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Archeology and the language-ready brain

Abstract: In this book, Michael Arbib presents a most interesting and comprehensive account of the evolution of language. The work is both impressive and convincing in its description of how the language-ready brain evolved and how languages emerged through cultural evolution. As we are in broad agreement with Arbib's evolutionary story at the neurocognitive level, we focus on an underdeveloped part of his argument: when did language evolve in the human lineage? How does Arbib's neurocognitive argument connect with what archeology teaches us about human evolution?

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In his book Arbib identifies four stages in the evolution of language, which he links to the evolution of stone tools:

1. The first stage is associated with Oldowan industries. The simplicity of those industries, according to Arbib, suggests the absence of complex imitation skills among early members of the genus *Homo*. Communication among early *Homo habilis* and *Homo erectus* would have consisted of “a limited repertoire of vocal and manual gestures akin to those of a group of modern great apes” (Précis, p. 16).
2. The second stage is linked to Acheulean industries that Arbib describes as “transitional” between simple and complex imitation. His argument is based on the fact that Acheulean industries represent an improvement over Oldowan, but are still very conservative in nature, exhibiting only limited changes over ca. 1 million years.
3. The third stage begins with the late Acheulean and the emergence of *Homo sapiens* at about 200 ka (Sisk and Shea 2008). According to Arbib, *Homo sapiens* were the first humans to have a language-ready brain. This does not mean that early *Homo sapiens* could speak like people do now as, he argues, modern language still had to be invented.

4. The fourth and final stage begins with the rapid innovations in human material culture observed between 100 ka and 50 ka. This process corresponds to the cultural evolution of fully-fledged human languages. Arbib thus suggests that it took tens of millennia for the language-ready brain to produce the type of languages with which we are now familiar.

Although we are in broad agreement with Arbib's neurocognitive story, we raise some questions about the connections he proposes with the archeological record. In particular, we address three points concerning Arbib's reconstruction:

1. How complex would language have been prior to the evolution of *Homo sapiens*?
2. Is there really a significant gap between the evolution of morphologically modern *Homo sapiens* and the evolution of cumulative cultural behavior?
3. Is language evolution really the best explanation of the kind of innovations that appear with *Homo sapiens*?

1 Language before *Homo sapiens*

Arbib describes human evolution before *Homo sapiens* as a long process towards the creation of the language-ready brain. This process would have spanned almost two million years, from the emergence of the first members of the genus *Homo* to that of *Homo sapiens*, at about 200 ka. It would have been marked by a long period of relative stasis and the slow development of a protolanguage, composed of a small but growing set of vocal and manual gestures. Over the course of millennia protolanguage would have been gradually enriched as human populations acquired new brain mechanisms.

Humans before *Homo sapiens* lacked a language-ready brain because they did not have complex imitation skills. But how do we know that? Arbib's inference is based on the relative stasis of material culture of *Homo sapiens*'s predecessors. The production of Acheulean handaxes is arguably more demanding of working memory than that of Oldowan choppers. Nevertheless, the fact that Acheulean culture exhibited limited variation over almost one million years suggests that *Homo erectus* and *Homo heidelbergensis* had a limited capacity for innovation, at least in a technological sense. Did this apparent limitation also extend to language?

Stone knapping provides only a limited window on the behavior of early humans. A reconstruction of their lifeways shows a departure from the limited ranges occupied by earlier hominin species and the ability to expand out of Africa into Asia and Europe. Successfully adapting to a range of climates and environ-

mental conditions suggests advanced levels of social cooperation and a technology that at least must have been adaptable. Their stone tools may have remained relatively simple but the adaptation of other technologies in less durable materials like wood, bamboo and bone remain a possibility. Further innovations among *Homo erectus* (Asia) and *Homo heidelbergensis* (Eurasia) populations reveal increasingly advanced cognitive and social systems prior to the evolution of *Homo sapiens*. The evolution of large-game hunting, for instance, implies that human groups were capable of taking significant risks and that they engaged in food sharing. Their depth of cooperation is also evidenced by the evolution, significantly before *Homo sapiens*, of a human-like life history, with prolonged infancy, one of the biological mechanisms that Arbib presents as key to the evolution of the language-ready brain (property 7). Prolonged infancy suggests not only that human children had more time for social learning, but also that adults were engaged in highly demanding cooperative breeding (Dubreuil 2010).

What does this mean with respect to language evolution? Limited innovation prior to *Homo sapiens* suggests that early human cognition was not on par with that of our species, but it is still likely that several of the brain mechanisms relevant to the evolution of language were already present. Cooperation, for instance, is presented by Arbib as a prerequisite for complex imitation (property 1) (pp. 198–201). Participation in high stakes cooperative ventures also suggests a capacity for *intended communication* (property 2) and an ability to move *beyond the here and now* (property 6) by engaging in some form of temporal planning. We agree with Arbib that significant neurocognitive differences must have existed between *Homo sapiens* and their predecessors, but suggest that the brain of late *Homo erectus* and *Homo heidelbergensis* was sufficiently “language-ready” to permit the development of significantly complex syntactic structures. High levels of cooperation among *Homo erectus* and *Homo heidelbergensis* indicate the presence of a strong motivation to communicate. It is unlikely that this motivation did not, during the hundreds of thousands of years of existence of those species, lead to significant grammaticalization. Our view contrasts with Arbib’s claim that hominins before *Homo sapiens* communicated with a limited repertoire of vocal and manual gestures.

2 From modern morphology to modern behavior

The second point that we question is the gap that Arbib describes between the evolution of modern *Homo sapiens* morphology (at around 200 ka) and the first appearance of symbolically mediated culture, including art and burials, associated with later *Homo sapiens* (which he dates at 100 ka – 50 ka, following

Noble and Davidson 1996). The reason for this gap, according to Arbib, is that, although the brain of early *Homo sapiens* was language-ready, it still took tens of millennia for language to evolve through a tinkering process, where each generation crafted new grammatical structures that were culturally transmitted to the next.

This claim is surprising given the rapid development of Nicaraguan Sign Language (NSL) and Al-Sayyid Bedouin Sign Language (ABSL). Arbib supports his argument by saying that these sign languages evolved rapidly because these groups of deaf people were a part of a population that had complex language, and that established language can act as a catalyst. Nevertheless, we question whether ca. 100 ka would be needed for the initial evolution of languages. Grammaticalization would act faster, in our opinion, because people would need more complex syntactic structures to understand each other. As Arbib points, out the pragmatic need to communicate and overcome ambiguity are alone powerful drivers of linguistic innovation.

Arbib's argument is based on the existence of a 100 ka gap between the evolution of modern *Homo sapiens* and rapid behavioral evolution. But this gap is highly questionable at the archeological level. It is true that the earliest known *Homo sapiens* fossils from Omo Kibish are dated ca. 195 ka (Sisk and Shea 2008) and that significant innovations are documented at or after ca. 100 ka (e.g. Henshilwood et al. 2011).

Among the innovations that appear at ca. 100 – 60 ka are:

- a. the first known production of a multi-component pigmented compound at 100 ka and the earliest use of a container, in this case an abalone shell, also at 100 ka. The contents of the shells indicate a planned sequence of actions in order to produce and store the ochre rich compound. The ability to source, combine and store substances that enhance technology or social practices represents a benchmark in the evolution of complex human cognition (Henshilwood et al. 2011);
- b. ochre pieces and bone fragments engraved with abstract patterns dated to c. 75 ka (d'Errico et al. 2001; Henshilwood et al. 2002). The engraved ochres, associated with the remains of *Homo sapiens* constitute, at present, among the most ancient persuasive evidence for symbolic behaviour;
- c. convincing evidence for the use of personal ornaments, consisting of perforated marine shells, is found at sites in South Africa (d'Errico et al. 2005), North Africa (d'Errico et al. 2009), and the Near East (Vanhaeren and d'Errico 2006) dated to between 100 and 70 ka;
- d. the deliberate heating of lithic raw materials to enhance knapping at 75 ka (Mourre et al. 2010) and the first known application at 75 ka of pressure flaking on the pretreated lithic materials (Mourre et al. 2010);

- e. the use of mechanically-projected weaponry such as the bow and arrow at ca. 60 ka (Lombard and Phillipson 2010);
- f. the recovery of hundreds of pieces of ostrich eggshell deliberately incised with distinct parallel or cross-hatched geometric motifs dated at c. 60 ka. (Texier et al. 2010);
- g. the manufacture of standardised composite tools at c. 65 ka, the use of plant resin for adhesion of stone tools to hafts, the addition of ochre to mastic used as an adhesive, and the ability to repair composite tools through the replacement of parts is directly comparable to behaviours observed in the post 40 ka Later Stone Age in southern Africa (Wadley et al. 2009; Lombard and Pargeter 2008).

However, several behavioral innovations also appear significantly before c. 100 ka. At Twin Rivers in Zambia (Barham 2002) and at Kapthurin in Kenya (McBrearty 2001) there is convincing proof of the symbolic use of pigments during the Acheulean-Middle Stone Age transition (ca. 200 ka) associated with early *Homo sapiens*. At Twin Rivers many fragments of pigment were found in levels that date to between 400 – 260 ka and five of these show traces of use. The variation in the colours of these pigments shows more than just a functional use. If pigment use is an archaeological indication of symbolic behaviour, as has been suggested by many authors, and indirectly of language, then the origin of these abilities, traditionally attributed to *Homo sapiens* has to be considered more ancient than commonly accepted. The use of ochre is also attested at Pinnacle Point Cave in South Africa by c. 164 ka (Marean et al. 2007).

Despite significant advances in recent years, it must also be emphasized that well dated archeological sites between c. 300 ka and c. 100 ka are rare, so the evolution of *Homo sapiens* during this key period is still poorly understood. There might have been a sudden surge in human innovation at c. 100 ka, but the possibility of a much longer and gradual evolution of modern behavior following a mosaic pattern is clearly probable (e.g. Henshilwood and Dubreuil 2011; Lombard 2012; Henshilwood and Lombard in press).

Another possibility is that, despite the appearance of anatomically modern humans at c. 200 ka, neural reorganization within the human brain was not a punctuated event, but happened gradually between 200 ka and 100 ka. Depending on selective criteria that may have favored or disfavored novelty and change, periods of rapid innovation or stasis might have followed. Until a clearer picture of human evolution between 300 ka and 100 ka has emerged, it is hard to produce a detailed argument about the link between neural and behavioral evolution in early *Homo sapiens* (e.g. see Henshilwood and d'Errico 2011).

3 Does grammaticalization explain modern behavior?

The social life of *Homo erectus* and *Homo heidelbergensis* was complex and dependent on cooperation and this gives plausibility to the hypothesis that proto-language had reached significant complexity before the evolution of *Homo sapiens* and did not consist of a limited set of vocal and manual gestures. If this was the case, however, how can we explain the rapid growth in cultural innovation that coincides with the evolution of modern *Homo sapiens* and that is clearly in evidence in the archaeological record in Africa especially after 100 ka?

An essential attribute of cognitively modern societies is the capacity to create symbolic systems and to reflect these visibly in their material culture. Recognition of distinct symbols that impart different meanings by members of a social group requires that the material representations show morphological variation that imparts to each an “identity”. By identity we mean the collective aspect of the set of characteristics by which a symbolic item is recognizable or known. Symbols change through time because of remodeling of the original concepts. Individuals play a major role in this process, either stimulating changes in the meanings of symbolic representations or experimenting with novel material expression of the same concepts.

A key question is whether these mechanisms of cultural innovation are operant even among early *Homo sapiens*? In the archaeological record this should result in representations that are identifiable as instances of the same concept. Such representations may present morphological variability possibly attributed to the degree of freedom allowed to individuals responsible for their production, within societal norms, or to diachronic or regional changes within the symbolic tradition. Individual freedom is crucial for the evolution of a symbolic system and the degree of freedom may influence the rate of change in a system of beliefs. Innovation relates to individual freedom but if the innovators’ social group does not accept the novelty it will likely rapidly obsolesce. That same innovation may however, if transmitted, be acceptable to and spread within other groups that adhere to the same symbolic system of beliefs.

In previous papers (Henshilwood and Dubreuil 2009, 2011), we argue that the innovative technologies and social practices observed in the archeological record, mostly at and after c. 100 ka in Africa, provide evidence that humans were capable of creating rich symbolic systems. We contend that these innovations, described above, are not best explained by the evolution of language strictly construed (whether biological or cultural), but by a change in social cognition and perspective taking, the origins of which may (or may not) date back to the first

evolution of anatomically modern humans. Our argument is that innovations in material culture reveal *Homo sapiens*' unprecedented capacity to take into account the point of view of others, for example the use of personal ornaments and abstract engravings, the presence of polish and painting on stone and bone tools, the production of a bright red compound mixture (paint) applied to surfaces likely as decoration. Such innovations associated with *Homo sapiens* have one thing in common: they indicate an interest in how other people look at the material culture that is produced. Importantly, it also reflects that these people shared a symbolic system that had common meaning within their group and that this act of sharing codes applied probably both to their material and spiritual life.

However there is some disagreement as to whether personal ornaments, such as the shell beads found at Blombos and other sites in Africa and the Middle East, actually "symbolized" something. We think that, at a minimum, they provide evidence that their makers cared about their appearance and were ready to invest significant time and energy to meet meaningful esthetic standards. Our view is consistent with the idea that humans prior to *Homo sapiens* already had advanced social cognitive skills. If they did not, they would not have been able to engage, as they did, in highly demanding cooperative feeding and breeding. However, we believe they were not as adept as modern humans are in reconstructing the viewpoint of others. They could understand *what others were seeing*, but could not easily *imagine how they see it*. This distinction is captured in psychology by the concepts of "level-1" versus "level-2" perspective taking (Flavell 1992). Level-1 perspective taking is about understanding that someone can see something when it is in one's visual field, while level-2 is about understanding that this object might look different from another viewpoint.

Level-2 perspective taking is significantly more demanding at the cognitive level and appears later in child development. It is also closely related to other concepts in psychology, such as "theory of mind," the capacity to read the mental states of others. Some forms of theory of mind appear early in child development, as toddlers learn to infer others' goals, beliefs and intentions. The capacity to ponder and focus on more abstract mental states, however, develops much later, building on the development of more general cognition and long social learning.

This key distinction help us to explain why human populations prior to *Homo sapiens* were good at cooperating, yet they failed to create the kind of symbolic life that is central to modern humans. It also helps explain why cultural evolution accelerated with *Homo sapiens*. Arguably, humans' improved capacity to understand each other's viewpoint had a direct impact on their disposition to learn and transmit complex cultural practices. We assume that Arbib would agree with this view, as he recognizes the link between intention reading and complex imitation.

4 When did the language-ready brain first evolved?

Although we are in broad agreement with Arbib's evolutionary theory at the cognitive and neural levels, we question the way this story plays out at the archeological level. Arbib's argument is that the language-ready brain first evolved with *Homo sapiens* and that a long process was needed for fully-fledged language to evolve culturally. By contrast, we argue that the level of cooperation reached in the human lineage before *Homo sapiens* is consistent with the earlier evolution of key features of language through grammaticalization. If we are right, the cultural evolution of languages would not explain the rapid behavioral innovations associated with *Homo sapiens*.

This leaves open the question as to when the language-ready brain first evolved. We can give no definitive answer to this question. Language readiness results from a combination of several neurocognitive mechanisms, often independent of one another. The absence of one of these mechanisms may not have prevented the evolution of language, but may have led to the evolution of impoverished forms of language. The most likely scenario, in our view, is that the brain was almost language-ready significantly before *Homo sapiens* and that the cultural evolution of languages was well underway when the first *sapiens* evolved. This is not to say, however, that *Homo erectus* and *Homo heidelbergensis* were speaking languages totally akin to ours. Limitations in perspective-taking and mind-reading abilities might have prevented some features of modern human languages from evolving, such as metalinguistic awareness, irony, and potentially some complex syntactical structures.

To conclude, we emphasize that what we say is not inconsistent with the neurocognitive story that is at the center of Arbib's great book. We hope that our comments may contribute to improve the linkages with the archeological record, which, we think, should play a greater role in informing on the theories of language evolution.

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