e-ISSN 2723-9640

JoLMA
Vol. 4 — Num. 2 — December 2023

What Are We Talking About When We Talk About Cognition?
Human, Cybernetic, and Phylogenetic Conceptual Schemes

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Abstract In this paper I will outline three conceptual schemes for thinking about cognition. One is the anthropocentric scheme that dominated our thinking for thousands of years: human cognition. Another is the approach founded in classical cognitive science and artificial intelligence: cybernetic cognition. The third is the framework of evolutionary biology that encompasses all traits of evolved organisms: phylogenetic cognition. I will explain all three and sketch their current relationships. Each scheme forms the conceptual ground of a valid research programme, but how these programmes and schemes will end up in relation to each other is an open question.

Keywords Cognition. Cybernetics. Evolution of cognition. Basal cognition. Cognitive ontology.

Edizioni Ca'Foscari

Peer review

Submitted 2023-12-05
Accepted 2023-12-26
Published 2024-02-07

Open access

Citation Figdor, C. (2023). “What Are We Talking About When We Talk About Cognition? Human, Cybernetic, and Phylogenetic Conceptual Schemes”. *JoLMA*, 4(2), 149-162.

DOI 10.30687/Jolma/2723-9640/2023/02/001

1 Introduction

What are we talking about when we're talking about cognition?[1] This paper will outline three broad conceptual schemes currently in play in the sciences concerned with explaining cognitive abilities. One is the anthropocentric scheme – human cognition – that dominated our thinking about cognition until very recently. Another is the cybernetic-computational scheme – cybernetic cognition – rooted in cognitive science and flourishing in such fields as artificial intelligence, computational neuroscience, and biocybernetics. The third is an evolutionary biological scheme – phylogenetic cognition – that conceptualizes cognition in terms of the phylogeny-based approach we take to all other traits of evolved organisms. These schemes are not pristinely distinguished in practice, but they differ markedly in their conceptions of cognition and ground different research questions and methods. It is also not yet clear how they will end up being related, although I will consider below how they are related at this time.

I'll discuss human cognition in Section 2, cybernetic cognition in Section 3, and phylogenetic cognition in Section 4. The labels pick out conceptual frameworks in which cognitive abilities are defined and investigated, not particular cognitive abilities. In Section 5, I show how these frameworks schemes are related at present, as well as the key questions that remain as we determine their eventual relationships.

2 Human Cognition

Psychology as a whole is anthropocentric in multiple unobjectionable ways. Human cognition, perception, and behaviour are its main explananda and most research is devoted to understanding them and their developmental, clinical, and social aspects. A traditional, but separable, component of this anthropocentrism is the human cognitive conceptual scheme: human cognition. This scheme conceptualizes cognition in terms of the suite of human abilities that enable or comprise human thinking. For example, (natural) language is the system for communicating thought that humans have, episodic memory is what humans exhibit when they think about past personal experiences, and so on. Descartes' ([1641] 2017) examples of mental abilities are paradigm cases of cognitive abilities as seen from human cognition: reasoning, imagining, doubting, and the rest are understood in terms of what humans have or do – in his case, necessarily so. Much of our intellectual history, from Aristotle to Kant and beyond, agrees: human cognition is the only possible

1 I thank two anonymous referees for helpful comments on an earlier draft of this paper.

conceptual scheme for thinking about cognition if you think only humans (among earthly denizens) have cognitive abilities (what Aristotle called *nous* or the rational soul).

Even if we disagree with many canonical philosophers on the uniqueness question, we still assume human cognition when we determine whether other species have cognitive abilities or not depending on how similar they are to the human prototype. For example, from this perspective Bennett and Hacker (2003, 19), following Hacker's interpretation of Wittgenstein, are correct that cognitive concepts are essentially anchored in human cognition: "[O]nly of a living human being and what resembles (behaves like) a living human being, can one say that it has sensations; it sees, is blind; hears, is deaf; is conscious or unconscious" (Wittgenstein 1958, § 281). If nonhumans have anything cognitive, it is often qualified as a less sophisticated or "proto-" version; such relative judgments use human abilities as the yardstick. Thus, nothing counts as a (natural) language unless it has the features we recognize in human language (e.g. hierarchical syntax); nothing counts as true episodic memory unless it has the features we recognize in humans (e.g. autonoetic consciousness), and so on.

This classificatory role of human cognition contrasts with that of human perception. Our comparisons of perceptual abilities across species are not conceptually anthropocentric. A species can have vision, not merely less sophisticated or proto-vision, without having human vision; it can become blind by losing its own visual abilities. Folk psychology – our practices of ascribing cognitive abilities to others – is somewhat lax in its use of human cognitive concepts for nonhumans. Descartes never convinced the folk that animals don't and can't feel pain, nor do the folk necessarily agree that only humans have cognitive abilities. In other terms, strictly speaking, within this conceptual scheme ascriptions of cognitive abilities to nonhumans *must* be anthropomorphic, whereas in folk psychology they often are but we allow for some fudging and are not always consistent.

Human cognition may appear to be a straw man nowadays, particularly in some scientific circles. However, it is fair to say this conceptual scheme remains the implicit default in many areas of inquiry concerned mainly with humans, such as most of psychology, social science, and moral, social, and political philosophy. It can even remain potent in the midst of apparent challenge. When Shettleworth (1993) and others called for ending an anthropocentric perspective in comparative psychology in favour of an ecological or biocentric perspective, one of the problems motivating their call was the persistence of cross-species comparisons that still used human cognition as the standard. Classical evolutionary psychology (e.g. Cosmides, Tooby 1987) assumed that to explain the evolution of cognition was to explain the evolution of human cognition in terms of what was adaptive for humans in the Pleistocene era; the fact that humans are (e.g.) mammals played no explanatory role. Similarly, philosophers and others working in cognitive ontology aim to revise cognitive concepts primarily in the light of fMRI studies of human brains functioning during cognitive tasks (e.g. Anderson 2015; McCaffrey, Wright 2022). For this project, studies of human adult, infant, and impaired human brains and behaviour, cross-cultural studies of human behaviour, and hypotheses of human brain evolution all support inferences to human cognitive abilities and possible revisions within human cognition scheme. But studies of vervet monkeys or corvids are not relevant without a different conceptual grounding for cross-species comparisons than what human cognition can offer.

For some, human cognition may seem inevitable, even inescapable, given our human perspective on cognition. But while human cognition has been our starting scheme, we do not need to end there. The other two conceptual schemes offer non-anthropocentric alternatives.

3 Cybernetic Cognition

The most developed alternative is cybernetic (or cybernetic-computational) cognition, the conceptual scheme of classical cognitive science augmented by cybernetics, in which cognition is information-processing in feedback control systems (Wiener 1948; Rosenblueth, Wiener, Bigelow 1943; Figdor 2018). Turing (1950) and Newell and Simon (1961) initiated the interpretation of cognition in terms of information-processing by showing how input-output relationships associated with cognitive processes as defined by human cognition could be carried out by a machine; Wiener further specified that the information-processing was in the service of an agent's environment-responsive behaviour guided by its goals. This fact – that cognition was something done by autonomous agents to achieve their purposes in their environments – could be taken for granted by human cognition given that humans are paradigmatic autonomous agents. It had to be added to Turing's original information-processing approach. At the same time, it is foundational to cybernetic cognition that machines can be autonomous agents. This possibility is ruled out by human cognition.

While cognition as information-processing was originally specified as the manipulation of internal representations according to rules, it has since become a matter of debate what is required for information processing (Piccinini, Scarantino 2011). In particular, information-processing need not require representations on traditional views of what counts as a representation. This loosening of the original theory extends to cybernetic cognition as well. Research programmes in robotics, computational modelling, dynamic systems theory, predictive coding, enactivism, ecological psychology, and others, may be representationalist or anti-representationalist, but would all count as forms of cybernetic cognition. Acknowledging this loosening of what is required for cognition, Allen (2017, 4241) suggests "adaptive information-processing" as a neutral umbrella label for what cognitive science studies. The label "cybernetic cognition" is similarly neutral but is preferable because it explicitly includes artificial systems: the Darwinian vocabulary of adaptation is not required, and if we redefine "adaptive" to avoid its biological implications, we are just talking cybernetics. Either way, however, cognitive science is not a neutral party in discussions of cognition. It comes with its own specific conceptual scheme, one that is quite distinct from human cognition.

A key commitment of cybernetic cognition is to medium-independence, whereby what feedback control systems are made of doesn't matter for their being classified as such. The philosophical theory behind this is classical functionalism (Putnam 1967; Levin et al. 2021). This commitment guarantees the broad applicability of cybernetic cognition to many systems. When Baluska and Levin (2016, 1) define cognition as "the total set of mechanisms that underlie information acquisition, storage, processing, and use, at any level of organization", whether the system looks or functions like a human being doesn't matter. It also means that cognitive abilities are defined at an extremely high level of abstraction. Memory, for example, is "experience-dependent modification of internal structure, in a stimulus-specific manner that alters the way the system will respond to stimuli as a function of its past" (Baluska, Levin 2016, 2). A cognitive system with memory can be a human, a nonhuman organism, or an artificial autonomous agent, inter alia. This enables cognitive scientists to claim that the differences between a computational model of a brain and a biological brain do not matter: the former exhibits genuine cognition and not something merely analogous to it (Chirimuuta 2021). So while Bennett and Hacker would never consider a computer "just another experimental animal", as neurobiologist J.Z. Young held (Miłkowski 2018, 532), from the perspective of cybernetic cognition Young is correct.

It follows that there is nothing essentially biological about cybernetic cognition. Cybernetic cognitive systems are physical systems, but they do not have to evolve, develop, or be implemented in biological materials. They need not bear any evolutionary relationships to each other, and even if they do, those relationships play no role in distinguishing among cognitive abilities: such differences are not relevant for ascribing cybernetic cognitive abilities. Human cognition is interestingly equivocal on this point. Dualists such as Descartes are in agreement with cybernetic cognition in terms of conceiving of cognition as not essentially biological, although Descartes disagrees with cybernetic cognition in holding it is not physical at all. On the other hand, physicalists who adopt human cognition agree with

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e-ISSN 2723-9640

cybernetic cognition that cognition depends essentially on physical stuff. But because they limit full-fledged cognition to humans, only the human brain and body provides that physical support. At best, other physical bodies (including artificial ones) may support less sophisticated or "proto-" cognitive abilities.

Finally, cybernetic cognition's foundational commitment to medium-independence has made it the ideal alternative for some of those who reject human cognition, such as advocates of bacterial, plant, and/or basal or minimal cognition generally (e.g., Lyon 2015; Calvo, Keijzer 2009; Baluska, Levin 2016). Bacteria cognition is cybernetic cognition applied to bacteria, plant cognition is cybernetic cognition applied to plants, and so forth. This warm embrace has been facilitated by the fact that cybernetic concepts can easily be given a Darwinian gloss: the goals or purposes are those of homeostasis, survival, and reproduction, and feedback control is interpreted as adaptive responses to environmental contingencies. This is not a merger of equals but an apparently seamless conceptual takeover that promotes explaining biological complexity from a simplifying engineering perspective conducive to research based in computational methods.

In these two conceptual schemes – human cognition and cybernetic cognition – we have gone from a very narrow focus on one biological species to an extraordinarily broad framework that applies to artificial and biological systems equally. This shift from one extreme to another raises an overarching question: what are, or should be, the relevant similarities and differences to use when defining cognitive concepts and kinds? In human cognition, we abstract away from individual differences in human behaviour, bodies, and brains, but differences between humans and nonhumans rule out the latter as full-fledge cognitive entities. In cybernetic cognition, we abstract away from material compositions and embodied behaviours; a system is cognitive as long as it exhibits patterns of behaviour that we can describe using the relevant mathematical models. If you think cybernetic cognition ignores differences that are relevant to cognition while human cognition treats too many differences as relevant, neither human nor cybernetic cognition will be satisfactory. You will want a conceptual scheme that relies on different relevant similarities and differences for defining its cognitive concepts and kinds. Phylogenetic cognition is one such scheme. It shows that to de-humanize cognition is not necessarily to cyberneticize cognition.

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4 Phylogenetic Cognition

Phylogenetic cognition is a newcomer to the cognition game. In contrast with both human and cybernetic cognition, phylogenetic cognition defines cognitive abilities using a standard biological scheme for defining all other evolved traits. In evolutionary biology, characters are evolved traits that are defined (individuated) across species; these can be distinguished from phenotypes, which are the evolved traits of particular species that are specific ways of having a character (Figdor 2022). Phylogenetic cognition adopts this basic dual conceptual scheme. What we are talking about when we talk about cognition are both cognitive characters and cognitive phenotypes. Neither human nor cybernetic cognition has a similar distinction. So some further explanation will be helpful. Phenotypes are largely familiar, but characters are not.

Although there are several character concepts in biology, the phylogenetic character concept is dominant because these characters are used to construct phylogeny (e.g., Wagner 2001, 2014). Characters encapsulate evolutionary-historical information about how and when an ability or feature originated and how it evolved and differentiated in phylogeny.[2] They are defined by abstracting away from some species-specific details while treating others as relevant similarities. For example, the forelimb character is common to all tetrapods and helps define that major clade (or monophyletic group), which comprises the original tetrapod species and all and only those species descended from it.[3] But different tetrapod species have different forelimb phenotypes, all of which are species-specific ways of having the same forelimb character. This means that to define the forelimb character, biologists abstracted away from the many differences between dolphin dorsal fins, bat wings, and monkey arms, inter alia, to isolate the relevant similarities across all these species, such as relative position in the body and developmental origin. Phylogeny itself – the tree of life – is a nested hierarchy of such clades, where

2 The homology concept is closely related to this phylogenetic character concept: homologs are characters that are shared by two species because they both inherited it from their last common ancestor. Characters used to create phylogeny are homologs. When characters are shared across two species for reasons other than common ancestry (typically, common environmental pressures), they are homoplasies (a.k.a. are convergent or independently evolved characters). Thus, being an acoustic communicator is a character mapped to phylogeny – in particular, to birds, mammals, and amphibians – that is thought to have evolved independently in these clades (Chen, Wiens 2020); species in these groups did not inherit it from their last common ancestor. As the acoustic communication character shows, it is likely that many cognitive characters will have evolved convergently in distinct branches of phylogeny.

3 Snakes are a case of reversal, whereby a species loses a character that was possessed by its last common ancestor with other tetrapods. They are still classified as tetrapods.

small clades of species that share one or more narrowly possessed characters (e.g., having hair) are nested in ever larger clades of species that share more widely possessed characters (e,g., having vertebrae) until we reach the broadest level of biological classification (the domains of bacteria, archaea, and eukarya).

The fact that characters are individuated across species ensures that claims about which species have (or do not have) a character are *a posteriori*. For example, it is trivial to say that a given cognitive (or other) phenotype is unique to a species – phenotypes are species-specific, after all – but it is significant when a cognitive (or other) character is unique to a species. From the perspective of phylogenetic cognition, human cognition mistakenly uses human cognitive phenotypes to define cognition, making it *a priori* that only humans have cognitive abilities. It also means defining characters is a difficult business, given that the same character can be determined in phenotypes that differ markedly in form and/or function from each other. Differences in the phenotypes that determine the tetrapod character (noted above) is one example of many. Characters are modified within each species' lineage to fit the lifestyle of each species that has it. While these species-specific differences are extremely important for defining the phenotypes, they are not relevant for defining the character. To use a Cartesian example: human reason (the phenotype) might be characterized in certain ways that are not shared by other species, but it does not follow that other species don't have reason (the character), each in its own way.

This phylogenetic framework may be new for cognition, but it is well established when it comes to defining behavioural and perceptual characters and using them in various research contexts.[4] For example, after mapping acoustic communication to a phylogeny we can empirically test whether it is correlated with nocturnal or diurnal lifestyles (Chen, Wiens 2020). Duda and Zrzavy (2013) use a suite of life-history and behavioural characters, such as post-natal growth rate, social structure, dispersal patterns (philopatry), tool use, and others, to propose a hominin lineage. Brain characters have been elaborated in sufficient detail to enable us to identify a primate brain character, of which the human brain is a species-specific phenotype (Herculano-Houzel 2012). And some researchers suggest leveraging what we know about the evolution of brains (neural characters) to reconsider how to define perception, cognition, and action (Cisek 2019).

4 Griffiths (1997) introduced the idea of individuating emotions as characters; others (e.g. Matthen 2007, Ereshefsky 2007) have tended to focus on the homology concept rather than the character concept directly.

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4, 2, 2023, 149-162
e-ISSN 2723-9640

A specific illustration of how phylogenetic cognition can be developed can be found in some episodic memory research.[5] Episodic memory was originally defined from a human-cognition perspective as a memory of a past experience (Tulving 1972); our only subjects were humans and our main (often only) behavioural evidence was verbal report. Experiments with naturally food-caching corvid species showed abilities to recall what particular food items were stored, where, and when (Emery, Clayton 2004). This sparked debate as to whether the birds had episodic memory or just something similar to it, using the human-cognition yardstick. Tulving (2005) held that true episodic memory could only be human because it requires autonoetic consciousness, and only humans have autonoetic consciousness. One response to this challenge was to reject the autonoetic criterion (Allen, Fortin 2013). This made the concept more widely applicable at the cost of making it less useful for drawing important distinctions (such as distinguishing episodic from semantic memory). Clayton and Russell (2009) take another tack: they de-humanize the concept of autonoetic consciousness so that nonhuman phenotypes can be cases of real autonoetic consciousness. Very briefly, they suggest that what is essential for autonoetic consciousness is an egocentric spatial perspective relative to the recalled event. We don't have widely accepted criteria of consciousness in other species, so the suggestion is still quite speculative. But their move towards defining episodic memory as a character is clear: modulo satisfying the other criteria, each species that has autonoetic consciousness, and thus episodic memory, would have it in its own species-specific way. Scrub jays would not be ruled out by definition from having real episodic memory. Yet the definition is not so weak that it loses its scientific utility. We can still use it to distinguish between species that have true episodic memory and those that do not.

This same example can be used to underline some key differences between the three conceptual schemes. One key difference is the types of abstractions, or similarities and differences, that each considers relevant when defining cognition. For phylogenetic cognition, the many differences between humans and (e.g.) scrub jays are not relevant for defining episodic memory across both species. Both can have episodic memory, even if each has it in its own species-specific way. For human cognition, the differences between humans and scrub jays are relevant. Humans alone have true episodic memory because they alone have true autonoetic consciousness, defined in terms of the human phenotype; it follows that what scrub jays have is at best only episodic-memory-like. For cybernetic cognition, humans and scrub jays

5 This example of episodic memory is based on a somewhat longer discussion in Figdor 2022. A fuller treatment is in preparation.

both have memory (defined as above by Baluska, Levin 2016), and episodic memory is not in its conceptual repertoire. Cybernetic cognition does not distinguish humans, scrub jays, or any other cybernetic system in terms of memory, and it is silent about anything more specific.

This key difference can also be shown in the debate over cognitive abilities in plants (e.g. Segundo-Ortin, Calvo 2022). Human cognition says plants do not have cognitive abilities because they are too dissimilar to humans. Cybernetic cognition says plants have cognitive abilities because they, like humans, are adaptive systems that use environmental feedback to modify their behaviour. Phylogenetic cognition says it is an open question whether plants have cognitive abilities, because we don't yet know how cognitive characters of various types will be defined and mapped to phylogeny. Some cognitive characters may be shared across animals and plants, others may be specific to animals, and others might turn out (*a posteriori*) to be unique to humans.

A second key difference between the conceptual schemes is in terms of the inferences to cognitive abilities we might make from known instances. Consider any clear case of a cognitive ability that (unimpaired) adult humans have when they exhibit certain behaviours. We then observe what seem like many of the same behaviours in another individual. For human cognition, we can infer to that cognitive ability with reasonable strength and confidence if the new individual is also a human. Inferences to any nonhuman are strictly speaking unjustified; we can infer to abilities that are similar but not full-fledged. For cybernetic cognition, we can infer to that ability with equal strength and confidence in any artificial or biological individual as long the behaviours are captured by the same formalisms or models. For phylogenetic cognition, we can infer with variable strength and confidence to any organism depending on what species it belongs to, and therefore what phylogenetic relationship it has to species that have the ability. In our hypothetical case, we are inferring from a human to a nonhuman organism, but starting from a human is not required.

5 Relating the Conceptual Schemes

I leave it as an exercise to the reader to determine which of these schemes their current uses of cognitive vocabulary best fall under. What is clear is that discussion of cognition is massively ambiguous between these conceptual schemes, engendering plenty of verbal disputes over what is really cognition. As I see it, each conceptual scheme has a perfectly legitimate claim to the term "cognition", to defining specific "cognitive" processes within its framework, and to applying those concepts to whatever phenomena are considered within its scope. This scope will in turn determine its basic investigative orientation – humans, mathematical models, organisms – and the appropriate methods for carrying out research within that orientation.

But it is too early to think this supports pluralism. Pluralism implies that different investigative orientations can co-exist in relative peace for the most part. Different investigators look at different aspects of a complex phenomenon and may make particular assumptions appropriate for their research that are not in fact compatible with those made by others. But pluralism is not conceptual chaos. The disorientation that many feel trying to understand cognition in the contemporary context supports Aizawa's (2017) point that the sciences of cognition are in a period of "revolutionary" science, where fundamental questions are in dispute. How these three schemes will eventually be related – including, potentially, pluralism – will depend on how certain foundational questions are answered.

First consider phylogenetic cognition and human cognition. This relationship is simple once we accept that human cognitive abilities evolved just as any other human phenotype evolved. If our cognitive abilities are non-trivially unique, we will still need cognitive characters in order to make that *a posteriori* determination. With this basic evolutionary orientation accepted, human cognition is a species-specific special case of phylogenetic cognition. It is the conceptual scheme of human cognitive phenotypes, which are determinates of cognitive characters the way our arms are determinates of the forelimb character. Importantly, there is no conflict between investigating cognitive characters and investigating the human cognitive phenotype. Many researchers in psychology and philosophy of psychology will continue to focus on the human cognitive phenotype. Cognitive ontology can continue to be a thriving research area aimed at revising or reconsidering human cognitive phenotypes in the light of neuroscience. However, any revisions must also take into account the character that the human phenotypes are determinates of. In other words, human cognitive phenotypes will be partly defined by features not specific to humans, the way the human forearm is partly defined by what it is to be a forelimb. Meanwhile, researchers more interested in phylogenetic cognition will be keen to distinguish those features of human cognitive phenotypes that are specific to humans and those are shared with other species and help define the characters. We will also be interested in determining how non-cognitive characters at other levels of biological organization – genetics, morphology, development – constrain behavioural and cognitive characters, and thus constrain human cognitive phenotypes too.

Unfortunately, the relationship between phylogenetic cognition and cybernetic cognition is not so simple, and will need a great deal more work before it will be understood. This uncertainty also affects human cognition given its relation to phylogenetic cognition. The basic issue is medium-independence: we don't know which (if any) biological details might be relevant to cognition and which are not. Since cybernetic cognition abstracts away from all of them, it implies that none of those details matter. We actually don't know if that is true. For example, Chirimuuta (2021) notes that the abstractions of computational models of the brain leave out aspects of neurons and neurophysiology that matter for cognition. As a result, it may be that computational models merely involve artificial kinds that are convenient for computational neuroscientists. More broadly, we don't know if computational models capture what is relevant to biological cognition or if the models don't really tell us very much about it.

As a result, the relationship between phylogenetic (and human) cognition and cybernetic cognition is unclear. It could be that phylogenetic cognition is a special case of cybernetic cognition with some additional restrictions; human cognition would then be a special case of this special case. But it is also possible that they do not nest in this way, or that they end up in some more complicated relationship, and in this case some form of cognitive pluralism might be the outcome.

6 Conclusion

I have presented three conceptual frameworks currently in play in scientific and humanities research on cognition: human cognition, cybernetic cognition, and phylogenetic cognition. All provide a legitimate ways to talk about cognition but they are in apparent conflict in various ways. Clarifying each conceptual scheme can help give us distinguish which disputes about cognition may be verbal (for example, whether human cognition is unique) from those which are fundamental (for example, the role of biological composition in cognition). I have also argued that the relationship between all three is still unclear. Human cognition is easily understood as a special case of phylogenetic cognition, but the relationship between phylogenetic cognition and cybernetic cognition is an open, and difficult, question.

e-ISSN 2723-9640

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