<CT>Comparative analyses of speech and language converge on birds

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<C-AB>**Abstract**: Unlike non-human primates, thousands of bird species have articulatory capabilities that equal or surpass those of humans, and they develop their vocalizations through vocal imitation in a way that is very similar to how human infants learn to speak. An understanding of how speech mechanisms have evolved is therefore unlikely to yield key insights into how the human brain is special.

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Ackermann et al.'s efforts to understand the evolution of "brain mechanisms of acoustic communication" focus on neuroanatomical adaptations in non-human primates that may have enabled the evolution of articulated speech. Unlike these authors, however, we do not think that an understanding of how articulation evolved in terms of common descent from our primate ancestors must be key to an understanding of how the human brain is special. Particularly when it comes to speech and language, large-scale patterns of evolutionary convergence provide insights that are at least as important as insights from analyzing recent common descent.

Speech is one possible external interface for human language, and speech-like capabilities per se are not unique to humans or primates but are in fact widespread among species far removed from the primate clade. Ackermann et al. briefly mention songbirds as an experimental model system to study neural control of speech-like behavior, but at least as important is that from a broader comparative view, songbirds also provide important evolutionary insights. Not only do birds have structured, articulated vocalizations, but just like human infants, they acquire these vocalizations through imitation learning, a trait that is rare among mammals and appears to be completely absent in non-human primates. In addition, the way in which songbirds learn to sing is very similar to the way that human infants acquire speech. First, in both cases there is a sensitive period during which learning proceeds optimally. Second, developing individuals go through a transitional phase of vocal development, which is called "babbling" in infants and "subsong" in songbirds (Bolhuis & Everaert 2013; Bolhuis et al. 2010). In both species, vocal imitation and learning typically play a large role, though as noted above, in humans, the interface modality can be gestures rather than speech. Beyond their human-like way of acquiring their vocalizations, many songbird and parrot species also produce highly virtuoso vocalizations, using special adaptations for phonation and articulatory control. Birds have evolved a specialized organ, the syrinx, solely for vocalization, unlike the human larynx. In songbirds, this organ is bipartite, enabling them, for example, to sing with two independent voices at the same time, to use one side for singing and the other side for respiration to avoid running out of breath, or to use one voice for low registers and the other one for high registers. Further, vocal articulation in birds is not restricted to this specialized organ, but also includes fast lingual and oropharyngeal movements that either support voice articulations or add another layer of complexity on top of it (Beckers 2013; Beckers et al. 2004). In short, there is no question that the vocal capabilities of many species of birds surpass those found in any other clade, including humans.

Vocal virtuosity in birds serves a variety of functions, including the social ones that Ackermann et al. suggest played a role in human speech evolution. Articulatory and vocal imitation capabilities have existed in these large clades for at least 50 million years (Jarvis 2004), providing ample opportunity for evolutionary tinkering, especially given that birds are very diverse in terms of ecology and behavior. Despite this, none of the many thousands of extant species of vocal learning birds have so far been reported to possess a "special" brain. This comparative result suggests that Ackermann et al. place too much weight on the notion that the evolution of more versatile call-like vocalizations for improved communication in our hominin ancestors played a crucial role in the origin of any traits that may be uniquely human.

Regarding the mechanisms underlying vocal behavior, Ackermann et al. discuss the neural and genetic (FOXP2) parallels between humans and non-human primates in some detail. Here too, common descent may not be a reliable guiding principle for comparative research, because changes in FOXP2 are implicated not only in differences between humans and non-human primates, but also other mammals (e.g., bats and cetaceans) as well as birds. Songbirds also have a FOXP2 gene that differs very little from the human variant. Moreover, in zebra finches the FOXP2 gene is apparently involved in vocalization and vocal learning, as it is in humans (Bolhuis & Everaert 2013; Bolhuis et al. 2010). Additionally, in comparison with humans, songbirds have analogous (and perhaps homologous) brain structures that are involved in vocal production and auditory perception and memory (Bolhuis et al. 2010).

Arguably, an important reason for the uniqueness of the human brain/mind is our capacity for language per se, rather than articulatory competence (Berwick et al. 2013). Given the already strong parallels between humans and songbirds in terms of auditory–vocal imitation learning, and the often remarkable articulatory skills in many avian species, it is reasonable to ask whether songbirds also possess human-like syntactic abilities (Berwick et al. 2011). Recent claims of such syntactic abilities in songbirds (e.g., Abe & Watanabe 2011) have been shown to be based upon flawed experimental methodologies (Beckers et al. 2012). Nevertheless, we argue that the absence of evidence for human-like combinatorial abilities in songbirds does not as of yet constitute evidence of their absence. Should such syntactic capabilities be present in non-human animals, songbirds would prove more likely candidates for comparative evolutionary analysis than apes or monkeys. Taken together with the neurocognitive parallels between birdsong and human speech that we sketched above (Berwick et al. 2011; 2013; Bolhuis et al. 2010), this has important consequences for any evolutionary interpretation of speech and language.

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