dramatic increase in human inventions occurred: needles for sewing, fishing hooks, spear throwers, jewelry, even musical instruments. Humans went from making the same few tools for 300,000 years to inventing something new every few generations. Scientists call this time period the Upper Paleolithic Period, though the name doesn't capture the magnitude of what happened.[2]

This time period was an awakening, as if the species had been walking around half asleep for 300,000 years, and suddenly the lights came on. Consciousness itself seemed to transform from something private and locked inside individual skulls to something shared, something that could leap from mind to mind, and something that could build on itself across generations. The question that has obsessed researchers for decades is: What changed in human culture 50,000 years ago that turned us from just another ape into the species that would dominate the planet?

Language with Syntax

The answer isn't simple; underlying the explanation seems to be *language*—not just the ability to make sounds and communicate basic ideas (chimpanzees can do that), but real language with *syntax*, the kind that lets you describe things that don't exist and the kind that lets you plan for tomorrow or remember yesterday with such clarity that the past and future become almost as real as the present. In East Africa 300,000 years ago, *Homo sapiens* looked just like humans today: same height, same bone structure, same brain size.[3] If you measured their skulls, examined their skeletons, and analyzed their anatomy, you'd conclude they were your people—*Homo sapiens*.

If you could watch them for a day, you would notice they were not acting like modern humans. Their tools were simple: just hand axes that their ancestors had used. Yes, they'd build shelters and care for their children, though they wouldn't bury their dead with any rituals, and they wouldn't be creating any art. They wouldn't seem to plan more than a few days ahead. And most tellingly, when they communicated with each other, it was basic grunts, gestures, and simple vocalizations to warn about predators and express their basic emotions. There was nothing that resembles modern language. For 300,000 years, before they started acting modern, these ancient humans had the same anatomical hardware as we current humans do. It was as if a computer were sitting there with all the right components, while the operating system hadn't been installed.

Three hundred thousand years ago, our ancestors had vocal cords identical to the ones we have today. The descended larynx that allows complex sound production had already evolved. The FOXP2 gene (forkhead box protein P2, the so-called speech gene) was in the same form it is now.[4] Broca's area and Wernicke's area were both fully developed— these are the brain regions associated with speech production and comprehension. Every piece of physical equipment needed for language was present and accounted for, though our ancient ancestors were not using them. All that capability was dormant for hundreds of thousands of years.

Visit any early human site that existed 50,000 to 300,000 years ago, and you'll find the same thing: stone tools that vary slightly by region yet show almost no innovation over time. To an archaeologist, a tool from 200,000 years ago and one from 100,000 years ago will look essentially identical with the same crafting techniques, same

designs. Generation after generation of humans—each with the same enormous brain and same skillful hands—were all making the exact same tools their ancestors had made 100,000 years earlier.

For comparison, modern humans went from the invention of agriculture to landing on the moon in 12,000 years and from smoke signals to the internet in a few centuries. Yet these early humans with brains identical to ours went tens of thousands of years without any significant innovations.

It's not that they were stupid. The archaeological record shows they were perfectly capable of complex behaviors. They were hunting large game animals, which requires planning and cooperation. They were using fire systematically, which demands understanding of cause and effect. They were surviving in diverse environments from tropical Africa to temperate Asia. They clearly had some form of communication and some way of coordinating activities. However, it was all concrete, all immediate, all tied to the here and now: grunt to indicate hunger, gesture to show where the good water source was. This kind of communication helps you to survive. Even prairie dogs have alarm calls that can describe the size and shape of approaching threats.

Here's what these communication systems can't do. They can't discuss the past or plan for the future. They can't describe abstract concepts. They can't tell stories. They can't lie, speculate, or imagine. Every message is immediate, concrete, and tied to something in the environment right now.

And that's what human communication was like prior to 50,000 years ago. It was sophisticated enough to coordinate hunting and warn about dangers, and it was complex enough to maintain social bonds and share basic information. However, it was nowhere near the recursive, generative, flexible system we call *language* today.[5]

For 300,000 years, humans had all the ingredients for language laid out in their brains, though no internal monologue narrating their experiences was occurring. They had no ability to rehearse future conversations or replay past ones. They had no capacity to think through complex problems by talking to themselves. They were not able to imagine elaborate scenarios or construct detailed mental models of absent situations. The neurological infrastructure was there, though it wasn't switched on. Something crucial was missing.

Modern humans think in *words.* Even when we're not speaking out loud, there's usually a voice in our heads, a running commentary on our experiences, a way of using words to organize and make sense of the world. We use language to remember, to plan, and to reason. It's hard to imagine thinking without words. Early humans did not think with words for hundreds of thousands of years. Their thinking was probably more visual, more spatial, and more tied to immediate sensory experience.[6]

Their thinking was similar to how you might navigate a familiar route to work without conscious verbal thought. That kind of nonverbal cognition is still present in us, running in the background, handling all sorts of complex tasks without language getting involved. Our ancient ancestors were able to learn complex skills through observation and practice, while they were missing the linguistic layer that would eventually transform consciousness into something unprecedented in evolutionary history. Though they could make effective tools by copying techniques they'd seen, they couldn't innovate by describing new techniques verbally nor combine ideas from multiple sources.

Everything had to be learned through direct observation and hands-on practice. Knowledge transfer was slow, limited by what could actually be seen or imitated. Innovation was incremental, constrained by what individuals could figure out through trial and error within their lifetimes.

Cultural evolution was glacial because there was no efficient way to store and transmit complex information across generations and between groups.

The unchanging stone tools used by our ancient ancestors is not evidence of their stupidity. It is evidence of a prelinguistic world where innovation was hard, transmission was limited, and cultural evolution moved at a crawl. A skilled toolmaker could create a perfect hand axe. They could teach others through demonstration, though they could not explain the principles or share innovations across large populations. So, tool technology stayed locked in the same basic patterns for long stretches of time. And then, around 50,000 years ago, something changed—not everywhere at once, not in all populations simultaneously—and the switch flipped.

All that latent neural machinery that had been sitting dormant for 300,000 years suddenly activated.[7] And when full recursive language emerged in human populations, it didn't just add a new skill to the toolkit. It fundamentally transformed what it meant to be human. It changed how we think, how we remember, how we plan, and how we imagine. It turned us from regular animals into something entirely new. We became beings that could accumulate knowledge across generations, innovate at unprecedented speeds, and eventually build civilizations that would dominate the entire planet. And what was the catalyst that took all the existing neural machinery in the human brain and finally activated it for full linguistic communication?

Genetic Factors

The story of how language came into human consciousness is a story about genetics, neuroscience, and population dynamics. The scientific breakthrough that made it possible to understand how humans developed complex grammar and recursive thinking came in 2001. A team of geneticists studying a British family with severe speech disorders discovered something extraordinary. They found a mutation in a single gene—the FOXP2 gene[8]—that made it nearly impossible for affected family members to produce complex speech sounds or to understand grammatical structures. This wasn't just a minor speech impediment. Members of this family—known in the scientific literature as the KE family—couldn't form sentences properly.

They struggled with basic grammatical rules that three-year-olds master easily. They had trouble coordinating the precise facial and tongue movements needed for clear speech. Most telling, they processed language slowly. By the time they figured out what someone had said, the conversation had moved on. The researchers realized they had found something profound: a single gene that, when damaged, destroyed the ability to produce and process complex language. This meant that FOXP2 wasn't just any gene. It was fundamental to the neural architecture that makes human language possible.

Located on chromosome 7, FOXP2 encodes a protein that acts as a transcription factor, binding DNA to control the activity of hundreds of other genes.[9] FOXP2 protein is active in regions of the brain such as the thalamus, basal ganglia, and cerebellum. And here is where it gets really interesting: when scientists sequenced the FOXP2 gene in other species, they found versions of it everywhere. Mice have FOXP2; birds have it; even fish have a version of this gene. It's ancient—over 100 million years old—and has been conserved across vast spans of evolutionary time. In other animals, FOXP2 helps coordinate sequences of movements. It's involved in birds' song learning, in the way mice learn to produce specific vocalizations, and in the motor-control systems that let animals produce complex learned behaviors.

The human version is different. Our FOXP2 gene has two specific amino acid changes that appeared sometime in the last few hundred thousand years—just two substitutions out of our 715 amino acids,

two tiny changes that rewired how our brains process sequential information. That is amazing because, at the neurological level, you need to coordinate dozens of muscles in your tongue, lips, jaw, and vocal cords. You need to process incoming sounds, break them into meaningful units, and map those units into concepts, all in real time while simultaneously planning your own responses. You need to understand that word order matters and that the same words in different sequences mean different things. This is what FOXP2 helps orchestrate.

The FOXP2 gene doesn't create language by itself. It acts as a master conductor, coordinating multiple brain regions that have to work together for language to function. The gene regulates the expression of hundreds of other genes during brain development. When FOXP2 is working properly, it helps build the neural circuits that make language processing fast and automatic. When the two specific amino acid changes appeared in the human version of FOXP2, something fundamental shifted. The genes started building neural circuits that were optimized for processing grammatical structures, for handling recursion, and for mapping sounds to meanings with the kind of precision that human language requires.

Furthermore, the FOXP2 gene wasn't working alone. Genetic studies have identified dozens of other genes involved in language processing.[10] CNTNAP2 (contacting associated protein-like 2 gene) helps build the long-range connections between language areas in the brain. FOXP1 (forkhead box protein P1), which is located on chromosome 3, works together with FOXP2 to regulate brain development. SPRX2 (Sushi repeat containing protein X-linked 2), which is located on the X chromosome, is involved in the formation of the cortical circuits that process grammar. Each of these genes has its own evolutionary history. When all these genes came together in the right configuration, the genetic toolkit for modern language was finally in place.

Recent research suggests that the final assembly happened sometime between 100,000 and 200,000 years ago, not as one dramatic mutation but as the last pieces of a complex genetic puzzle fell into place. Even with all the genetic pieces assembled, the right trigger was still needed. This is what scientists call the *switch hypothesis*.[11] The genetic capacity for language could have existed for tens of thousands of years without being fully expressed, waiting for the right environment and social conditions to turn potentiality into reality. The genetic potential is meaningless without the right environment to activate it.

For humans, that environment was social. Language is fundamentally a collective phenomenon. You can't have language alone. You need a community of speakers. You need a large group that is interconnected enough to transmit linguistic complexity across generations. This is where the FOXP2 story connects back to the archaeological evidence. This gene created the neural hardware for language processing; but that hardware needed to be shaped by social interaction from early childhood.[12]

Studies of the KE family showed that their FOXP2 mutation did not just affect speech production. It affected their ability to learn from social interactions. They had problems picking up the implicit rules of language that normal children absorb effortlessly. This suggests that FOXP2 and related genes don't just build language circuits; they build social learning circuits, which are neural systems that are specifically adapted to extract patterns from social interactions. When these genes are working properly, children become sponges for linguistic information. They hear their parents talking, automatically start extracting grammatical rules, and start learning the sound patterns of their native language.

This incredible learning ability works only in the right social environment. You need consistent exposure to complex language from caregivers. You need interaction with multiple speakers. You need a community where language is being used

for sophisticated purposes: telling stories, planning future actions, and explaining abstract concepts. As human populations grew and groups needed to coordinate increasingly complex activities, the selection pressure for better communication intensified. Individuals with slightly better language abilities had huge advantages. Over thousands of generations, this superiority created a feedback loop between genes and culture. Culture created stronger selection pressure for better linguistic genes. Better genes improved the brain's ability to process and transmit information.

Brain imaging studies of people who are learning a language show that FOXP2 is particularly active in the basil ganglia and cerebellum.[13] These are deep brain structures involved in learning sequential patterns and automating complex behaviors. When you are first learning a language, speaking requires deliberate thought. As you practice, something remarkable happens. Those patterns get transferred to the basal ganglia where they become automatic. FOXP2 seems to help orchestrate this transfer, building the neural circuits that make language processing fast and unconscious. Eventually, you can speak without thinking about it. This automation is crucial for human language. We speak at about 150 words per minute, which means we are producing multiple syllables per second, selecting words from a mental dictionary of thousands of options, and applying grammatical rules—all simultaneously. No other species has the neural architecture to make this kind of processing possible.

The most important thing FOXP2 enabled wasn't faster speech. It was *recursive thinking*, which is the ability to embed concepts within concepts indefinitely. This joining is what linguist Noam Chomsky identified as the core of human language.[14] It's the ability to take two ideas and combine them into a larger idea; then take that combined idea and merge it with another idea, building structures of unlimited complexity. For example, consider the sentence, "The person you saw yesterday was wearing a blue sweater that she bought last week from the store that recently opened downtown." That sentence has four levels of embedding, four recursive structures nested inside each other.

We process sentences like this effortlessly. Still, the neural computation required is staggering. You have to keep multiple levels of structure active simultaneously and resolve ambiguities in real time. FOXP2 and related genes built circuits capable of this kind of computation; the circuits were built gradually, not all at once, over hundreds of thousands of years. Each small improvement on recursive processing ability provided advantages: better planning, better social coordination, and better teaching of complex skills.

Cultural Factors

Genetic changes created the potential for recursive language. The cultural and environmental changes over the last 50,000 years finally activated that potential. Once complex language was being used regularly in human communities, there was no turning back. The advantages were overwhelming. Groups with sophisticated language could outcompete groups without it, and the gene-culture feedback loop accelerated. Within a few thousand years, language had transformed from a biological potential into a species-defining trait.

Language is the factor that made us fundamentally different from every other animal that had ever existed. The genetic story, however, is only part of the picture. To understand why the cognitive revolution happened when it did, we need to look at the physical artifacts that show when and how human behavior changed. The real question is what altered inside the human mind that made *Homo sapiens* so effective compared to the other animals. The archaeological evidence is overwhelming and hard to ignore.

Fifty thousand years ago, during the Upper Paleolithic Period, cave paintings appeared in Europe with stunning drawings of lions and mammoths. Small sculptures—carved from ivory and bone—of women with exaggerated sexual

characteristics appeared at sites from Spain to Siberia.[15] They are abstract representations of the human form, requiring symbolic thought and planning. Also, jewelry appeared at archaeological sites across Africa and Asia. Jewelry is pure symbolism; it has no survival value. Tool technology exploded, too. Prior to 50,000 years ago, there were a few distinct tool types present in any human population. More recently than 50,000 years ago, hundreds of specialized tool types existed: microliths for composite tools, specialized scrapers for different materials, bone needles for sewing, harpoons for fishing, and spear throwers for hunting.

Each tool was designed for a specific purpose, and many required multiple steps to manufacture. You can't just pick up a rock and make a bone needle; you have to find the right bone, cut it to size, grind it smooth, and drill a hole through one end without splitting it. That's a multi-step process requiring planning, patience, and technical knowledge. More importantly, these tools show standardization. An archaeologist can look at a spear point from southern France and another from Northern Spain made by a different people, then identify them as the same design. That's impossible without communication and without the ability to share detailed technical information between groups.

Evidence from archaeological sites shows that, prior to 50,000 years ago, raw materials were all local while sites that date to more recently than 50,000 years ago show evidence of long-distance trade.[16] And think about what trade requires. First, you need to recognize that someone else has something you want and that you have something they want. That's abstract valuation. Second, you need to negotiate an exchange, agree to terms, and develop relationships of reciprocity. Third, you need to maintain those relationships over time, because one-time exchanges don't create networks. Networks require interactions, memory of past dealings, and expectations of future cooperation. All of this is impossible without sophisticated communication. You can't negotiate a trade agreement with gestures and grunts. You need complex language capable of expressing abstract concepts such as value and obligation.

The time span from the first appearance of sophisticated art to fully developed trade networks was about 5,000 years. That's less than 100 generations. And it happened in Africa, Europe, Asia, and even Australia where modern humans reached around 50,000 years ago. The specific artifacts vary. African populations developed tool traditions different from those of European populations. Asian art styles differ from European ones, while the underlying pattern appears across multiple continents among genetically connected though geographically isolated populations. It was the same all throughout the world. There was a sudden explosion of symbolic thinking, artistic expression, technological innovation, and social complexity.

There was a phase transition, a fundamental reorganization of human cognitive capabilities. Something happened 50,000 years ago that unlocked potential that had been waiting dormant for tens of thousands of years. *Homo sapiens* as a species is about 300,000 years old; fossils prove this.[17] Anatomically, modern humans with brains the same size as ours existed in Africa 300,000 years ago, without being behaviorally modern. They had the hardware, the brain structure, and the physical capacity for symbolic thinking; and they were not using it.

Anatomically modern humans existed for 300,000 years without creating art and without showing evidence of the symbolic thinking that defines our species today. Then, about 50,000 years ago, their symbolic thinking emerged. The software became upgraded, and the operating system came online. Something changed that allowed humans to access cognitive capabilities they'd always had although never fully utilized. And that change spread through populations across three continents within a few thousand years, transforming every group it touched into behaviorally modern humans. The human mind had become conscious.

NOTES

1. Laura M. Ahearn, "Topics in Linguistic Anthropology" in *Living Language: An Introduction to Linguistic Anthropology* 3rd ed. (Hoboken, NJ: Wiley Blackwell, 2021), 17–21.

2. Alessandro Duranti, "Registers of Language" in *A Companion to Linguistic Anthropology* (Malden, MA: Blackwell Publishing, 2019), 23–45.

3. Ahearn, "Language Acquisition" in *Living Language*, 72–83.

4. Duranti, "Registers of Language" in *A Companion to Linguistic Anthropology*, 23–45.

5. Duranti, "Flexible Language System" in *A Companion to Linguistic Anthropology*, 221–244.

6. Ahearn, "Language, Thought, and Culture" in *Living Language*, 90–97.

7. Duranti, "Agency in Language" in *A Companion to Linguistic Anthropology*, 451–473.

8. Ahearn, "Speech Areas" in *Living Language*, 129–136.

9. Ahearn, "Code Switching" in *Living Language*, 137–145.

10. Ahearn, "Code Mixing" in *Living Language*, 146–153.

11. Ahearn, "The Transcription Factor" in *Living Language*, 154–161.

12. Duranti, "Language Socialization" in *A Companion to Linguistic Anthropology*, 349–369.

13. Ahearn, "Instant Messaging" in *Living Language*, 162–171.

14. Ahearn, "Performance as a Display" in *Living Language*, 197–210.

15. Duranti, "Language and Social Inequality" in *A Companion to Linguistic Anthropology*, 474–495.

16. Duranti, "Language Ideologies" in *A Companion to Linguistic Anthropology*, 496–517.

17. Ahearn, "Hegemony" in *Living Language*, 285–301. Ω