

The Importance of Processes in the Paleolithic Era

By Rick Doble

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ABSTRACT: A sense of linear time with a past, present, and future plus a sense of duration was an essential element of behavioral modernity. Modern human behavior could not have occurred without it. This sense of time was necessary for planning and coordination. But how did Homo sapiens develop this sense of time that was so different from the animal world that they were a part of? In this paper, I argue that the hominin sense of time developed over millions of years and developed because of their familiarity with processes such as stone-tool making. I am assuming that they developed a variety of other processes as well and each process had a step-by-step way to proceed. I am also assuming that as processes developed, they became more complicated and in addition, a proto-language and a concept of time emerged which gave them greater control and also the conceptual tools to modify and improve these processes. In short processes with their step-by-step structure became the model for linear time and time duration.

NOTE: This article repeats a number of ideas about processes that were touched on in previous articles, but goes into much more detail about the nature of Paleolithic processes.

INTRODUCTION

The role of processes in the life of hominins in the Paleolithic era is one of the key factors that influenced increasingly complex cognition, planning, sharing and communication and eventually led to modern human behavior that is known as behavioral modernity.

While I have suggested in previous articles that weaving processes began early on, this is theoretical. It does not matter which processes were involved. It is the nature and the dynamics of processes that are important and not any particular one or kind.

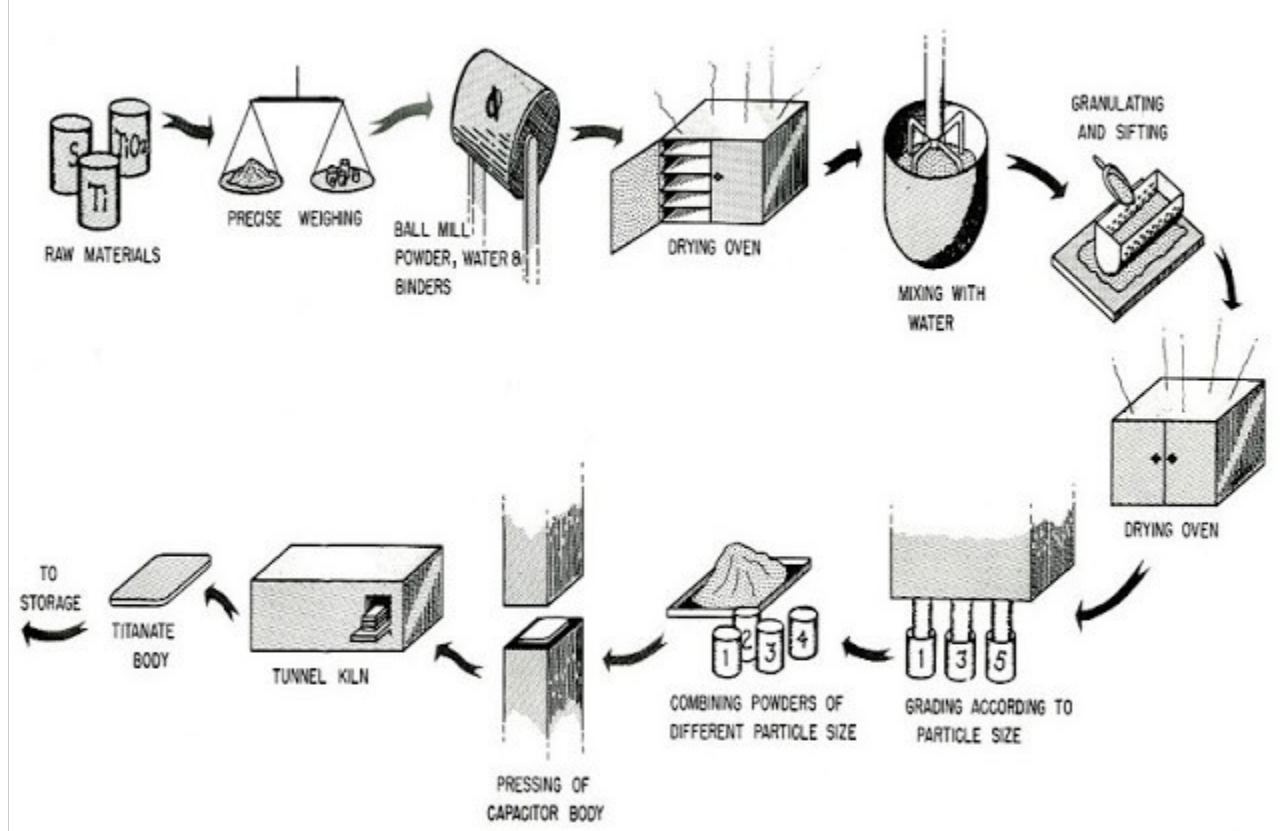
Processes have a dynamic all their own. They can start very simply with just a few steps and eventually evolve into complicated procedures with many steps and conditions. And this is exactly what happened with the one Paleolithic process we do know a lot about, that of stone-tool technology.

Google Word Definition Process:

-- a series of actions or steps taken in order to achieve a particular end --

This short definition says it well. A process requires a series of actions in a sequence that must be learned and then executed. And at the same time, the practitioner must have a clear idea of the end result. This, among other things, requires a sense of time and procedure. It also requires planning. In addition knowledge of a process must be taught to the next generation if the use of the process is to continue.

Example Of How Processes Expand And Become More Complex With More Steps

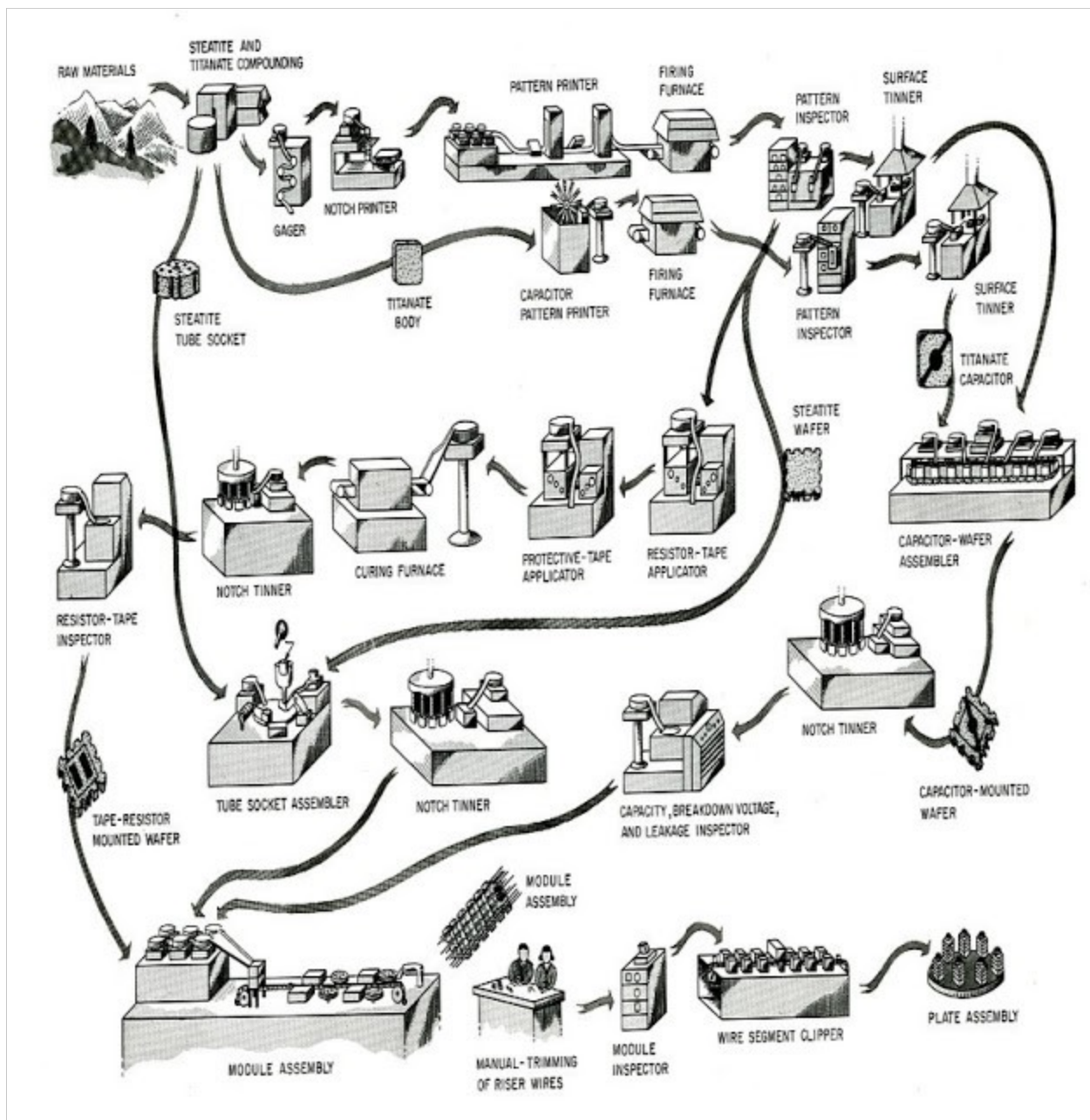


PROCESS DIAGRAM: PROJECT TINKERTOY (Early 1950s)

https://commons.wikimedia.org/wiki/Category:Project_Tinkertoy

Project Tinkertoy facility - "Code-named Project Tinkertoy, the major objective of the program was the design and construction of a pilot plant compatible with the principles of modular design and mechanized production of electronics... NBS intended to develop a process for automated manufacture of electronic equipment and to demonstrate it on a pilot production line."

National Institute of Standards and Technology



See a full video about Project Tinkertoy
<https://archive.org/details/47174USNavyProjectTinkertoy>

THE EVIDENCE FOR STONE-TOOL PROCESSING IS CLEARLY ESTABLISHED

We do know for certain that *Homo habilis* (perhaps the earliest hominin) had mastered an initial process, what we might call an entry-level process, i.e., that of Oldowan stone-tool making. And they were able to teach and communicate this skill from generation to generation.

While the Oldowan stone-tool technology has often been characterized as crude, it nevertheless required a number of specific steps, in order, to make useful tools. And these required a good deal of skill to get the desired results.

HOW MUCH SKILL WAS INVOLVED?

"Recent studies have shown, however, that even among the oldest sites flakes do indicate high levels of skill. For example, at Gona, Ethiopia, material dated to 2.5-2.6 myr represented skillfully flaked lava cobbles (Schick and Toth, 2006; Semaw, 2000).""Evidence suggests that skillful flaking and forethought were components of human tool production even as early as 2.5 million years ago..." Turcotte, Cassandra M. "Oldowan Stone Tools." The Center for the Advanced Study of Hominid Paleobiology (CASHP). http://www.bradshawfoundation.com/origins/oldowan_stone_tools.php



"A juvenile capuchin monkey (*Sapajus libidinosus*) using a stone as tool to open a seed."
https://commons.wikimedia.org/wiki/File:Stone_tool_use_by_a_capuchin_monkey.jpg

Some animals use basic tools such as a rock or a twig.

But they do not have the ability to make a complex tool when many steps are required.

ABOUT OLDOWAN STONE-TOOL TECHNOLOGY

The simple Oldowan stone-tool technology marked a major step, if not the crucial step, which eventually resulted in culture and civilization today.

If we are to understand that this technology was a *process* as I have said, we need to understand the steps that were involved. And this is especially important because this initial process became the underlying structure that led to many more processes in the Paleolithic era.



Hammerstone (left), striking the core with the hammerstone (middle), the core and a flake (right) in a later stone-tool process.

To begin the stones that were often used were river pebbles. Choosing the right stones was crucial and it appears that *Homo habilis* became quite skilled at this.

Hammerstone: This was the stone that was used to strike the core and break off a flake. This stone was round, fat, hard and could be easily held in the hand. It also would not shatter.

Core: The core was the stone that was struck. The core was generally a crystalline stone such as quartz, basalt, flint or chert. Obsidian was particularly desired as it made the sharpest edge. Naturally, it depended on what was available. The abundance of these kinds of rocks that were used for these tools shows that *Homo habilis* knew the difference between rocks. They understood which stones were best for holding a cutting edge.

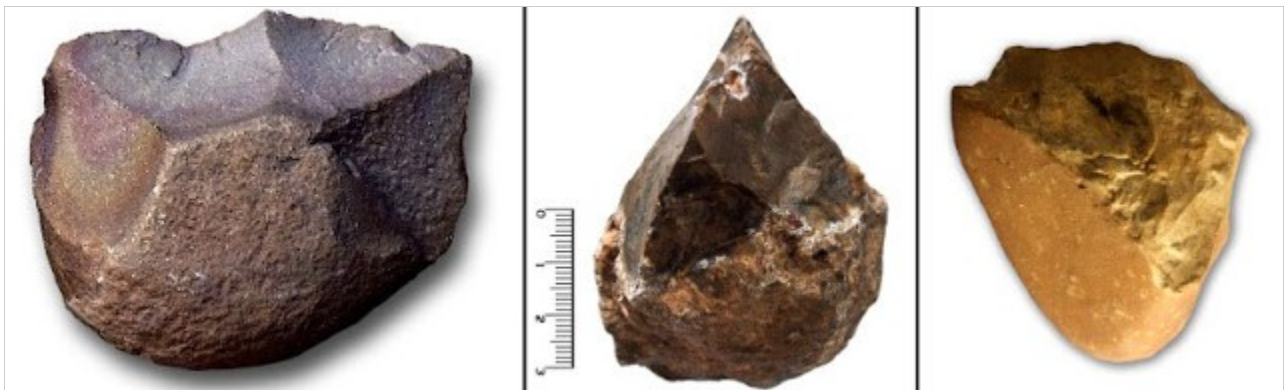
Striking the Core: The core had to be hit at just the right angle, at a certain point and with the correct amount of force. Hitting the core could produce sharp flakes that became tools in themselves or the core could be hit in such a way that when a flake was removed, the core was left with sharp cutting points. This was then called a chopper and may have been used to cut plants or chop a tree or butcher an animal.

Flake: The flake was the fragment that split off from the core. Producing a flake with a sharp edge was often the reason for hitting the core. A flake was then a tool in itself which could be quite sharp, as sharp as a surgical knife today, depending on the core's material.

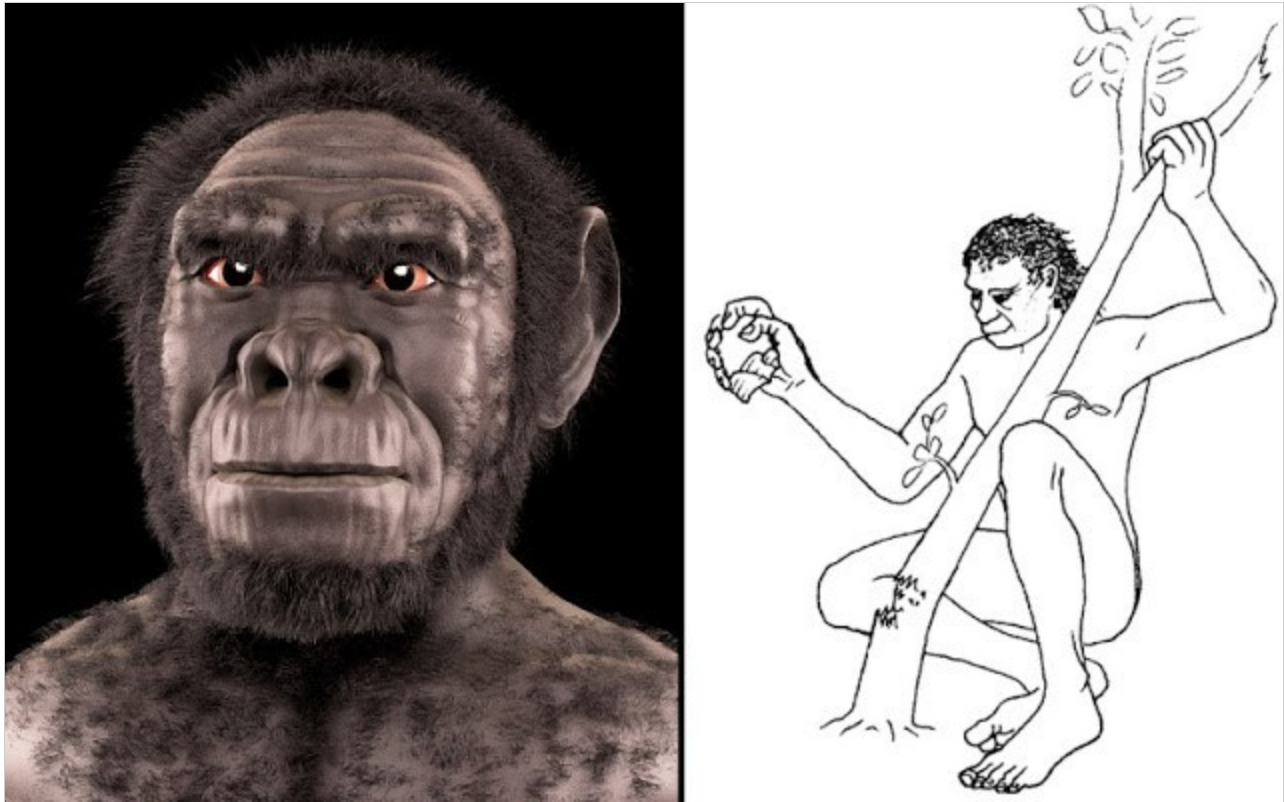
Handling these tools: The blunt side was called the proximal surface and the sharp surface was called the distal surface. The proximal surface was held in the hand and then the sharp distal surface was used to cut.

Conchoidal fracture: The fracture this process produced is known as a 'conchoidal fracture' which does not happen in nature and can only be produced by a deliberate sharp impact. This kind of fracture makes a solid tool that keeps its integrity and is not prone to breaking apart. And because this does not occur in nature, it is clear that these tools were man-made.

The general name for this kind of technology is **percussion technology**.



Examples of choppers made from the core.



Homo habilis - forensic facial reconstruction (left).
One of the ways that the chopper might have been used (right).

"The Oldowan represents the first instances of technological innovation in human history, wherein our ancestors first began to enhance their biological abilities with the manufacture of stone tools...Tool production and use is thought to be intimately linked to, if not the instigator of, major changes in cognitive development..."

Turcotte, Cassandra M. "Oldowan Stone Tools." The Center for the Advanced Study of Hominid Paleobiology (CASHP). http://www.bradshawfoundation.com/origins/oldowan_stone_tools.php

EARLY STONE-TOOL PROCESS EVOLUTION

The initial Homo habilis stone-tool process:

The Oldowan Technology

"These early tools were most likely used to help these humans butcher animals...cut up plants, and even do some woodworking." "Stone is simply pretty good at standing the test of time, but it would not have been the only thing these people used in their daily lives. It is likely that a whole range of material spanning from skin and bark [were] used to create containers; wood used to create digging sticks, spears or clubs; and digging tools made out of horn or bone were also used."

The next and more complex Homo erectus process:

The Acheulean Technology

"While the Oldowan was still in full swing...Africa became the initial host to a second tool industry: the Acheulean (c. 1.7 million years ago to c. 250,000 years ago)...It saw the development of tools into new shapes: large bifaces like hand axes, picks, cleavers and knives enabled the contemporary Homo erectus...to literally get a better grip on the processing of their kills and gatherings. More precisely shaped tools meant a more delicate technique was needed; and indeed, softer materials such as wood, bone, antler, ivory, or soft stones, were now used as percussors in what is known as the soft hammer technique."

Groeneveld, Emma. "Stone Age Tools." Ancient History Encyclopedia Limited, 21 December 2016. <https://www.ancient.eu/article/998/stone-age-tools/>

It is important to note that In the Acheulean stage, stone-tool making had now developed so that hominins were making tools to make the tools, known as meta-tools -- a critical meta-step in the technology. So this process was not only more complicated but it included another level of cognition and planning.

OTHER PROCESSES

While we do not know exactly what other processes Homo habilis and the later Homo erectus used, we can be reasonably sure that these early hominins did use other processes in their daily lives. We know for certain that they mastered the process of Oldowan stone-tool making and then later the more advanced Acheulean technology, therefore it appears likely that they would have created other processes as well.

These processes would have probably involved wood and vegetation, for example. Unfortunately, we do not have direct evidence of this due to their decay -- although cut marks on stone-tools, when viewed through a microscope, indicate that stone-tools were often used to cut plants.

"In whichever way archaeological remains are interpreted, one must always be aware that the vast majority of the materials with which prehistoric people were surrounded and with which they worked is lost to us today. ...organic materials start to decay as soon as they are deposited in the ground." Grömer, Dr. Karina. "An Introduction to Prehistoric Textiles" Brewminate.com, Natural History Museum, Vienna, March 01, 2016, <https://brewminate.com/an-introduction-to-prehistoric-textiles>.

Dr. Adovasio has made the point that there is "ample ethnographic evidence that perishable technologies form the bulk of hunter-gatherer material culture even in arctic and sub-arctic environments (e.g. Damas 1984; Helm 1981). Archaeologists working with materials recovered from environmental contexts with ideal preservation clearly confirm that this is also true for the past as well. Taylor (1966:73), for example, notes that in dry caves he recovered 20 times more fiber artifacts than those made of stone, Croes (1997:536) reports that wet sites yield inventories where >95% of prehistoric material culture is made of wood and fiber, and Collins (1937) confirms the same for sites in Alaskan permafrost."

Soffer O, Adovasio JM, Hyland DC, Klíma B, Svoboda J. "Perishable Industries from Dolní Vestonice I: New Insights into the Nature and Origin of the Gravettian." Paper Prepared for the 63rd Annual Meeting of the Society for American Archaeology Seattle, Washington, 25–29 March 1998. DolniVestonice.pdf.

I suggest that if Homo habilis could invent the Oldowan stone-tool process, they could also have created a number of other processes using natural fibers, wood, bone, etc.

And once Homo habilis had established a life-style that relied on processes, it set hominins on a path of working with processes that would become more complicated and therefore required larger brains and the use of more areas of the brain.

In the beginning, the skill of using these processes could have been taught through imitation and learned and repeated via "muscle memory" but later, as the processes became more complex, other areas of the brain probably became involved and eventually some form of basic proto-language developed.

According to *The Evolution of Culture*, very few animals possess the ability to learn via imitation. But the genus Homo was/is one of them. (*The Evolution of Culture*, Volume 4. Linquist, Stefan, Editor. Rutledge, 2017.) "The first obvious signs of imitation are the stone tools made by Homo habilis about 2.5 million years ago, although their form did not change very much for another million years. It seems likely that less durable tools were made before then, possibly carrying baskets, slings, wooden tools and so on."

Blackmore, Susan. "Evolution and Memes: The human brain as a selective imitation device." *Cybernetics and Systems*, Vol 32:1, 225-255, 2001, Taylor and Francis, Philadelphia, PA.

THE INCREASING COMPLEXITY OF PALEOLITHIC PROCESSES

"Stone toolmaking action analyses...demonstrate the presence of cumulative cultural evolution in the Lower Palaeolithic and suggest that this accumulation displays an accelerating rate of change continuous with that seen in later human history. This should encourage interest in intrinsic processes of cultural evolution that might tend to produce such a uniform curve, including the potentially autocatalytic effects of increasing technological complexity...Lower Palaeolithic technologies clearly do increase in hierarchical complexity through time, raising the possibility of important interactions with the evolution of human cognitive control..."

Stout, Dietrich. "Stone toolmaking and the evolution of human culture and cognition." *Philos Trans R Soc Lond B Biol Sci.* 2011 Apr 12; 366(1567):
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3049103/>

PROCESSES LED TO LARGER BRAINS AND MORE COMPLEX COGNITION

In a landmark experiment, Dr. Dietrich Stout designed a study in which modern people who were skilled at making stone-tools in the manner of the Oldowan and Acheulean technology were observed via brain imaging as they made these tools.

"Increasing levels of abstraction in action organization place demands on increasingly anterior portions of frontal cortex [22] and precisely this pattern of increased anterior activation has been observed in a brain imaging study comparing late Acheulean versus Oldowan toolmaking [29]. This is consistent with the possibility that evolving neural substrates for complex action organization could have interacted with autocatalytic increases in technological complexity to produce a 'runaway' process of biocultural evolution [8,65]."

Stout, Dietrich. "Stone toolmaking and the evolution of human culture and cognition." *Philos Trans R Soc Lond B Biol Sci.* 2011 Apr 12; 366(1567).
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3049103/>

PROCESSES AND THE UNDERSTANDING OF LINEAR TIME

The use of processes played a critical role in the human understanding of time, an understanding that was/is unique among animals.

"Our sense of time involves some sense of duration and also of the differences between past, present and future. There is evidence that our sense of these distinctions is one of the most important mental faculties distinguishing man from all other living creatures. For we have good reason to believe that all animals except man live in a continual present."

"It must have required enormous effort for man to overcome his natural tendency to live like the animals in a continual present."

Gerald James Whitrow. *Time in History: Views of Time from Prehistory to the Present Day.* Oxford, UK, Oxford University Press. 1988, pages 7 & 22.

How and why did humans leave the immediacy and comfort of their animal existence and invent language, culture, and a sense of linear time with a past, present, and future? Did it require enormous effort? I would say no.

I would argue that this transition took place gradually over millions of years. And that rather than being difficult and painful, the break with our animal past, that led to our acquisition of behavioral modernity and the modern sense of time, occurred quite naturally.

After perhaps two million years, we know for certain that the skill and technology of stone-tool making had become quite complex. And because of this, we can perhaps assume that other processes based on natural fibers and wood, etc. had also become equally complex.



The progression of stone technology during the Paleolithic era showing the evolution of stone tool processing.

(Left) Acheulian flint chopper, North Somerset, UK; ca. 750 kya.

[https://commons.wikimedia.org/wiki/File:583_three_handaxes_ventral_\(FindID_101523\).jpg](https://commons.wikimedia.org/wiki/File:583_three_handaxes_ventral_(FindID_101523).jpg)

(Middle) Lower Paleolithic flint stone tool, Egypt; ca.200 kya.

https://commons.wikimedia.org/wiki/File:Tool_MET_06-322-21.jpeg

(Right) Bifacial silcrete point; Blombos Cave, South Africa; 71 kya.

https://commons.wikimedia.org/wiki/File:Blombos_point_white.JPG

In the late Paleolithic period, tools became even more sophisticated. As many as 80 different types of implements have been unearthed for what are called the Perigordian and Aurignacian industries in Europe. It is believed that these tools were used for hunting and butchering, clothes making, and a great variety of other tasks that moved early humankind closer to modern life. In all, hundreds of highly complex tools have been found, some of which are the prototypes for modern tools.

STONE TOOL INDUSTRY

<https://www.britannica.com/topic/stone-tool-industry>

While understanding an individual process was limited to particular materials and desired results, all processes involved a sense of time. Each step had to be done in a certain order, for example, and the eventual outcome was dependent on past steps that had been done correctly. Advanced processes often required precise conditions for specific durations of time -- such as the exacting heat treatment of silcrete (see below) to make it as workable as flint. The resulting stone was essentially an "artificial flint."

AN EXAMPLE OF A LATER COMPLEX PROCESS WHICH CONTINUED TO DEVELOP

The Heat Treatment Of Silcrete For Stone Tools

Approx 130 - 60 kya

About 130 kya Paleolithic people learned to heat treat certain kinds of locally available stones. Instead of needing to use flint, for example, they, in a sense, made their own "artificial flint" by treating silcrete so that it had flint-like properties, which made it an excellent material for tools and arrows. The heat treatment made the stone harder, less prone to fracturing and easier to shape. Over perhaps 70,000 years into the Middle Paleolithic era (the time before the Upper Paleolithic cultural explosion), this technique became quite sophisticated.

Beginning with an above-ground method of placing stones in a pile of embers, it evolved into a well crafted controlled method that used "underground heating in an earth-oven like fire-pit. (sciencedaily.com -- see reference next)" This is a good example of the evolution of a Paleolithic process and the increasing complexity, precision, and sophistication that was achieved.

The "silcrete heat treatment...may provide the first direct evidence of the intentional and extensive use of fire applied to a whole lithic chain of production."

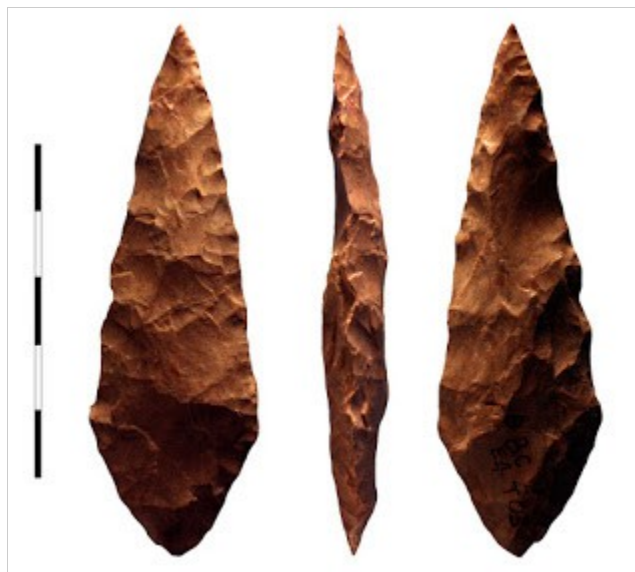
"This heating process marks the emergence of fire engineering as a response to a variety of needs that largely transcend hominin basic subsistence requirements,"

"Early humans used innovative heating techniques to make stone blades." Science Daily. October 20, 2016.

<https://www.sciencedaily.com/releases/2016/10/161020092107.htm>

It was familiarity with a wide variety of processes, including stone-tool making, that eventually led to an understanding of linear time. This was crucial for the transition from animal behavior to behavioral modernity and for the development of language.

Working with processes led to the development of a number of cognitive skills that were essential for behavioral modernity. Memory, a sense of time in terms of past, present and future along with a sense of time duration, goal-directed behavior, cognitive skills, and decision making came together as a result of managing a variety of complex and changing processes. In addition, there developed a way to teach and train each generation in these skills. Eventually, this culminated in modern human behavior including a full early language and a way to express linear time.



Example of heated silcrete stone that was then shaped
(the same stone seen from different angles).

THE PREFRONTAL CORTEX

The Homo sapiens brain was more than twice as large as the brain of Homo habilis and 1.5 times bigger than the brain of Homo erectus. But in addition, Homo sapiens had a distinct part of the brain that was unlike that in any other animal. This part is called the prefrontal cortex. And it is only in the last decade that we have begun to understand that this recently discovered area was critical when it came to planning, cognition and understanding the linear progression of time.

I believe an ability to work with complex processes and then to innovate came about because both the larger brain and the prefrontal cortex given to Homo sapiens allowed them to do so.

A full description of the prefrontal cortex is best left to scientific sources, so what follows are descriptions from scientific websites.

"This part of the association cortex, which is implicated in higher cognition and affect, is thus disproportionately large in humans relative to other primates."
Stern, Peter. The human prefrontal cortex is special. Science. Science22 Jun 2018 : 1311-1312.
<https://science.sciencemag.org/content/360/6395/1311.7>

"This brain region has been implicated in planning complex cognitive behavior, ... [and] decision making...The basic activity of this brain region is considered to be orchestration of thoughts and actions in accordance with internal goals." [ED: i.e., the future]
Prefrontal Cortex. The Science Of Psychotherapy. 2017.
<https://www.thescienceofpsychotherapy.com/prefrontal-cortex/>

I was one of the first writers in 2014 to focus on the prefrontal cortex as a critical component in our ability to understand and conceptualize linear time. We are the only animal that has this capability. See my most popular article (more than 10,000 readers since 2014) about the prefrontal cortex:

Animal Senses Compared to the Human Sense of Time
<https://deconstructingtime.blogspot.com/2014/08/animal-senses-compared-to-human-sense.html>

PROCESSES, TIME AND PROTO-LANGUAGE

After two million years, with their increased brain size and the added abilities of the prefrontal cortex, hominins began to develop a language and a set of conceptual tools that gave them greater control over their use of processes.

In particular, language gave humans the tools to work with time. Language could express basic linear time concepts that allowed them to imagine processes, the order of the steps involved and the duration of each step. It also allowed them to imagine different outcomes and to share and discuss processes. And, of course, language was used to instruct the next generation.

Linguists and anthropologists assume that a fully developed language, even the most basic language, would have had words that expressed concepts of time.

Anna Wierzbicka made a list of what are known as Semantic Primitives as listed by the Natural Semantic Metalanguage. The following are universal words for time that occur in all languages:
when/time, now, before, after, a long time, a short time, for some time, moment

It is important to note that language and time concepts are closely linked.

"Time reference is a universal property of language..." Jacqueline Lecarme, Ph.D., Linguistics

And since processes proceed step-by-step, they became a model and metaphor for time, not unlike a clock which advances step-by-step as the hands of the clock move forward.

We can find examples of this today such as in this expression:

Your idea is half-baked.

This comes from the process of cooking where the bread was not given enough time to bake.

CONCLUSION

Since hominins had been working with processes for millions of years, they were familiar and comfortable with them. So the eventual awareness of linear time that processes involved and the conscious understanding of the process steps evolved naturally.

And this is why an understanding of processes is so important. Processes became the model and the metaphor for linear time along with duration. And once language and modern human behavior was achieved, humans had even greater control over their processes and their ability to control their environment. This eventually led to the Upper Paleolithic, the Neolithic and then to civilization.

AFTERWORD

ABOUT PROCESSES

I am quite familiar with processes. I processed my own black and white photographic negatives and then developed prints from those negatives for fifteen years. Negative processes involved time, temperature and proper handling, such as agitation. The initial spooling took place in the pitch dark.

I soon learned that what I did at the beginning greatly affected the end result. So as time went on, I became more precise. I learned to make accurate photographic exposures before developing so that the chemical process of developing produced a fine-grained thin negative with a full range of tones. And I added a couple of steps to standard developing that improved the results such as using distilled water as a pre-soak and diluting the developer for more control over the development time.

Then I developed my own black and white slides which was even more exacting.

And finally, I developed color slides. This process was the most involved and the most precise. Color slides, for example, required that the developing solution had to be 100 degrees F +/- 1/2 degree for a very specific duration of time.

I say all of this because I do understand how processes work and how they evolve. Whether I am talking about photographic processing or making stone-tools in the Paleolithic era or preparing esparto grass for basket weaving or for making rope, basic step-by-step procedures are common to all.

THINKING OUTSIDE THE BOX?

I realize that my ideas may seem a bit different and unusual to Paleoanthropologists, but consider:

"Tools are the products of our brains, and we have millions of stone tools," Wynn added. "What we need are more creative ideas on how to extract understanding from them, and what they tell us about our evolution." Quotation from paleoanthropologist Thomas Wynn of the University of Colorado at Colorado Springs.

Choi, Charles. "Human Evolution: The Origin of Tool Use." LiveScience, November 11, 2009. <https://www.livescience.com/7968-human-evolution-origin-tool.html>. Accessed 10/26/2019.

A Caveat: While I believe that Homo sapiens became aware of linear time and were able to use it to their advantage, their sense of time was quite different from our own. I discuss this in other articles I have written.