Experimental Evidence for Phonemic-like Contrasts in a Nonhuman Vocal System

SIMON W. TOWNSEND
Department of Psychology, University of Warwick
Coventry, United Kingdom
simon.w.townsend@warwick.ac.uk

ANDREW F. RUSSELL
Department of Biosciences, University of Exeter, United Kingdom
a.russell@exeter.ac.uk

SABRINA ENGESSER
Department of Evolutionary Biology and Environmental Studies, University of Zurich
Zurich, Switzerland
sabrina.engesser@ieu.uzh.ch

The capacity to generate new meaning through rearranging combinations of meaningless sounds, so-called phoneme structuring, is a fundamental component of language and is central to its productive nature (Hurford 2011). Despite its importance, surprisingly little is known about how unique this capacity is to humans or indeed the evolutionary steps that characterised its emergence. Animal vocalizations have been shown to often comprise combinations of meaningless acoustic elements, for example humpback whales (*Megaptera novaeangliae*), gibbons (*Hylobates spec.*), and a number of passerine birds, are capable of constructing elaborate and meaningful "song" vocalisations from a variety of meaningless call elements. A hierarchical structure is ultimately achieved through an assembling of the single units in a potentially rule-governed way, in some cases reaching a considerable level of complexity (Payne and McVay 1971, Clarke et al. 2006, Berwick et al. 2012). However, evidence that rearranging such combinations generates functionally distinct meaning is

lacking (Berwick et al. 2011). Here we provide evidence for this basic ability in calls of the chestnut-crowned babbler (*Pomatostomus ruficeps*), a highly social bird of the Australian arid zone. Using acoustic analyses, natural observations and a series of controlled playback experiments, we demonstrate that this species uses the same acoustically distinct elements (*A* and *B*) in different arrangements (*AB* or *BAB*) to create two functionally distinct vocalizations: the flight call (used during movement, *AB*) and the prompt call (used when provisioning nestlings, *BAB*). Specifically, the addition or omission of a contextually meaningless acoustic element at a single position generates a phoneme-like contrast that is sufficient to distinguish the meaning between the two calls. Our results indicate that the capacity to rearrange meaningless sounds in order to create new signals occurs outside of humans. We discuss the implications of our data for understanding the evolutionary progression of phoneme structuring and suggest that basic phonemic contrasts represent a rudimentary form of phoneme structure, and a potential early step towards the generative phonemic system of human language.

References

Berwick, R.C., Okanoya, K., Beckers, G. I. J. L., & Bolhuis, J. J. (2011). Songs to Syntax: the Linguistics of Birdsong. *Trends in Cognitive Sciences*, 15(3):113–121.

Berwick R.C., Beckers, G.J.L., Okanoya, K. & Bolhuis, J.J. (2012). A Bird's Eye View of Human Language Evolution. *Frontiers in Evolutionary Neuroscience* 4: 5. pmid:22518103

Clarke, E., Reichard, U. H. & Zuberbühler, K. (2006). The Syntax and Meaning of Wild Gibbon Songs. *PLoS ONE* 1(1): e73.

Hurford, J.R. (2011). *The Origins of Grammar: Language in the Light of Evolution*. Oxford University Press.

Payne, R.S. & McVay, S. (1971). Songs of Humpback Whales. *Science*, 173(3997):585–597.