

Stone Tools as Palaeolithic Central Unit Processors

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Abstract

In the framework of prehistoric studies, stone tools are among the most crucial and puzzling artefacts. It has been argued (Shipton, 2019) that the evolution of flint knapping techniques can be described as a three stage process, from normativity (Acheulean handaxes) to recursion (Mousterian debitage) and finally to abstraction (Recent Palaeolithic cultural practices). This theory draws heavily on the idea that stone tool crafting, or flint knapping depends on the manipulation of logical, semantic, symbolic and even grammatical rules, developed since the 1980s (Shipton, 2018; Stout, 2011; Davidson and Noble 2002; Rolland and Dibble, 1990; Keeley and Toth 1981). These discussions deterritorialize recursion - a concept which blossomed in computer science - in order to make sense of some of the technological paradigms developed by early hominins. In the light of this discussion, we propose to further the implicit metaphor which consists in applying concepts from programming to palaeolithic technologies, and in turn to evaluate the relevance of comparing stone tools to present-day central unit processors, as both artefacts enable their user to execute a vast array of pragmatic functions. Our working hypothesis is rooted in the observation that Mousterian flaking techniques involve higher order abstraction and logical combination, which situates them beyond the scope of iterative algorithmics. We will thereafter evaluate the comparison between the process of microlithisation (reduction of the size of stone tools) and the miniaturization of central unit processors as prescribed by Moore's laws. The novel conceptual frameworks of anachronistic semantics, practical speculation and psychedelic pragmatism will thus enable us to renew our perspective on recent trends in culture such as retrogaming, 8-bit music and palaeo-computing.

keywords: recursion, stone tools, computer science, hand axe, processor, prehistory, palaeogaming, silicon valley, flintstones, psychedelic pragmatism, practical speculation, anachronistic semantics

Introduction

The lives of early humans revolved around a limited set of skills necessary in order to survive and to develop, both demographically and culturally. Strictly speaking, these skills were related to the functional operability of stone tools, understood as generators of a wide range of possible assets which determined the circumstances of social prosperity. In this paper, we will investigate the idea that handaxes and stone tools were multifunctional processors, comparable with the central processing units found in present-day computers. We will thus explore the archaeological record and the history of technological development from a cultural perspective, embracing the whole of human time, spanning from 3.3 million years BP (before present) to 2021.

In the framework of prehistoric studies, stone tools are among the most crucial and puzzling artefacts. It has been argued (Shipton, 2019) that the evolution of flint knapping techniques can be described as a three stage process, from normativity (Acheulean handaxes) to recursion (Mousterian debitage) and finally to abstraction (Recent Palaeolithic cultural practices). This theory draws heavily on the idea that stone tool crafting, or flint knapping depends on the manipulation of logical, semantic, symbolic and even grammatical rules, developed since the 1980s (Shipton, 2018; Stout, 2011; Davidson and Noble 2002; Rolland and Dibble, 1990; Keeley and Toth 1981). These discussions deterritorialize recursion - a concept which blossomed in computer science - in order to make sense of some of the technological paradigms developed by early hominins. In the light of this discussion, we propose to further the implicit metaphor which consists in applying concepts from programming to palaeolithic technologies, and in turn to evaluate the relevance of comparing stone tools to present-day central unit processors, as both artefacts enable their user to execute a vast array of pragmatic functions. Our working hypothesis is rooted in the observation that Mousterian flaking techniques involve higher order abstraction and logical combination, which situates them beyond the scope of iterative algorithmics. We will thereafter evaluate the comparison between the process of microlithisation (reduction of the size of stone tools) and the miniaturization of central unit processors as prescribed by Moore's laws. The novel conceptual frameworks of anachronistic semantics, practical speculation and psychedelic pragmatism will thus enable us to renew our perspective on recent trends in culture such as retrogaming, 8-bit music and palaeo-computing.

The Silicon Valley was recently shaken by a series of trials apparently disconnected from palaeoanthropology: the city of Hillsborough¹ sued a certain Florence Fang in 2019 on the grounds of disputed building permits. Fang's house is architecturally uncommon, as it was designed to resemble the imaginary dwellings of Hanna-Barbera's Flintstone family. By publicly designating the house as a "public nuisance", Hillsborough officials demonstrated not only their lack of humor, but also their lack of self-consciousness. Although Silicon Valley is not known as a prehistoric stone quarry, its very name refers to materials used to build both palaeolithic handaxes and computer chips: flint.

The year 1999 will be remembered by many as a countdown for the Y2K glitch. That same year, scientific journalist Marek Kohn and archaeologist Steven Mithen were publishing a seminal article titled *Handaxes: products of sexual selection?*² in which they speculated on the possibility that handax craft could have held a major role in prehistoric society. As the title suggests, they attributed a new function to stone tools: seduction, or more precisely sexual selection. The theory intends to account for a large set of archaeological oddities, including very large and sometimes fragile handaxes. Moreover, the sexual selection theory aimed at providing a new explanation for an unnecessary design feature common to many handaxes: symmetry. Ten years later, Anna Jane Machin³ and others⁴ dared to contest this appetizing theory after further researching the efficiency of symmetrical handaxes on butchery. Strikingly, the debate takes on Darwinian demography and sexual dimorphism. Since then, the sexual selection theory has been debated further.

This controversy illustrates the status of handaxes in the study of prehistory, and hints at the importance of deciphering the function of stone tools from the perspective of evolutionary psychology. This goal-oriented approach to the archaeological record is sometimes prone to ideologically oriented overinterpretation, which results in two types of outcomes. Because it renews the public's fascination for the origins of humanity, and because it often taps into the eidetic world of cultural stereotypes, evolutionary psychology proves to be a very popular approach to prehistory.

¹ Meisenzahl, Mary, (Oct 7, 2019), 'The owner of the controversial 'Flintstone House' in Silicon Valley says the city discriminated against her after they called her house a 'public nuisance,' and now the case is going to trial', Business Insider, online
<https://www.businessinsider.com/flintstone-house-owner-legal-battle-discrimination-suit-full-history-2019-10?IR=T>

² Kohn, Marek and Mithen, Steven, 'Handaxes: products of sexual selection?', *Antiquity*, Volume 73, Issue 281, September 1999, pp. 518 - 526, DOI: <https://doi.org/10.1017/S0003598X00065078>

³ Machin, A.J.. (2008). 'Why handaxes just aren't that sexy: A response to Kohn & Mithen (1999)', *Antiquity*. 82. 761-766. [10.1017/S0003598X00097362](https://doi.org/10.1017/S0003598X00097362).

⁴ Nowell, A. and Chang, Melanie, (2009), 'The Case Against Sexual Selection as an Explanation of Handaxe Morphology', *Paleoanthropology*,

On the other hand, because it claims to demonstrate the antiquity of cultural stereotypes, evolutionary psychology also generates a new form of philosophical skepticism, well illustrated by the writings of David Buller⁵. The most important problem emerging from these debates is the question of legitimacy: who has the right to speculate on prehistory? Because prehistory is based on the study of fragmentary data sets, it is not only error prone but also wide open to the wildest forms of misinterpretation.

This is the context in which we will attempt to demonstrate the useful nature of anachronistic semantics, a method of inquiry based on the comparison of antagonistic and otherwise unrelated objects. Since central unit processors as well as handaxes are made of silicon and both technologies play a crucial role in the daily lives of the human populations making and using them. Comparing them is therefore a necessary step in order to evaluate whether the role of technology can be thought of as a constant in social human behavior, despite the massive technical progress understood teleologically by proponents of the theory of intelligent design. In a sense, we are taking part in a war between different approaches of science. What is at stake here is the status of the scientific method in the context of creation science, the third wave of anti-evolution movements.⁶

1-Stone tools as evidence of behavioral recursion

Prehistoric handaxes, before being scientifically described and analyzed, were commonly worshiped in ancient Greece, in the Roman Empire as well as throughout medieval Europe, as amulets keeping their owners from thunder, disease and evil. Depending on the regional folklore, people would use them in different types of rituals and associate them with various myths. As such, they were called *cerauniae*, or “thunder stones”. It has been observed that prehistoric stone artifacts were to be found by native populations in Europe, Anatolia, North and South America, in South-Eastern Asia. They were believed to be heavenly weapons used in biblical times to defeat Satan, gifts from gods, cures for various illnesses and more generally cherished as talismans⁷.

⁵ Buller, David, (2006), ‘Adapting Minds: Evolutionary Psychology and the Persistent Quest for Human Nature’, MIT Press

⁶ Huskinson B.L. (2020), The Rise of Creation Science, In: American Creationism, Creation Science, and Intelligent Design in the Evangelical Market. Christianities in the Trans-Atlantic World. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-030-45435-7_2

⁷ Goodrum, Matthew, (2008), ‘Questioning Thunderstones and Arrowheads: The Problem of Recognizing and Interpreting Stone Artifacts in the Seventeenth Century’, Early Science and Medicine. 13. 482-508

Among the first recorded claims that these objects were actually crafted by humans were made by 16th century Italian scholar Michele Mercati; it is noteworthy that he worked as a superintendent for the Vatican's Botanical Garden. It is not before the 1850s that the scientific community managed to provide an explanation for the existence of thunder stones, and it took French proto-prehistorian Boucher de Perthes several decades to demonstrate the idea that they were the works of ancient humans. Indeed, the public opinion remained attached to the biblical version of history: around 6000 years ago, there was nothing; then God created the world and man, exiled Adam and Eve from the Garden of Eden, and some time later rebooted all of creation by flooding the world and destroying all life forms which he didn't care for.

Not only did this myth drive popular belief, it also had a strong influence on mainstream palaeontology, in particular Georges Cuvier's theory of Catastrophism, inspired by biblical cosmogony, according to which fossil bones belong exclusively to antediluvian creatures who had perished during the judeo-christian iteration of the flood myth. Against Jean-Baptiste de Lamarck's Transformism, Cuvier's theories are fixist: they assume that animal and vegetal species are perfect creatures created by a perfect god, and therefore cannot evolve. We can thus conclude that by the middle of the 19th century, the scientific interpretation of thunder stones cast severe doubt on the biblical timeline, prefiguring the Darwinian revolution to come. Thus, in the Western European tradition, long before they were accepted as proof of the existence of ancient human populations, the first function ascribed to handaxes was magical: as the product of thunder, the thunder stone was supposed to protect from thunder. Despite the fantastic nature of the idea, we should note the prominent circular logic at work here, as we will have to distinguish it from recursive logic later on.

Paleoanthropologists have been debating the implications of stone tool artifacts for decades; since these have been crafted for a period spanning over several millions of years from the earliest choppers to the most refined flint blades, the present conversation should be circumscribed to a specific lithic technology. In order to significantly compare stone tools to the central unit processors found in modern computers, the scope of this research has intentionally been limited to Mousterian techno-complex, often associated with Levallois debitage. In the archaeological record, items produced in accordance with Levallois-Mousterian flaking techniques can be found, roughly, from 400'000 to 40'000 BP, which is a short period only when compared to the age of the oldest stone tools known. Exhumed at the Lomekwi 3 site in Lake Turkana, Kenya, those are believed to be roughly 3 million years old⁸.

⁸ Harmand, Sonia, et al., (2015), '3.3-million-year-old stone tools from Lomekwi 3, West Turkana, Kenya', Nature Vol. 521(7552):310–315

The key concept here is that such handaxes were essentially multi-purpose tools, useful for hunting, cutting, scraping, piercing and many other typical carcass-processing tasks. The sheer multiplicity of functions of those tools evokes a sense of centralisation, which neighbors the central unit processor metaphor notoriously. However, we will look at another design paradigm altogether, one that has the particularity of externalizing several specific functions into different tools, albeit essentially from the same piece of rock.

Mousterian flaking techniques, often assimilated to Levallois debitage, are often described metaphorically as the “Swiss Army knife” of prehistory, because of the methodology and goal-oriented flaking strategy it involves. Although Acheulean handaxes are also multifunctional tools, the set of tools extracted from a single stone via Levallois debitage opens up another level of understanding of multifunctionality. It also deserves special attention because of the different mindset and attitude towards the prime material it requires. Instead of focusing solely on the ideal shape of the tool - whether it would be symmetrical or not is not always relevant - tool makers produced a series of usable flakes such as points and scrapers, while preserving and shaping the stone’s core throughout the process. Among the benefits of this approach, the economical aspect is important: human populations were not always living near sources of fresh flint, which was in itself a resource enabling the acquisition and processing of other resources. For this reason, flint stones are distinctively a meta-resource, and as such they deserved care. This is somehow reminiscent of the high symbolical value occupied by medieval thunder stones, which were believed to be gifts from heavens altogether.

Nevertheless, stone tools are unanimously understood as indicators of human evolution. As Mark W. Moore sums it up in his 2010 paper, they are “by-products of action grammars that track the evolutionary history of hominin cognition”.⁹ Since the first traces of Levallois technology is associated with African sites dated around 400’000 BP, it is fair to assume that the full maturing of this approach would only happen after populations got accustomed with it. The distinctive feature of the Levallois paradigm, as we will see, is the use it makes of combinatory logic, which from a linguistic point of view allows us to classify it in the category of recursion-oriented devices.

⁹ Moore, Mark, (2010), ‘Grammars of action and stone flaking design space’, *Stone Tools and the Evolution of Human Cognition*, 13-43.

The importance of combinatory Levallois innovation is most explicit in the framework of Moore's concept of "action grammars":

[Our] model shows that controlled flaking is achieved through integral sets of geometrical identifications and motor actions collectively referred to as the "flake unit". The internal structure of the flake unit was elaborated early in technological evolution and later trends involved combining flake units in more complex ways. Application of the model to the archaeological record suggests that the most complex action grammars arose after 270 kya, although significant epistemological issues in stone artifact studies prevent a more nuanced interpretation.¹⁰

Among the many debated aspects of stone tools, the question of education and of the transmission of knowledge plays a central role. Although it is not clear - and perhaps never will be - whether humans developed articulated language before developing advanced flaking techniques, it is generally assumed that since many animals make and use tools, language is not a prerequisite condition to tools themselves. In his 2019 article, Ceri Shipton argues that stone tool techno-complexes are efficient indicators of different stages of development of the human mind. The Acheulean biface is thus associated with the emergence of normativity, while the most refined achievements of Aurignacian and Gravettian cultures require the full development of abstract symbolism as a cognitive aptitude. The case of Mousterian technologies is perhaps more dramatic: it signifies the rise of recursion. In the field of linguistics, recursion has often been associated with the uniqueness of the human capabilities for language. All human languages are recursive, in that they require modular grammatical rules and enable relations of combination and of hierarchical embedding among propositions.

Shipton provides a compact and powerful definition of recursion :

Recursion is the ability to embed discrete concepts within broader concepts, often with feedback loops (Coolidge, Overmann, & Wynn, 2011).

Although he doesn't explicitly quote Noam Chomsky, we can sense from this short and compact definition that this understanding of recursion is vivid with linguistic-oriented assumptions. Among those, the essential idea that the Levallois technique requires a set of logical operations which could not be achieved via an iterative methodology. In other words, as opposed to the Acheulean handaxe,

¹⁰ Ibid.

the Levallois artefacts require a programmatic approach of flint knapping, through which the knapper becomes able to do more than simply carve a shape out of a block of stone. In Aristotelian terms, the Acheulean handaxe fully satisfies the definition of causality. As an artifact, the handaxe is no less than a sculpture, that is to say the final cause, or “that for the sake of which a thing is done”. Aristotle’s statue can be achieved via iteration: the sculptor would create a shape one gesture at a time, first by carving out the unnecessary materials of the marble block, and eventually by producing a cast or template from the final shape.

Flaking Mousterian stone tools is another story altogether: it involves a very lucid and predetermined approach of the series of operations which are to take place in order to reach the final goals. The goals are numerous: preserving the core is the necessary condition through which all the other more specialized tools will be flaked out, pertaining to Leroi-Gourhan’s¹¹ concept of operational chain. As computer scientists are likely to remind us, recursion is a programming technique; it is a way of formulating a function in order for it to be translated to machine language and eventually executed bit by bit at the lowest possible level, which is the very physical bedrock of 0s and 1s manipulated by the central unit processor. This means that recursion doesn’t happen on a sheer physical level, but on the semantic level of programming.

Here is how Shipton contextualizes the ethological circumstances in which the recursive Levallois flaking technologies appeared:

Recursion is perhaps the hallmark of Middle Palaeolithic knapping technology, but it may also be manifested in other aspects of behavior. Acheulean hominins seem to have used short-term landscape use strategies, with sites predominantly associated with easy to access knappable stone outcrops or nearby freshwater sources, and with short life histories of stone tools (e.g., Copeland & Hours, 1989; Goren-Inbar, 2011; Pappu & Deo, 1994; Shipton, Blinkhorn, et al., 2018; Shipton & Clarkson, 2015). In the Middle Palaeolithic, however, hominins were occupying upland regions (Giles Pacheco, Santiago Perez, Gutierrez Lopez, Mata Almonte, & Aguilera Rodri-guez, 2000; Roustaei, 2010), and targeting high-quality and difficult to access stone (Groucutt et al., 2017), which was sometimes transported over distances requiring several days’ travel (Blegen, 2017; Brooks et al., 2018; Féblot-Augustins, 1999; Mer-rick, Brown, & Nash, 1994; Nash et al., 2013).

¹¹ Soressi, Marie, and Geneste, Jean-Michel, ‘The history and efficacy of the Chaîne Opératoire approach to lithic analysis: Studying techniques to reveal past societies in an evolutionary perspective’, *PaleoAnthropology*, 2011

Concomitantly, Middle Palaeolithic stone tools have longer and more spatially fragmented life histories in comparison to those of the Acheulean (Shipton et al., 2013; Turq, Roebroeks, Bourguignon, & Faivre, 2013). This difference in landscape use may be underpinned by recursion, with stone procurement and tool production recursively embedded within spatially and temporally broader journeys. Such embedding is particularly indicated in the targeting of seasonal migrations of ungulate species and the transport of exotic stone to such locations (Costamagno, Liliane, Cédric, Bernard, & Bruno, 2006; Gaudzin-ski & Roebroeks, 2000).

Mousterian stone tools are recursive in several different senses. First of all, the material and technical gestures which enable their creation are not organised in an iterative manner as would be the case in the making of Acheulean handaxes. On top of that, the Mousterian lithic industry occurs in highly complex environments, the study of which requires an ethological understanding of the concept of recursion. Finally, the Mousterian industry has been known to exist until roughly 40'000 BC, in sites where cohabitation of Neanderthal and Homo Sapiens populations has been assessed such as the Qafzeh site in Israel. It is quite safe to assume that in its latest developments at least, the Mousterian industry has coexisted with human language, which is famously recognized by authoritative scholars to be essentially recursive. Stone tools are thus recursive in a triple sense, which makes it even harder to resist associating them, or even comparing them with computers. It is beyond the scope of this paper to develop the computerized simulation of different lithic industries which would be necessary to assess the recursive nature of Levallois debitage from a computer science perspective. However, as we now well see, this is not only beyond the scope, but also beyond the point.

2-Comparative functionalism: stones as processors

Today's central unit processors are the locus of the calculation going on in our computers. They are functionally distinct from memory and I/O interfacing apparatuses and come in different specialized versions such as graphic processing units and audio signal processors. Comparing processors with stone tools is a rather costly endeavour, as it would seem to blur the line between scientific inquiry and creative writing. The prime objective of this paper is to demonstrate the well-founded nature of comparing silicon-based stone tools and silicon-based electronic chips known as CPUs. Such a comparison enables us to introduce the concepts of anachronistic semantics, practical speculation, and psychedelic pragmatism. These three topics are embedded in each other recursively, yet many scientists might object that such a methodology amounts to nothing but tautology.

Since scientific methodology is one of the elements at work here, it is essential that we make a clear distinction between circular logic and recursion. From a non-scientific perspective, circular logic bears cosmetic resemblance with recursion, but the two have nothing in common when it comes to pragmatic efficiency: recursion is a highly efficient method in computer programming, while circular logic most often appears as a defect, useful only in the framework of poetic or absurdity-oriented philosophical demonstrations. Yet, from a *psychedelic pragmatic* point of view, circular logic is only one of the elements of what recursion stands for, which is also true in computer science since recursive functions are based on logically controlled loops, although such processes can often be formulated using an iterative approach.

Benoît Mandelbrot's theory of fractals is a well-known and widespread use case for recursion. From a phenomenological point of view, fractals come across as looping self-embedded patterns. As complex mathematical objects fractals are much more than pattern-generating algorithms. Their popularity outside the scientific community is notorious, and once devoid of technical understanding of their nature, they are intuitively perceived as dynamic patterns. Conversely, reducing fractals to patterning appliances is a common error encountered essentially in the field of goal-oriented computer programming, where they are used to serve practical purposes bearing little or no mathematical implication. They can be used in creating backgrounds for video games, in the context of procedurally-generated graphics. For this reason, fractals are typically used as mere tricks enabling the lazy programmer to achieve maximum effect with minimum functional decision taking. Interestingly, this is also a commonplace understanding of recursion. Yet, before the commercial distribution of processors enabling the manipulation of 16 bit integers, fractals were often the only way for thriving computer programmers to even come close to achieving anything close to what they intended to build.

In contrast, from the standpoint of the psychedelically modified perception, reality *is usually perceived as a massive recursive function*. Numerous reports of drug-induced visual hallucination and spiritual realizations provide self-generating fractal phenomena. Although best studied from the point of view of visual perception,¹² such phenomena commonly affect the logical structure of reality as it is perceived during psychoactive drug use. Altered states of perception associated with psychoactive substances open up unusual phenomenological phenomena which are directly related with the neurological processing of reality - drug users colloquially report themselves as being

¹² Sayin, Umit. (2017). Sayin HÜ. 'Neurons' Secret Geometric Language: Entoptic Images', Phosphenes & Archetypes SexuS Journal, 2017/2 (6): 308-348. 2. 309-348.

“stoned”.¹³ Psychedelics seem to enable human perception to look *through* patterns, and to distinguish the underlying existence of a driving logic. Outside the field of psychedelic studies, computer generated fractal¹⁴ patterns have become a debated topic, as traditional psychological models associate them with background neural activities¹⁵ Such neurologically generated phenomena bear some resemblance to mystical revelations¹⁶ experienced and reported worldwide under names such as “grace”, “godly agency” and “intelligent design”.

This is precisely the reason why the scientific community, and the public at large, should strive to keep such perspectives and experiences well in sight, and prevent them from being appropriated by fundamentalist ideologies. In this sense, the renewed interest of the scientific community for psychedelic studies is an interesting perspective, well in alignment with William James’ attempts to study and analyze religious experience from a psychological point of view without discarding its value¹⁷. Going back to the comparison between stone tools and processors, let us start over by asking simplistic questions: if stone tools were to be compared to processing units, what data would they process and in what form would that data be found? Indeed, central unit processors deal with discrete values and binary data, which doesn’t seem too compatible with the infinite complexity of reality, which seem to be dealing with continuous values and phenomena which could be reduced to data sets only via human endeavor, which comes at a very high cost in terms of discrepancy.

Going back to pragmatics, stone tools are known for serving several daily functions in the lives of prehistoric humans, among which animal skin scraping and meat processing. The use of the word “processing” in this context is certainly not due to mere chance. Butchery has played a most vital role in the lives of early humans whose lives depended on their ability to sort and utilize animal carcasses to their full potential. Surely there is a very steep learning curve between the omnivorous behavior of the Australopithecus and the elaboration of minute processing patterns which has become the hallmark of early Homo Sapiens and Neanderthals which led to the rise of the recursive approach to the processing of reality.

¹³ Montagne, Michael, (2010), ‘Buzz, High, and Stoned’ 10.1002/9781444324440.ch4.

¹⁴ Taylor, Richard & Sprott, Julien Clinton, (2008). ‘Biophilic fractals and the visual journey of organic screen-savers’, Nonlinear dynamics, psychology, and life sciences. 12. 117-29.

¹⁵ Vitiello, Giuseppe, (2009), ‘Coherent states, fractals and brain waves’, New Mathematics and Natural Computation (NMNC), 05. 245-264. 10.1142/S1793005709001271.

¹⁶ Barrett, Frederick & Griffiths, Roland. (2017), ‘Classic Hallucinogens and Mystical Experiences: Phenomenology and Neural Correlates’, 10.1007/7854_2017_474.

¹⁷ Hart, Curtis, (2009), ‘William James’ The Varieties of Religious Experience Revisited. Journal of religion and health’, 47. 516-24. 10.1007/s10943-008-9200-3.

What is certainly obvious, even from a lay computer programmer's perspective, is the irregular and complex nature of the fabric of reality, understood as an abstract set of materials to deal with. Indeed, Shipton's (2019) three-stage model describes the development of abstraction as the apex of a process leading from the elaboration of norms to the development of abstract behavior through the rise of recursive logic. In order to thrive, early hominins have learned to process reality itself, decomposing it into thin slices, thereby elaborating diverse task sharing models which we can only access through speculative inquiry¹⁸. Aside the meat from dead mammals' bodies, stone tools enabled humans to process reality itself by providing the technical substrate needed to build the many appliances they required to survive, such as weapons for hunting, fur and leather laces used to resist cold weathers or grease lamps which were necessary for early cave artists. This process led to the fabrication of specialized tools to process a world in which every object is in itself a function, an approach akin to that of functional programming languages. This has little to do with the stereotype of a caveman hitting a rock by chance and throwing it on an unsuspecting reindeer strolling nearby. Processing leather, fur, bones or antlers, these tasks necessary for survival were also crucial in the development of human cultures adapting to their environment. Silicon-based stone tools, which became increasingly specialized and modular, centralized the processing of reality through the means of technology. Thus, comparative functionalism doesn't take us on a quest to explain how today's silicon-based central unit processors decompose reality into digits in order to make it computable, but rather into a function-oriented description of silicon-based stone tool processors.

3-Retro-aesthetics: nostalgia and resistance to miniaturization

What supplementary benefits might we gain from the metaphorical approach prescribed by anachronistic semantics? We put forward the idea that our metaphor would yield a pragmatic perspective on the programmatic understanding of reality developed by early humans. We still have to show how this system can be applied practically to contemporary culture. Surely, the classical dichotomy dividing all possible understandings of reality into two lumps has never been out of currency. On the one hand, the speculative approach to reality which terrorized humanity throughout Antiquity and the Middle Ages, ascribing magical properties to an overwhelming, all-engulfing concept of Nature. On the other hand, the practical approach, held forth by Descartes et al. according to which Nature as a whole does not exist, and specific laws can produce exact predictions of the unravelings of physical phenomena.

¹⁸ Barkai, Ran, (2019), 'An elephant to share: rethinking the origins of meat and fat sharing in Palaeolithic societies', 10.17863/CAM.47189.

The working hypothesis behind our working hypothesis is that speculation, in the light of pragmatism, can serve a purpose that rationality as well as academia fail to fulfil: a fruitful and inspiring analysis of the present.

Put plainly, the rational approach to reality is frustrating because it makes the human tendency for higher meaning invisible, via the description of an autonomous realm of ideas and other such ideologically tainted backworlds. When it comes to human happiness, the realm of ideas is rarely of any consolation. This is obvious in the way the successive scientific revolutions since the 17th century have restlessly been counteracted by creationist overtakes of the rational discourse. Organizations such as that of John Templeton¹⁹ - also known as “foundations” in the *lingua franca* of finance - continue to fund religion-oriented scientific research, in an attempt to undermine the idealistic process of gradual accumulation of scientific knowledge. Indeed, mainstream science scarcely takes into account Thomas Khun’s concept of paradigm shifts, and this blindness somehow guarantees the prosperity of a conformist and self-limiting scientific community, oftentimes unable to think outside the box. Ideologies are fighting for power, but it is not always clear what exactly is at stake. In our opinion, the most important feature of this war is the engineering of and the control over the public opinion via mainstream culture. Again, what do modern processors process?

Hence, we will now focus on the realm of entertainment in order to reap the fruits of the anachronistic, speculative and pragmatic methodology we claim to have been using. Among the many marvels to which human genius has been applied, entertainment has often been depreciated and even underestimated - perhaps even sometimes wronged. Central unit processors are able to analyze physical phenomena by taking them apart, and through various feedback loops, they are also able to ascertain their own efficiency, thus altering the world of humans on several hierarchically distinct levels. But central unit processors are able to do much more, much better and much faster, in much larger quantities: they are capable of responding to the human craving for transgression and play²⁰, and enable individuals as well as groups to engage in playful activities through what is known as video games.

¹⁹ Hale, Tamara & Pharoah, Robin & Rowe, Becky, (2008), ‘Doubting Darwin: Creationism and Evolution scepticism in Britain today’, Theos/John Templeton Foundation..

²⁰ Leonard, David, (2006), ‘Not a Hater, Just Keepin’ It Real: The Importance of Race and Gender-Based Game Studies’, Games and Culture - Game Cult. 1. 83-88. 10.1177/1555412005281910.

Among video game consumers, several groups stand out. A careful sociological approach to gamers is well beyond the scope of this relatively humble paper, but it has been repeatedly claimed that the gamer community is composed essentially of “rich white males”²¹, a social category which would easily be described as holding the monopoly it holds over symbolic capital via direct control of economic and political resources in the current globalized economy. However, despite the apparent cohesive sociological nature of the gamer caste, the latter can and is *de facto* subdivided into into different sub-groups, like any other groups of rich or non-rich, white or non-white, male or non-male humans or non-humans.

Particularly apparent in the public discourse are groups such as hardcore-violent gamers, which seem to represent a fairly good share of the total gamer population. Inexplicably, humans engaging themselves with alternate realities generated by central unit processors display an eagerness of sorts to simulate processes pertaining to social domination via virtualized interpersonal violence. Although this thirst for confrontation might seem legitimately eligible for our anachronistic semantics, in that it evokes stereotypes of brutal primitiveness, we wish not to give this idea any credit. In contrast, we claim that the lives of prehistoric humans has little to do with Call of Duty, except foundational cognitive aptitudes such as target-tracking and spatial recognition. Since the idea is rampant in mediatic discourse, it has had more than enough time to inseminate the public’s mind. And since it’s beyond the scope of this rather humble paper, it shall be examined by our lab’s personnel as soon as possible, as soon as we get our grant from the Templeton foundation or the Institute for Creation Research.

More importantly, a distinctive trend has appeared since the 2000s in the world of video games, and it is by no means exclusive of the public’s demand for physical-domination-oriented ludic apparatuses. Interestingly, after the rise of 64 bit processors, making it possible for ever-smaller machines to render tridimensional simulations effortlessly, one particular consumer segment has started to express nostalgia for the older generation of video games, associated with 8-bit graphics and sound processing limitations. This nostalgic trend seems to illustrate the dissolution of cultural identities which has been going taking place throughout early 21st century mainstream culture²².

²¹ibid.

²² Benzon, William, (2012), ‘Culture, Plurality, and Identity in the 21st Century’, SSRN Electronic Journal. 10.2139/ssrn.2180925.

The mere fact that a term like Palaeo-Gaming would emerge is evidence in itself that the video game consumers of the early 21st century have been misleading themselves into believing they were actually living in an entirely different era, ahead of the 1980s, something like *Back from the future's* future. Although times have changed, humans have not had the time to evolve.

The trending value of 1980s computer aesthetics is often associated with some kind of philosophically rooted resistance. Were this claim legitimate, what exactly would retrogamers be resisting? One way of looking at it would be to say that the human mind takes tens of thousands of years to evolve, which would make it logical for people's taste to evolve at a different pace than the restless progress of the consumerist marketplace. But Retrogamers do not fight against the global market²³. Sales demonstrate they also appreciate and financially support new content, as long as it feels kind of "retro", much like the tourists purchasing contemporary imitations of impressionist paintings when visiting the Sacré-Cœur in Paris.

We could also look for an answer by considering the ecologically disastrous nature of a technology dependent on polluting electric power plants. From this perspective, a subcategory of our silicon processors comes to mind: graphic processing units, stored in gigantic warehouses called "farms" in order to mine crypto-currencies, are not environment-friendly. Surely, the Internet itself is hardly compatible with the concept of ecology, as it is mainly made possible through the unleashing of a gigantic web of supercoated wires throughout the world. Thus, if Retrogamers themselves made the claim that they are really trying to resist the craze of the ecologically disastrous standards of 4K 3D massively online violence-driven gaming, they might be wrong since smooth computer graphic renders are no more responsible for climate change than the world wide web: since they find and share their resources online, Retrogamers can hardly be said to resist anything. They simply happen to prefer one specific type of digital artform, which they contribute to commodify and overvalue. But this acquired nostalgic taste for allegedly primitive computer aesthetics has only been made possible by the steady pace at which processors and devices have been shrinking since the 1970s.

According to Gordon Moore's incentive predictions, the number of transistors in equally sized integrated circuitry should double every two years. Although often described as a fascinating, empirical piece of statistics-based scientific knowledge, some scholars claim that this "law" is in fact no more than a trend, a tacitly agreed goal pursued by industrialists driving the field of research in physics, chemistry and nanotechnologies.

²³ Suominen, Jaakko, (2012), 'Mario's legacy and Sonic's heritage: Replays and refunds of console gaming history', Nordic DiGRA 2012 conference

But what does Moore's law have to do with prehistory? As it turns out, the tendency toward the miniaturization of technological artefacts is not a recent invention. Perhaps Gordon Moore was even inspired by the archaeological record when he started, quite earnestly, to piece together the raw data from the transistor manufacturers. He famously witnessed a tendency in the tech industry: integrated circuits were becoming much smaller, in a very regular manner. Stone tools have also shrunk dramatically toward the end of prehistoric times, although not quite as smoothly - and conveniently - as the steady shrinking pace the tech industry was able to keep up since the end of the 1970s. This process, called microlithisation²⁴, has been noticed by archaeologists. It accompanied a radical transformation of the overall social organization of work. Indeed, smaller tools, hafted more minutely on more carefully crafted implements, meant a thorough revision of the functional division of tasks prescribed by the design features of Mousterian stone tools seen as processors of raw and continuous lumps of fleshy real-life data.

These new miniaturized silicon processors were the product of novel flaking algorithms; they directly affected the behaviors and social structures of their makers. It should be underlined that the comparison can be pursued here, as the miniaturization of silicon-based central unit processors also dramatically altered the behavior and ethology of modern humans, by equipping them with small-sized computers called "smartphones"²⁵.

Let's try a bit of irrational evolutionary psychology here. Let's suppose the last Neanderthals were sexually eliminated because they attempted to stop this apparently senseless process of microlithisation. It would follow logically that retrogamers are really today's equivalent - if not the most direct genetically related descendants - of those resisting Neanderthals. Enough creationist-friendly speculation, let's cut it short and over-dramatize this last paragraph.

Neanderthals never died, they just got sucked into our DNA²⁶ - without consent - and were therefore prosecuted and demonized for a very, very long period of human time. In parallel, retrogamers do not - not necessarily, at least - share that many genetically inherited behavioral traits with Neanderthals²⁷.

²⁴ Belfer-Cohen, Anna & Goring-Morris, Adrian, (2002), 'Why Microliths? Microlithization in the Levant. *Archeological Papers of the American Anthropological Association*. 12. 57 - 68. [10.1525/ap3a.2002.12.1.57](https://doi.org/10.1525/ap3a.2002.12.1.57).

²⁵ Le, Huy Viet & Mayer, Sven & Wolf, Katrin & Henze, Niels, (2016), 'Finger Placement and Hand Grasp during Smartphone Interaction.' 2576-2584. [10.1145/2851581.2892462](https://doi.org/10.1145/2851581.2892462).

²⁶ Von Haeseler, Arndt & Sajantila, Antti & Pääbo, Svante, (1996), 'The archaeology of the human genome' *Nature genetics*. 14. 135-40. [10.1038/ng1096-135](https://doi.org/10.1038/ng1096-135).

²⁷ Ekblad, Leif. (2020). Hunting adaptations in autism and neurodiversity. [10.31234/osf.io/q7mn8](https://doi.org/10.31234/osf.io/q7mn8).

Claiming that many gifted computer users are on the spectrum of autism, and correlating this unfounded assertion with the popular rumor according to which autism might be an indicator of high percentages of Neanderthal-inherited genetic material²⁸ would be preposterous, foolish and utterly unscientific²⁹. Also, who knows what creationists would do with such a claim? They probably would steal it and run someplace safe with it in order to engineer some kind of physico-teleological conspiracy. in the name of good old antediluvian Mousterian time's sake.

Conclusion

Stone tools have enabled early humans to process their surrounding reality in a variety of specific ways ranging from simple butchery to complex resource management. From what we know of their technical history through the archaeological record can positively be associated with the gradual development of recursive thinking as a cognitive ability. Comparing stone tools to modern-day central unit processors is intriguing from a layman's perspective, but it is also useful in that it enables thorough reconsideration of the processes at work in flint knapping as a functional approach to problem-solving. The novel methodological tools involved in this research (anachronistic semantics, practical speculation and psychedelic pragmatism) enabled us to elaborate a comprehensive analysis of the problem, and to connect the dots far beyond the apparent limitations of the metaphor. While today's processors allow the virtualization of technical processes, stone tools were used by early human populations to process reality on a physical level. This seemingly humorous comparison thus contributes to renewing contemporary discourse on technical objects.

²⁸ Pfuhl, Gerit & Ekblad, Leif, (2018), 'Neurodiversity traits linked to Neanderthal admixture.' [10.31219/osf.io/w4nh5](https://doi.org/10.31219/osf.io/w4nh5).

²⁹ Whiting, Kai & Konstantakos, Leonidas & Sadler, Greg & Gill, Christopher, (2018), 'Were Neanderthals Rational? A Stoic Approach.' *Humanities*. 7. 39. [10.3390/h7020039](https://doi.org/10.3390/h7020039).