Cognition, Stone Tools and Aristotle

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Beatriz (Montejano Clouté) Byrne

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Calle Venancio Martín, 45 – 28038 Madrid, España
Rua Diogo Botelho, 1327 – 4169-004 Porto, Portugal
info@editorialsinderesis.com
www.editorialsinderesis.com

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INTRODUCTION

There are different views, in the areas of Palaeontology and Archaeology, on the subject of when human cognitive abilities appear for the first time in both records. In the archaeological record several criteria have been used such as: the emergence of symbolic thought in certain forms of art; behaviours such as burial; the appearance of mental templates needed to manufacture certain type of stone tools in the Lower Palaeolithic Era; and the manufacturing of stone tools with a cutting edge. Paleontological criteria refer to changes in the size and organization of the brain; the morphological traits related to bipedalism; and changes in size and shape of teeth. Tobias (1987, 757) defined *H. habilis* as the first truly human hominid based on the emergence of certain brain areas such as the Broca and Wernick areas directly related to the capacity for articulated speech or language and a new level of more human-like brain reorganization.

However, in the last decade there has been a realization in the field of neurology that brain function does not strictly correspond with certain parts of the brain, and it is more related to neuronal paths which engage several brain areas (Van den Heuval and Sporns 2011, 15786). This view distorts the above-mentioned assumption of the emergence of humanity linked to the emergence of human-like brain areas such as the Broca. In the absence of clear paleontological and archaeological criteria, the present research aims to find better interdisciplinary criteria through delving into the concept of cognition in the fields of Cognitive Archaeology, Cognitive Psychology, and Comparative Psychology specifically primate cognition. However, the concept of cognition has been influenced by Descartes' sharp distinction between the nature of the body and the nature of mental states and their apparent lack of interaction (Murillo 2014, 81), so in order to find answers that connect the body which makes the tools with the mind which thinks about them it would be useful to address the answers given by Aristotelian Philosophical Anthropology.

The specific path followed in the present research to study the emergence of cognition in human evolution, is focused on the only archaeological record which has survived from the beginning of human evolution: stone tools. In the last two decades Cognitive Archaeology has expanded the knowledge of cognition required to manufacture stone tools thanks mainly

to Experimental Archaeology. The concept of cognition in Cognitive Archaeology is taken from the field of Cognitive Psychology. Due to the fact that humans are not the only organisms which make and employ tools for survival purposes, it is also necessary to find out what is understood by cognition in Comparative Archaeology, specifically in primate cognition, and how it differs from human cognition. The paleontological record is contrasted with the archaeological one in order to determine the different stages of human evolution of the hominid candidates to manufacture the various stone tool types.

As can be seen from above, the present thesis uses an interdisciplinary approach which is based on an irreducible point of view of the findings in the above-mentioned sciences to a materialistic approach which ignores the existence of mental states. The introduction of Philosophical Anthropology answers the problem of how the mind integrates with the body as well as explaining the nature of cognition. This interdisciplinary approach, however, is taken with a view that fully respects both methods, scientific and philosophical, and their findings. In a metaphorical sense, the present approach can be understood as the mountain climber who wishes to see the present academic situation on the subject as a whole from the top of a mountain, using a pair of spectacles made of special glass which allows him/her to see the findings of the above-mentioned sciences superimposed on those of philosophy.

A. The area of Archaeology committed to the study of cognition in the archaeological record is Cognitive Archaeology. When cognition refers to human evolution it is called Evolutionary Cognitive Archaeology (ECA). Cognitive Archaeology began as a branch of Archaeology and explains 'thought and practical activity going forward together' and the 'extended mind' which sustains that cognitive processes are not bound by the skull or the skin but incorporates structures from the environment such as tools, artefacts, and cultural practices (DeMarrais, Gosden & Renfrew 2004: 1; Boivin 2008 in Pebbles 2012, 77; and Knappet 2005 in Van Oyen 2012, 221; Donal 2001, 96-97). It accepts the existence of a mind different from the brain because it is understood as such in Cognitive Psychology, the area from which the concept is borrowed. For the same reason, it also accepts the existence of mental representations and processes. These concepts will be explained later on, however, it is sufficient to say here that the existence of a mind is deduced from the existence of facts such as the insights required for solving problems encountered by organisms including humans

or the impossibility of detecting intentions in brain activity (Epstain 2006), among others.

The study of cognition in Archaeology, however, has been influenced by a movement in Archaeology, Anthropology and Social Sciences away from the tradition that separated subject from object, and mind from matter. In Cognitive Archaeology this means that the focus of study is not only on mental representations but on the objects themselves, matter and the world. This theory develops common relational ways of interpreting the complex interactions between brain-body-world: a theory which moves away from the idea of an isolated internal mind and a demarcated external material world, towards the mutual constitution of the three as an inseparable analytic unit also known as Neuro-Archaeology. According to Melafouris (2012), the contribution of Cognitive Archaeology is to provide a focus on the interaction between cognition and material culture, and the mutual constitution of brain, body and culture beyond skin and across the scales of time (Melafouris 2012, 3843).

The idea of returning to things in social and human sciences as opposed to the earlier focus on only mind activity (Boivin 2004; Domanska in Hodder 2011, 155; Olsen 2003, 87-88), can be detected in a number of events such as the application of philosophical phenomenology for the study of landscapes; the philosophy of Heidegger in Julian Thomas (2006) which claims that things only reveal themselves in a world of relations, things are embedded in a complex network of relationships between people and things; and of Bjorner Olsen (2010) which is based on Heidegger's idea of people's entanglement with things as the way to be in the world, implying that the use of things determines a new way to be in the world (Olson 2010, 69-70); the philosophy of Hegel and Marx in the area of material culture which proposes the dialectic process to study relationships in past and present social contexts (Salmon 1993, 325); the concept of materiality by Gosdem (2005, 208) which highlights the demands that the material world imposes on people; Ingold (2011) who advocates the form of things arising from within the materials in which they are found, materials which are in constant change (Ingold 2011, 24); Bruno Latour's notion of symmetry between humans and things which moves away from the philosophical concept of being, to substitute it for a relational one (Shanks 2008, 593; Latour 1990, 3; Hodder 2011, 155).

However, while the abovementioned movement in Archaeology, Anthropology, and Social and Human Sciences in general to return to things avoiding the cognitive approach, focused on mental representation and the demarcation between mind and matter, and object from subject, brought

new understanding on the role of things and humans, the fact remains that cognition is the way for humans to understand the world which surrounds them including other co-genres and the environment. Material culture and communication are the two ways to express human cognition. Cognition makes it possible for the individual to have dealings with the outside world in a unique way, philosophically known as intellectual and sensorial knowledge (Murillo 1996, 851). Nevertheless, developments over the last few decades in cognitive science have raised other aspects of cognition such as embodied cognition which proposes that the brain or the nervous system are not the only cognitive structures. There are other domains such as in the areas of memory and concepts, among others, where aspects such as sensorimotor mechanisms, which were previously thought as not involved in memory, act as information retrieval. Concepts understood as context independent symbols are now known to depend on patterns of bodily activity such as talking or thinking about objects. These actions reactivate previous experiences and the neural circuits involved during perception, suggesting the re-enactment of the multimodal information involved during perception (Wilson and Foglia 2016, 33-42). As will be explained later in the research, this is precisely what Aristotelian philosophy proposed two and half thousand years ago.

Evolutionary Cognitive Archaeology (ECA), the area of study of the present thesis, is increasingly influenced by this view, as can be seen in the reductionist 'dual-inheritance' view of co-evolution between biology and culture (Richerson & Boyd 2005); and in the Brain Artefact Interface theory (BAI) developed by Melafouris (2010, 264) described above which defends the non-existence of mental states or only conceives them as an epiphenomenon of brain activity. However, there are other understandings of the human mind which have been applied to the evolutionary record. Three in particular have been influential on ECA. 1) The first is that syntactical language is the key to the modern mind: language precedes cognitive development. This is an interpretation which can be traced back to the Chomskian revolution. Representative authors of this view are Tattersall, Reuland, Walker, and Uomini (Wynn 2010, 145). 2) The second stance is the action-centred approach of Leroi-Gourhan (1964 in Wynn 2009, 145) which bestows importance to action, and understands cognition as something that arises from the dealings of the individual actor and the task at hand. 3) The third position is a psychological one which conceives the mind as an internal computation, understood as the capacity to combine mental representations which are ultimately reducible to the brain function. Representative authors of this view are Barnard, Moore, Nowell and White, Davidson, Stout, de la Torre, Wurz and Khun (Nowell and Davison 2010, 13, 67, 105,

135, 159, 185, 207), Moore (Nowell and Davidson 2010, 13), De Beaune, Wynn and Coolidge (De Beaune *et al.* 2009, 3, 45, 83, 145).

There is another recently-developed method based on the neurological imaging of the brain during the process of manufacturing stone tools and other related activities. It shows that neurophysiologic constraints play an important role during the creation of cultural inventions (De Beaune, in De Beaune *et al.* 2009, 14). It also displays a three-dimensional image or picture of functional processes in the body, in the process of human knapping (Staut and Chaminade 2007, 1091; Stout *et al.* 2009, 1939); and makes it possible to research into the kinds of learning, memory and skill required to make Oldowan tools as opposed to nonhuman primate tools (Davidson and McGrew 2005; Haidle 2009; Wynn and McGrew 1989 in Davidson and Nowell 2010, 3). In the latter case, a series of studies addresses questions regarding the origins of language: Is it possible to learn how to make stone tools in the absence of language (Nowell 2000; Wynn and Coolidge 2010; and Davison 2009, in Davidson and Nowell 2010, 3) or other verbal instructions? (Davidson 2009, in Davidson and Nowell 2010, 3). Is it possible to detect from flakes if the individuals were right-handed and can this imply brain lateralization and preconditions for language specialization in the left hemisphere? Corballis 2003; Noble and Davidson 1996; Pobiner 1999; Steele and Uomini 2005; Toth 1985a; Wilkins and Wakefield 1995 (Davidson and Nowell 2010, 3); Moore (2010); de la Torre (2010); Davidson (2010; Davidson and Nowell 2010, 3) address the question of the transition to hominid knapping from a common ancestor similar to chimpanzees and bonobos in their abilities. Davidson (2010, 187); (Davidson and McGrew 2005, in Davidson and Nowell 2010, 3) stresses the fact that apes have never been claimed to cut anything in the wild, though they learn to cut a cord in the lab. It seems that cutting is one of the key innovations that makes stone tools part of the hominid adaptation.

The same method has been used in the brain and artefact interface theory of Malafouris (2010) to show that there is an extra flow of blood in the brain which is used to assess cultural influences on the neural substrates of our perceptual, emotional and embodied cognitive processes. It attempts to discern possible ways that observed brain changes (functional or anatomical) can be associated with the various 'complementary' strategies and culturally situated tasks that humans employ when 'adapting the environment instead of themselves' (Kirsh 1996, in Malafouris 2010, 270-271; Malafouris 2010, 264-273).

Among the above-mentioned theories in Archaeology, there are two which adapt better to the hypothesis sustained in the present research, as

will be enunciated at the end of the first chapter, and are based on the identification of human cognitive abilities in the manufacturing process of Lomekwian and Oldowan stone tools. These are the Action-Centred approach of Leroi-Gourhan (1964 in Wynn 2009, 145) and the Malafouris Brain and Artefact Interface theory (Malafouris 2010, 270-271). The Action-Centred approach of Leroi-Gourhan was developed from the practical expertise of Bordes and Tixier (Tixier 1967 in Pelegrin 2009, 95). Tixier systematized principles of the operational sequence by "technological reading" of lithic objects. He proposed the distinction between *technique* and *method*. *Technique* refers to the physical mode of executing flake detachment and therefore distinguishing respectively the modes of flake detachment corresponding to the four distinctive lithic modes such as Oldowan, Acheulean, Mousterian, and Aurignacian known in 1967, which will be explained in the chapter on Archaeological Review together with the newly discovered Lomekwian mode. *Method* refers to the spatial and chronological organization of stone removals during knapping sessions which included shaping, retouch, preparation and flaking. If this organization was repeated in an archaeological assemblage then a method is identified (Pelegrin 2009, 95-96). With regard to the Malafouris Brain and Artefact Interface theory which moves away from mental representations and understands cognition as the interaction of brain, body and culture, the present research admits the existence of mental states parallel to brain activity while it fully defends the mind's dependence on the brain, body and the environment. This assumption is based on the Aristotelian interpretation of the human being as the animal who has logos or reason (Polo 2015, 197), the organic being which is endowed with a cognitive ability which equips him/her with mental capacity to know generalities (Polo 1993, 126) and consequently to deal with the environment in a different way from other organisms endowed with only sensorial cognitive abilities. Aristotelian theory of cognition views cognition as operations of certain organic beings, intrinsically related to them and to the environment in which they live. Organism, cognitive operation of the organism, and the environment in which the organism operates, form an indissoluble union which will be explained in the last chapter.

Stone tools were used for several purposes such as skinning, disarticulating and defleshing animals, breaking open long bones to access marrow, working wood, and processing vegetable matter (Bunn 1981; Domínguez-Rodrigo *et al.* 2005; Keeley and Toth 1981; Pobiner *et al.* 2008; Shea 2007, in Davidson and Nowell 2010, 3). This knowledge is based on microware studies, experimental work and cut marks on animal bones. Bone tools were also used to break into termite mounds (Blackwell and d'Errico 2001,

2008 in Davidson and Nowell 2010, 3). Hominids also carried stones in view of the fact that artefacts have been found far from their sources (Ambrose 1998; Braun *et al.* 2008 and references therein; Whallon 1992, in Davidson and Nowell 2010, 3), knapped stones from different sites that can be fitted back together with the exception of a few missing flakes (Dalagnes and Roche 2005, 435; Von Peer 1992, in Davidson and Nowell 2010, 3) and cut bones with no stone tools associated with them (Davidson and Nowell 2010, 3).

These observations have led researchers to further their knowledge on a number of questions based on cognition including the types of mental maps required to find resources across a diverse landscape, to what extent this ability exceeds what the cognition of nonhuman primates is capable of (Boesch and Boesch 1984) and to what extent Oldowan and later stone industries are evidence of forethought, planning, and enhanced working memory, Wynn and Coolidge (2001; Hadle 2009, in Davidson and Nowell 2010, 4). The identification of standardized tools has been used to show the depth of intentionality in stone tool making (Nowell 2000; Nowell *et al.* 2003, in Davidson and Nowell 2010, 4). Kuhn (2010) differs on this point indicating that standardization is forced by the way analysis is done in Archaeology.

There is an underlying interpretation of the mind in the abovementioned theories which conceive the mind as springing from language; computation; action; or an epiphenomenon of the brain, as not constrained solely to brain activity. In other words, independently of how the mental states are produced they are not reduced to brain activity. This is directly related to the concept of cognition as understood by Cognitive Psychology, as mental representations of the outside world, which are subsequently processed in different ways (Marrs 1982, 6). The latest interpretation of the mind, however, as an inter-relation between the body, brain and the environment is a further step towards understanding it as an epiphenomenon of the brain which denies a separate existence for the mind in some cases.

B. Cognitive Psychology emerged in the 1960's as the outcome of several developments in the first part of the twentieth century. These developments were as follows: psychophysicists introduced measurement methods; structuralism and associationism engaged in the study of how elements of mental states were connected; Gestalt Psychology examined regularities in perception. Behaviourists specifically concentrated on the study of behaviour in order to establish relationships between stimuli and responses and hence they studied the process of learning purposely ignoring the existence

of a middle medium, such as the mind, which could account for changes in behaviour. Linguistics understood language as an expression of the mind and sought to find the mental process that made it possible. Information Processing Systems captured the idea that information was transformed through a variety of mental processes. The latter idea was developed in computer science, which in turn became an influential model for Cognitive Psychology. Influenced by this, researchers began to view perception, reasoning and other cognitive functions similarly to symbolic computation (Haberlandt 1994, 8-25), and the study of human cognition in Psychology further developed on the assumption that there is an abstract entity called the mind and this is composed of mental states and mental processes (Quinlan and Dyson 2008, 13). There have also been developments in Cognitive Psychology since the cognitive revolution. The concept of embodied cognition argues that cognition cannot be localized in the brain area solely and that it is the result of bodily and environmentally intertwined activity: embodied cognition (Anderson, Richardson and Chemero 2012, 1; Wilson and Golonka 2013, 1) which was also taken up by Cognitive Archaeology as seen above. However, these approaches do not account for the nature of cognition or mental states.

As can be gathered from the foregoing, concepts of cognition and specifically mental representations and processes used in Cognitive Archaeology, can be situated within those used in modern Psychology; concepts which emerged thanks to the scientific method adopted by Psychology at the end of the 19th century. However, humans are not the only organisms working with mental representations as was experimentally established early in the 20th century by Kohler (1925, 1951, 186).

C. The concept of cognition in Comparative Psychology was studied at the end of the last century and the beginning of the present century. However, it was first studied by Aristotle in the 5th century BC. He mantained that human sensorial knowledge was shared by humans and animals (Aristotle, *De Anima II*, chap 2, 413 b5, cc 10, 15 and 20) because both are endowed with sensorial organs (Aristotle, *De Anima II*, chap. 6, 418 a10) which extract information from the outside world in order to direct their behaviour to satisfy their needs (Aristotle, *De Anima III*, chap. 13, 435 b20). Thomas Aquinas studied Aristotle's philosophy in the 13th century and developed his work on sensorial cognition in several parts of his works such as his *Commentaries on Aristotle's On Sense and What is Sensed* (Thomas Aquinas, *Commentaries on Aristotle's On Sense and What is Sensed*, prologue) which is about his comments to Aristotle's work on sen-

sorial knowledge. Sensorial cognition accepts the existence of mental representations made from sensorial perceptions. Aristotle's theory is a philosophical one which understands cognition not only as a result of a cause such as environmental pressures, as Tomasello and Call (1997) state, but also from a foundational view of reality based on his theory of causes. Cognition is also linked to the interpretation of life as an immanent movement with different stages of development, cognition itself being one of them. This view will be explained later. Descartes, a 17th century philosopher, understood animal cognition as mechanical movement not originated within the animal but depending ultimately on God as the cause of all movement (Sellés 1991, 36-37). From the Cartesian era onwards, the ability to think was reserved to humans. In the 19th century Darwin's theory of evolution led some authors to admit that there was continuity between animal and human cognition linked to morphological changes in the species (Tomasello and Call 1997, loc. 62). Other authors include Pavlov in the early 20th century who showed how animals change their behavioural responses by association of other stimuli different from the original one (Windholz and Lamal 1986, 13); and Vatsuro (1948) who showed in an experiment the incapability of a chimpanzee named Raphael to transfer learnt behaviours to new situations (Razran 1961, 367). This experiment has not been repeated to the author's knowledge and its validity could be questionable. In the meantime the experiment could still account for a cognitive ability different from perceptual categorizations.

The first experimental works with great apes which made possible the assumption of mental processes in animals, were made by Wolfgang Köhler in 1925 (Köhler 1925, 186) in his experiments carried out in the Canary Islands. He presented chimpanzees with problems whose solutions needed an insight into them to achieve a solution other than trial and error. His results show that a type of mental or perceptual representation, mental insights, was needed in order to achieve the solutions. Robert Yarks (Tomasello and Call 1997, loc. 84), an American researcher, around the same time, in his experiments with great apes found how their memory and their cooperative skills worked to solve problems. The results suggested the idea of mental or perceptual representations. The advent of the Behaviourist movement which ignored the study of cognition and focused on behavioural processes, and the Ethological movement which only recognized instincts as responses determined by genetics in animals, put a halt to research into animal cognition until the emergence of Cognitive Psychology in the 1960's.

The main achievements of the new cognitive approach were in communicative skills, including sign language, knowledge of space and an ani-

mal theory of mind which suggests the existence of understanding other conspecific behaviour. I refer here to the next chapter on Comparative Psychology. Nowadays, Tomasello, an American researcher in the Max Plank Institute in Leipzig who leads the study of animal cognition and Developmental Psychology, takes the view that there are sensorial mental representations, removed from picture-like ones, and that cognition refers to morphological and behavioural responses to environmental challenges from the physical or the social environment. Tomasello concludes that the frontier between animal and human cognition rests on humans' capacity for shared intentionality. Human toddlers not only understand the behaviour of conspecifics but they are able to assume in their minds their intentions and make them their own. There is no shared intentionality in great apes (Tomasello 2014, 3).

As can be gathered from the above summary of the concept of cognition in Cognitive Archaeology, Cognitive Psychology and Comparative Psychology, the concept of perceptual or sensorial mental representations has been widely used in Comparative Psychology and is based on the development of Cognitive Psychology on mental representations and processes. However, Comparative Psychology includes the view of cognition as responses to the environment, be this physical or social.

D. The concept of mental representations and their manipulations is a concept that permeates the three areas of cognition in Archaeology, Psychology and Comparative Psychology as briefly explained in this introduction. This is a concept born in Philosophy, as will be explained in the last chapter, which has continued to be taken into consideration when Psychology separated from Philosophy in the 19th century, although with different focuses throughout its history until the birth of Cognitive Psychology in the 60's. Modern cognitive theories, however, have embraced a relational concept of cognition which seems to move away from the representational aspect as has been pointed out earlier in the chapter.

The original concept in Philosophy understood cognition as part of the phenomenon of life, an immanent movement from within the organism shown in the activities of certain organisms which allow them to satisfy their needs (Murillo 2013; Polo 2009, 45-50). In the case of organisms with locomotion and sensorial organs, cognition is a movement from within the organism which allows them to gain knowledge of certain environmental traits related to survival purposes by a cognitive appropriation of the trait forms. This knowledge of the environment is not a representation of it but the result of the appropriation of certain environmental traits. Cognition in

Aristotle is intrinsically linked to the organism's behaviour and would not have appeared in evolution without the need for it. Human cognitive abilities are understood as the capacity to know generalities, or abstract thought, as well as the faculty of means, or practical reason, understood as the capacity to know things in real life as a means to get something. Cognition in Aristotle is also an understanding of cognition which makes it a development of certain organisms and therefore ignores the above demarcation between body and mind (Murillo *et al.* 2016, 9). Aristotelian cognition will be explained in more detail later in the thesis.

This research studies the manufacturing styles and modes of stone tools in order to detect the first appearance of human cognitive abilities and how cognition and manufacturing styles and modes of stone tools relate to each other. The results are then compared with findings about cognition in Cognitive Psychology and Comparative Psychology. The area of cognition in Philosophy is analysed with the purpose of clarifying the concept of cognition and its historical trajectory in order to learn the nature of cognition found in the manufacturing styles of stone tools as well as the differences between human and primate cognition. As a result, the present research will try to determine what type of cognitive abilities can be detected in the manufacturing of stone tools and if they are different from those of primates. As well as attempting to find out the role of material culture on human evolution given the fact that stone tools made it possible for humans to become increasingly more sophisticated controllers of their environment (Jordana 1988, 98; Polo 1994, 2016, 9) as opposed to having to adapt to it, including creating a medial or referential network among the things manufactured where one thing leads to another. Humans fill the environment with meaning rendered to the place they live in and the objects they manufacture and use. Humans not only inhabit the environment, they dwell in it (Polo, 2102, 2015, 201-205).

A number of research questions are asked. 1) Can human cognitive abilities be detected in the manufacturing of stone tools? 2) What is the nature of cognition? 3) How are human and animal cognition related to one another? 4) How do mental processes/operations and brain activity relate to one another? 5) How does stone tool technology relate to human evolution? 6) What is the role of material culture in human evolution?

The first chapter will deal with detecting human cognitive abilities needed in the manufacturing and use of stone tools in the archaeological and the paleontological record.

The second chapter will study primate cognition and its differences and similarities with human abilities.

The third chapter will focus on the understanding of human abilities according to Cognitive Psychology.

The fourth chapter will introduce the vision of anthropological philosophy in human cognition.

Conclusions will be drawn in the last chapter.

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