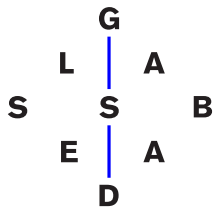

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Semiotic Epicycles and Emergent Thresholds in Human Evolution

Gary Tomlinson

1. Signs[1]

Two features mark the genus *Homo* at the point of its emergence some 2.5 to 3 million years ago: culture and technology. We know these as interlinked features, since culture—minimally defined as a sociality in which things learned in a lifetime are passed on to future generations—is revealed to us among early hominins by the artifacts they produced from stone-knapping techniques that required some form of imitative interaction for their persistence and eventual consistency of process. The first lesson of any deep-historical view of humans is that we were encultured toolmakers before we were human. And the corollary follows: humans did not invent either culture or technology but were invented by them, through the operation of selective dynamics always already cultural as well as biological, always shaped by material manipulations learned, taught, maintained, and enhanced across generations. These lessons were first appreciated by mid-20th-century observers such as André Leroi-Gourhan, and today they are accepted truths concerning our deep history.

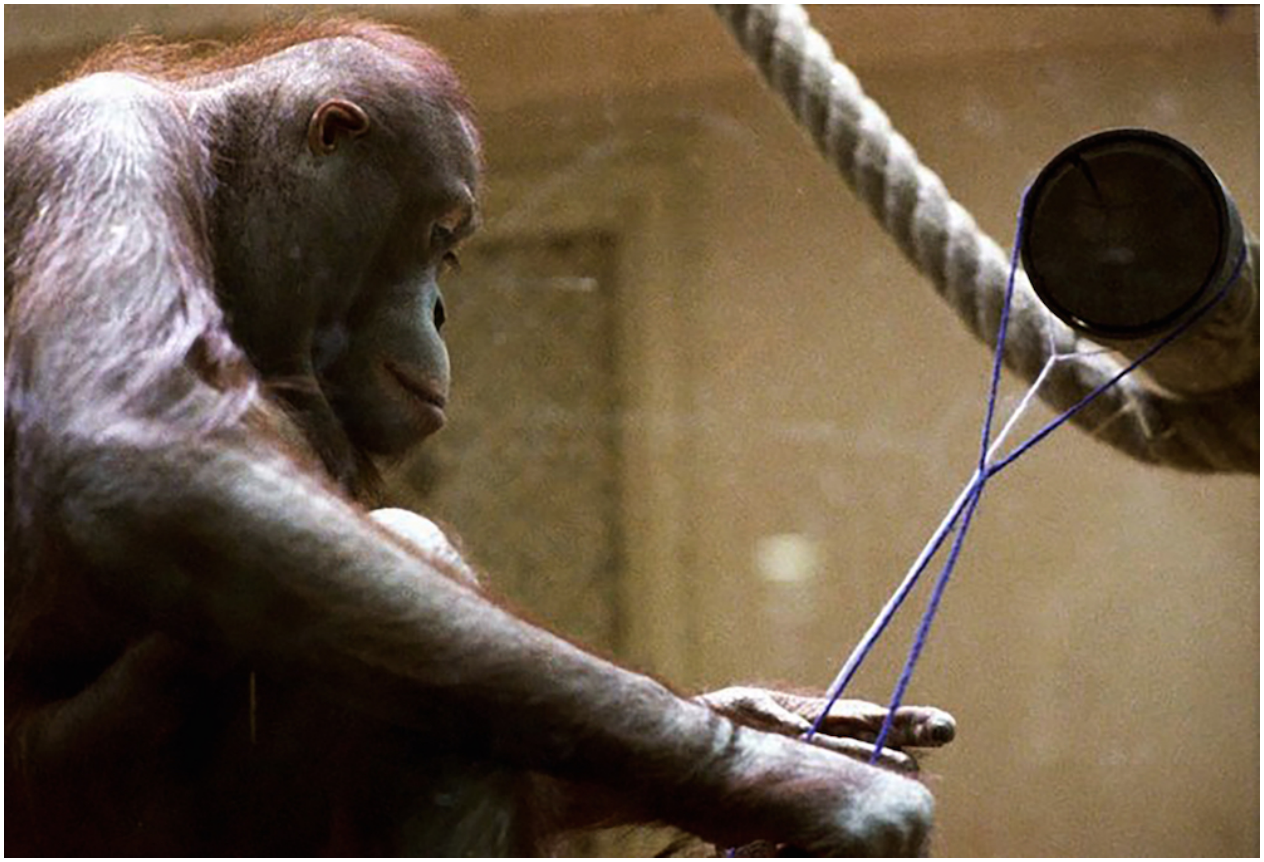
Acheulean handaxes from the site of Boxgrove (England), 500 000 BCE. Photograph by W. Roebroeks.

While culture and technology distinguish our lineage from its beginning, however, they are not unique to it in the world today—and were not unique, doubtless, when hominins first appeared. We have come to understand that both toolmaking and culture (in my broad definition) are present in an array of mammals, birds, and even a few other animals. Thus, the evolutionary course that would ultimately distinguish us categorically from all other animals was not an inevitable outcome of technology and culture. Other processes and features played a part, and modeling these has come to be a primary goal in the attempt to explain in general terms the emergence of modern humanity.

To build such models requires locating culture and technology in a broader frame of animal capacities. Culture is nested within the larger category of sociality, as I have suggested. While all cultural animals are social ones, only a small portion of social animals are cultural ones; that is, only a few kinds of social animals learn things during their lifetimes that they impart to succeeding generations. Baboon troops show a complex interplay that establishes rankings of power and status among females, but no ranking or system of ranking is learned and passed on as such;[2] they are social animals without culture. Chimpanzees, on the other hand, develop regional differences among

groups, with one group learning and transmitting repertoires of techniques not present in another.[3] Some passerine birds and both humpback and sperm whales also show such regional cultures, in these cases in the transmission of learned "songs" and click codes.[4]
Technology is also nested in a broader frame, making up a small corner of the vast matrix of material interactions with the environment that all living things engage in. For animals with complex behavioral panoplies, distinctions need to be drawn between tool-making skills and a larger realm of complex, intentful manipulations of the material world. A New Caledonian crow sharpening a twig to spear grubs works its material environment in a way different from a bird building a nest; a chimp using a stone hammer and anvil to crack a nut seems to have crossed a categorical line, while a beaver constructing a dam has not.
These distinctions are not simple ones, and students of animal toolmaking have found it difficult to locate exactly the shift from a non-technological to a technological interaction with the world.[5] We need to think flexibly here, not of thresholds surpassed and switches flipped, but instead of an analogue spectrum—or better, a three-dimensional landscape of interactive possibilities, with kinds of interactions grading smoothly into one another and tendencies accumulating in some directions but not others. The same kind of judgment is called for in the matter of culture. There is no overt tipping point between culture and non-culture, between the transmission of learned archives and its absence, but instead an ideational contrast *we* draw that involves, in the real world, a broad terrain of subtly graded differences.
When, in toolmaking and the transmission of learned archives, a certain level of regularity and complexity is reached, it is useful to describe the resulting interaction between animals and their environments as the construction of a *taskscape*—a term coined by anthropologist Tim Ingold that I use to name the assemblage of activities learned and more-or-less consistently transmitted within a set of material and other constraints and affordances.[6] Taskscapes can be discerned in the activities of some nonhuman animals, but early hominin taskscapes came to surpass all others in their complexity at least half a million years ago, and probably a good deal earlier. Eloquent evidence of this comes from the meticulously reconstructed taskscapes of certain Middle Paleolithic sites, such as Boxgrove in southern England.
Both culture and technology also form parts of the realm of sign-making in the world—the *semiosphere*, in Juri Lotman's term.[7] Without deploying signs, no animal could possess culture or fashion parts of the world as tools for achieving—that is, *pointing toward*—certain goals. I interpret the semiosphere from the perspective of a

Peircean semiotics, not the more limited Saussurean one with its emphasis on human language, and in this I follow the course of most biosemioticians. (Where I do not follow them will become clear below.) Peirce saw a broad extent of signs in the world, one that reached, especially in his late thinking, far beyond humans. He perceived this breadth by focusing on the process of sign-making rather than on the structure of the sign itself, as Terrence Deacon, one of the foremost neo-Peirceans today, has understood.[8] For Peirce the semiotic process involved not only a relation of sign and object, however complex, but also a relation to this relation, which he termed the *interpretant*.[9] Identifying this aspect was Peirce's fundamental contribution to the theory of signs. For Peirce himself it located semiosis in its proper ontological place, which, by virtue of its relation-to-a-relation, is not one of relationality but of *meta*relationality—in Peirce's own terms, not one of *soundness'* but of *thingness*. The extra level of relations involved in thirdness is constitutive of all signs.



Female orangutan Wattana tying knots at the Jardin des Plantes zoo in Paris, 2012. Photograph by Chris Herzfeld.

The interpretant is the opening onto this extra level. Two things in the world come to stand in a relation of sign and object not because of intrinsic relations between them, but because of the sensing by a third entity of relations between them (intrinsic or not). This

sensing can take the form of something we might call thought, or it can be more basic and experiential; but in either case it can be conceived as a calling *to* the third entity by the things that become sign and object that occurs simultaneously with a reverse calling of the things *by* that entity. A and B are called by entity C at the same time as they call it, and from this mutuality a signifying metarelation arises. The interpretant requires, on the part of the third entity, an *attentional* capacity, an ability to select from among the myriad stimuli received from its environment, some few to focus on and make special response to—some few, that is, to attend to. This attention depends in turn upon neural or cognitive systems of a certain complexity, and sign-making spans the living realm as far as we can find organisms endowed with such systems.

How far is this? I am not inclined to extend the semiosphere as far as many biosemioticians do, who identify sign-making by plants, microbes, and even intracellular molecules bound in genetic processes and metabolic cycles—DNA, for example, in a "semiotic" relation to transfer RNA and amino acids. In doing this, they ignore the fundamental Peircean insight and with it the all-important attentional interpretant, the cognitive concomitants of which suggest far more limited boundaries for the semiosphere. Trees, paramecia, bacteria, and (probably) sea urchins and flatworms do not *attend to*; they are non-semiotic organisms, while most vertebrates, including amphibians, reptiles, mammals, and birds, are sign-makers. The border between the semiotic and the non-semiotic is an uneven one, however, and can cut across individual phyla: within the mollusks, clams are non-semiotic, while cephalopods are accomplished semioticians.

This is not to deny that trees and paramecia and clams stand in hugely complex relation to their environments and the stimuli they receive from them. Theirs is not a semiotic relation, however, but an *informational* one, without interpretants or signs. Information, from the vantage of Claude Shannon[10] and the many outgrowths of his ideas developed since the 1940s, is a correspondence that manifests a condition of relationality—but not one of metarelationality. In Peirce's terminology, it is sheer secondness; in Jerry Fodor's happy phrase, "reliable causal covariance."[11] In discerning this informational realm we come to the largest category within which semiosis, sociality, technology, and culture are all nested. This topic, however, would take us far afield from deep human history, since the first hominins were not merely informational organisms, but semiotic, social, cultural, and technological ones as well. It is enough to note that living things, from the

simplest to the most complex, are all immensely intricate information processors; but only a small portion of them are endowed with the capacities to transform the relations of secondness into the metarelations of thirdness and thereby create signs.

2. Systems

To understand these relations of culture, technology, and semiosis is to begin to fashion a model of the final stages of human emergence. Hominin evolution from the outset combined culture and biology and, thus, was a *biocultural* evolution, its selective dynamics determined in some part by the shifting natures and balances of the semiosis, cultural transmission, and technological expertise that different hominins commanded. These were the balances that shaped the relations between the assemblages of activities comprised in hominin taskscapes and the environmental affordances and constraints they entailed.

These relations themselves developed according to an interplay that has come to be called *niche construction*. This denotes an interactive dynamic in which organisms shape their environments even as their environments shape them, across many generations, through natural selection. Niche construction is not restricted to the evolution of hominins, of course, but instead is ubiquitous in the history of life. Its fundamental systemic pathway is a *feedback circuit*: organisms living out their lives alter their environments in large or small ways, and these altered environments ultimately bring altered selective pressures to bear on the organisms that have altered them. Genetically determined traits are advantageous or harmful differentially in relation to environments altered by the organisms that manifest them. Niche construction is a major aspect of the novel evolutionary thinking that has emerged over the last forty years or so and is referred to today as the Extended Evolutionary Synthesis, to distinguish it from the Modern Evolutionary Synthesis that first combined Darwinian selection with Mendelian population genetics in the 1920s and -30s and held sway through the middle of the last century.[12] Niche construction challenges evolutionists to take account not merely of life forms changed by successive adaptations on stable adaptive terrains—the special achievement of the Modern Synthesis—but also of the selective consequences of ecosystems shifted by the organisms living in them.

The semiotic, cultural, and technological capacities of hominins were all powerful elements in their building of taskscapes—that is, in their construction of niches. Evolutionists in the Extended Synthesis camp have worked to develop quantitative models of the impact of cultural transmission on human niches and, through the

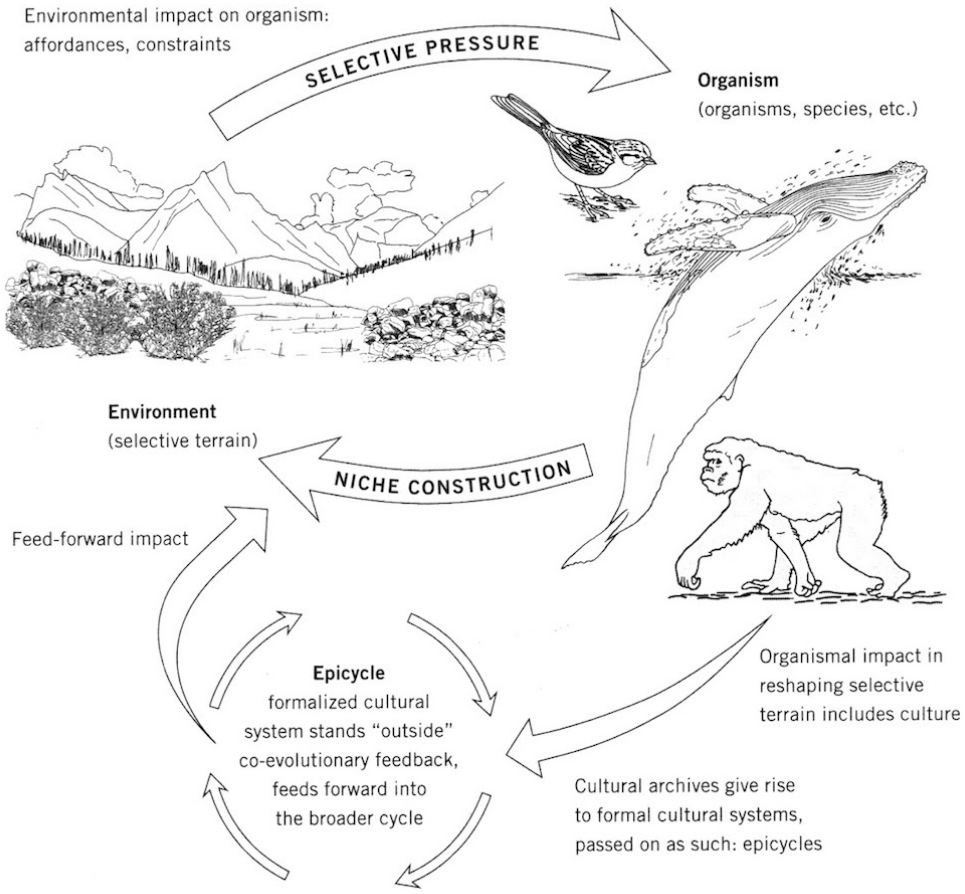
feedback loop, back onto the selective pressures of subsequent hominin evolution.[13] The general outcome of this effort has been to affirm the considerable power of cultural transmission and accumulation to alter the selective gradient. The cultural element in biocultural evolution, these models indicate, can change the nature of selection and thereby play a role in shaping the genomes of future generations.

But quantitative models are necessarily blunt in their conceptions of culture; not much nuance of cultural processes can be captured in the coefficients of recursion equations. The models take technology, in the form of shifting toolmaking industries, as a proxy for cultural change and its impact on the environment—as they must, since these industries are the chief evidence we have for long stretches of hominin evolution. What is missing from the models, however, is any notice of the changing semiotic means of the hominins in question across the last three million years, and specifically any awareness of their impact on culture. This is a major lacuna, because the semiotic changes introduced systemic novelties that rendered hominin niche construction different from any other in the history of earthly life. They brought about new dynamics operating on culture and the material aspects of the taskscape, and from these arose new kinds of relations of hominins to their environments.

The systematization of hominin culture began early. It can be glimpsed already in design consistencies of Acheulean biface industries, which first show themselves about 1.75 million years ago. Systematization accelerated and took off as a decisive factor, however, only in much more recent times, probably well after the 500,000-year mark. The acceleration, I argue, was driven by the agglomeration of signs into ordered arrays; this was the semiotic novelty that began to set hominin niche construction apart. The evidence afforded by both archaeological reconstructions of these societies and modern ethology suggests that the kinds of signs central to this stage were *indexes*, signs related to their objects by proximity, contextual connection, causal relation, and in general by a deictic, pointing operation. The pointing aspect of tools I noted before manifests such indexical semiosis, and the increasing complexity and hierarchic organization evident in toolmaking procedures in the period of Neandertals and the immediate ancestors of sapients are a reflection of the growing systematization of indexes.

The accumulating, ordered arrays of indexes inaugurated what I have called a *hyperindexical* stage of hominin culture,[14] characterized by heightened systematization of both action and communication without modern language or symbolic cognition. This

was an era of protolanguage or protodiscourse, of protomusic, and of nascent ritual—understood in a broad sense as the performance of more-or-less fixed and repeated collections of signs pointing to things beyond immediate, sensible perception. As systems of indexes took shape, the impact of semiosis on hominin taskscapes was recast. At first sporadically and later with increasing regularity, the sign-systems acquired an autonomy and stability in relation to the feedback loops of niche construction from which they had arisen. Initially these features were weak, nothing more than products of the repeatability of the actions enabled by the semiotic systems. Eventually they grew to be something more: stable, hierarchic arrangements of signs guiding, from a position somewhat apart, the ongoing feedback cycles of niche construction. These products of hominin semiosis and culture were new to the world, since the more basic semiosis of many other animals and the rudimentary cultures of some few of them did not rise to a systematicity that could create them. The stable complexity of the semiotic and cultural systems of late hominins caused them to stand apart from the feedback cycles of niche construction, and for this reason I have termed them *epicycles*.[15]



Epicyclic Biocultural Coevolution. Chart by Virge Kask. Published in Garry Tomlinson, A Million Years of Music, Zone Books, 2015.

The semiotic and cultural epicycles of early humans—of ancient *Homo sapiens*, of Neandertals, perhaps of their common ancestor *Homo heidelbergensis*, and no doubt of some other less well known late hominin groups—reshaped niche construction at a basic, processual level. The role of humans in it took on a new aspect, above and beyond the feedback relation to their environments they shared with the niche construction of all other organisms. Now feedback processes joined with semiotic systematization to give rise to control mechanisms directing niche constructive cycles from the outside. Such external controls are not feedback at all, whether positive or negative; instead they are *feedforward* elements. Feedforward had always been important in niche construction: climatic variations, geological changes ranging from volcanism to tectonic plate movements, and astronomical cycles are all feedforward elements in relation to the niche

construction of earthly organisms. But now, by virtue of the semiotic and cultural powers of early humans, niche construction had spawned from *within* its dynamic a new kind of feedforward control.

The consequences of semiotic and cultural epicycles were immense, nothing less than the advent of human modernity. They could exercise such profound effects because as they formed, they shifted the relations between evolving humans and elements in their environments. These shifts were often categorical ones, in which the epicycles (new kinds of controls) brought humans into interaction with new categories of constraints and affordances, unmet and untapped by earlier taskscapes. Because of this potential, the formation of an epicycle could have a liminal impact, defining a threshold or boundary across which lay new horizons in the interactions of humans and the world. The most powerfully transformative epicycles in this way brought "on line" whole new sets of criteria governing the relations of evolving cultural systems to their environments. They opened human access to new possibilities in the interactions of minds, bodies, and the materials of the taskscape, and they made this access a part of ongoing niche construction and biocultural evolution.

When in the 1990s John Maynard Smith and Eörs Szathmáry discerned several "major transitions" in the evolution of life on earth—threshold crossings that inaugurated new horizons of possibility in the course of evolution—they included the advent of human modernity as the latest example.[16] They worked to explain this transition as the product of human language and its social potentials, but their explanation failed to reach the broadest and deepest change that humans brought to the course of evolution, of which language was only one outcome, however important. By introducing feedforward controls generated from within niche-constructive feedback, semiosis and culture exploded humans' potential to alter their taskscapes, propelling them toward new social and material horizons. The distinctively human threshold crossings that resulted were irreversible, just like the other major transitions: not because of some ineluctable human progress, but because it is the nature of the abstract machine of biological and biocultural evolution—the Darwinian algorithm of inheritance, variation, and selection—to explore every search space that is opened to it. Feedforward epicycles expanded exponentially the search space in which selective forces could act on late hominins.

3. Beads

Bead-making offers a modest but clear example of the threshold effects of a cultural epicycle. With this phrase, archaeologists denote a technology that took many forms and appeared across a wide geographical range, starting in all likelihood more than 100,000 years ago. In all forms of bead-making, resources of the taskscape were drilled through or punctured, often with labor-intensive care, so as to be hung on straps, hair, or clothing. The materials used ranged widely according to different local taskscapes and include shells from harvested mollusks, ostrich eggshells, ivory, teeth from hunted animals, amber, and minerals. The goal of bead production, known from some relatively late cases (ca. 20-30,000 years old) and inferred for earlier instances, was to mark social distinction in one form or another, asserting status or power, granting access to special things or privileges, and in general betokening difference either from others in a group or from other groups. The bead industry seems to have emerged independently in many places humans went after a certain point in their evolution, perhaps even involving more than one species.[17]

Why was this technology so fecund and widespread? The answer lies in the irreversible crossing of a threshold, driven by a semiotic/cultural epicycle. The beads, viewed collectively as a unified industry, share little beyond two things: a technological operation unremarkable in itself, in that it is indistinguishable from similar processes used in making tools and weapons; and a foundational semiotic innovation which, once introduced, transformed this general operation. The combination made the beads powerful signs, indexes of the social order and complexity they marked. But the beads could not have become signs and the old technology could not have been redirected along a new path without a systematized indexical order already in place. The social complexity calling for material tokens and manifested in the beads was itself a product of the gathering of semiotic systems in the hyperindexical age. Once the semiotic foundations of such complexity were in place, the slight swerve of technologies to enlist material resources that could manifest them was a likely, almost inevitable development. Tried and true techniques were recruited for new ends glimpsed only because a hyperindexical threshold was crossed.

More specifically, once the material byproducts of hunting, harvesting, and scavenging came to be indexes of something else, both the processes of their collection and the materials collected were transformed. A shell collected on the southern African seacoast was no longer merely the waste product of a meal, to be tossed onto a midden outside the cave, and its collection was no longer a matter of sustenance only; the tooth of a wolf

or hyena killed while scavenging a carcass was no longer an incidental byproduct of subsistence. In each case a material aspect of the taskscape had been transformed by virtue of a threshold crossing, to become a sign-in-the-making. The shell or tooth was transmuted from non-signifying to signifying matter, and a process of production was endowed with novel semiotic powers by virtue of its place in the epicycle. And, once the transformation had occurred, there was no undoing it—no revoking of the semiotic *potential*, no matter how many times it was not exploited (the shellfish eaten, the shell tossed away).

The *feedforward control* here—the *epicycle*—consists in a set of semiotic conditions determining these new roles for actions and resources, and thereby turning niche construction in new directions and remapping humans' alterations of their niches. The epicycle brought about not merely an enrichment of the taskscape, but its opening out to new potentials, new horizons of possibility for its further elaboration; these were taken into the machinery of niche-constructive, biocultural evolution. In the instance of bead-making, this opening involved remaking affordances into new kinds of affordances. Other epicycles confronted humans in new ways with constraints, generating new possibilities, then, from the transformation of limits. I have elsewhere described such epicycles behind the human processing of discrete pitch in musicking (a transformation of informational constraints) and the emergence of propositional syntax in language (a transformation of semiotic constraints, as analyzed by Deacon).[18] But in all three cases and in many others the operational dynamic of the epicycle was the same: a system generated from within niche constructive feedback cycles came to operate as a mechanism controlling the cycles that gave rise to it; thresholds emerged and were crossed; and new search spaces widened the scope of humans' biocultural evolution.

Footnotes

1. This essay extends a discussion launched in my book *A Million Years of Music: The Emergence of Human Modernity*. New York: Zone, 2015. Print. It also anticipates a broader treatment of the issues in a new book: *Culture and the Course of Human Evolution*, forthcoming from The University of Chicago Press, 2018.

2. Dorothy L. Cheney and Robert M. Seyfarth. *Baboon Metaphysics: The Evolution of a Social Mind.* Chicago: University of Chicago Press, 2008. Print.

3. A. Whiten, J. Goodall, W. C. McGrew, T. Nishida, V. Reynolds, Y. Sugiyama, C. E. G. Tutin, R. W. Wrangham, and C. Boesch. "Cultures in Chimpanzees." *Nature* 399 (June 1999). Web.

4. Todd M. Freeberg, Andrew P. King, and Meredith J. West. "Cultural Transmission of Vocal

Traditions in Cowbirds (*Molothus ater*) Influences Courtship Patterns and Mate Preferences." *Journal of Comparative Psychology* 115 (2001): 201-11. Print. Nina Eriksen, Jacob Tougaard, Lee A. Miller, and David Helweg. "Cultural Change in the Songs of Humpback Whales (*Megaptera novaeangliae*) from Tonga." *Behavior* 142 (2005): 305-25. Print. Shane Gero, Hal Whitehead, and Luke Rendell. "Individual, Unit, and Vocal Clan Level Identity Cues in Sperm Whales." *Royal Society Open Science* (2016). Web.

5. Robert W. Shumaker, Kristina R. Walkup, and Benjamin B. Beck. *Animal Tool Behavior: The Use and Manufacture of Tools by Animals*. Baltimore: Johns Hopkins University Press, 2011. Print.

6. Tim Ingold. "The Temporality of the Landscape." *World Archaeology* 25 (1993):152-73. Print.

7. Juri Lotman. "On the Semiosphere." *Sign Systems Studies* 33 (2005): 205-29. Print.

8. Terrence Deacon. *The Symbolic Species: The Co-evolution of Language and the Brain*. New York: Norton. 1997. Print; Terrence Deacon. "Beyond the Symbolic Species." *The Symbolic Species Evolved*. Eds. Theresa Schilhab, Frederik Stjernfelt, and Terrence Deacon. Berlin: Springer, 2012. 9-38. Print.

9. See Paul Kockelman. *Agent, Person, Subject, Self: A Theory of Ontology, Interaction, and Infrastructure*. Oxford: Oxford University Press, 2013. Print.

10. Claude E. Shannon and Warren Weaver. *The Mathematical Theory of Communication.* Urbana: University of Illinois Press, 1949. Print.

11. Jerry Fodor. *A Theory of Content and Other Essays*. Cambridge, MA: MIT Press, 1990. 93. Print.

12. F. John Odling-Smee, Kevin N. Laland, and Marcus W. Feldman. *Niche Construction: The Neglected Process in Evolution*. Princeton: Princeton University Press, 2003. Print; Kevin N. Laland, Tobias Uller, Marcus W. Feldman, Kim Sterelny, Gerd B. Müller, Armin Moczek, Eva Jablonka, and John Odling-Smee. "The Extended Evolutionary Synthesis: Its Structure, Assumptions and Predictions." *Proceedings of the Royal Society B* 2015. Web.

13. See for example Robert Boyd and Peter J. Richerson. *Culture and the Evolutionary Process*. Chicago: University of Chicago Press. 1985. Print; Odling-Smee, et al. *Op cit.* 2003; Luke Rendell, Laurel Fogarty, and Kevin N. Laland. "Runaway Cultural Niche Construction." *Philosophical Transactions of the Royal Society B* (2011). Web.

14. Hyperindexicality is a matter first and foremost of the systematic and hierarchical arrangement of indexes in relation to one another, which brings them close to one of the characteristic features of the symbol. I discuss the presymbolic, hyperindexical stage of late hominin evolution in *Culture and the Course of Human Evolution*, *Op. cit.* 2018. Especially Chs. 4, 5, and 7.

15. For further discussion see *Ibid.* Chs. 5 and 7.

16. John Maynard Smith and Eörs Szathmáry. *The Major Transitions in Evolution*. Oxford: Oxford University Press, 1995. Print.

17. Francesco D'Errico and Marian Vanhaeran. "Evolution or Revolution? New Evidence for the Origin of Symbolic Behaviour In and Out of Africa." *Rethinking the Human Revolution*. Eds. Paul Mellars Katie Boyle, Ofer Bar-Yosef, and Chris Stringer. Cambridge: The McDonald Institute, 2007. 275-86. Print; and Marian Vanhaeren and Francesco d'Errico. "Aurignacian Ethno-Linguistic Geography of Europe Revealed by Personal Ornaments." *Journal of Archaeological Science* 33

(2006), 1105-28. Print.

18. See Gary Tomlinson. *Op. cit.* 2015. Chs. 5 and 7 and *Op. cit.* 2018. Chs. 5 and 7. For Deacon on semiotic constraints and symbolism, see *Op. cit.* 2012. 20-25.

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