DOMESTICATION AND EVOLUTION OF SIGNAL COMPLEXITY IN FINCHES

KAZUO OKANOYA

Department of Cognitive and Behavioral Sciences, The University of Tokyo
Tokyo, Japan
cokanoya@mail.ecc.u-tokyo.ac.jp

Among vocalizations birds make, a class of sounds that are consisted of more than two types of sound patterns arranged in a certain temporal sequence is called as a 'birdsong', not only because of the organization of sound patterns, but also because our musical aesthetics intuitively allow such an analogy. Scientific investigations of birdsong to date suggest that certain properties of birdsong extend beyond the musical to the developmental analogies.

Bengalese finches are domesticated strains of wild white-rumped munias imported from China to Japan 250 years ago. Bengalese finch songs are composed of multiple chunks and each chunk is a combination of 2-4 song notes. Furthermore, chunks are arranged in a finite-state probabilistic automaton. We studied how and why Bengalese finches sing such complex songs. We found the following facts. 1) The ancestral strain sing simpler songs. 2) There is high learning specificity in white-rumped munias but not in Bengalese finches. 3) Bengalese finches have larger song control nuclei and higher level of glutamate receptor gene expressions than white-rumped munias. 4) Both Bengalese finch and white-rumped munia females prefer complex songs as measured by the nest string assay and males with complex songs are physically fitted than the males with simpler songs. These results promoted sexual selection scenario of song complexity in Bengalese finches (Okanoya, 2004).

We further examined factors related with domestication. We examined songs of white-rumped munias in subpopulations of Taiwan (Kagawa, et al., 2012). Where there is a sympatric species to white-rumped munias, songs were simpler. This leads to a hypothesis that in the wild songs needed to be simple to secure species identification, but under domestication this constrains was set free. Not only that, analyses of isolated songs and cross-fostering results suggest that there are different degrees of learnability between white-rumped munias and Bengalese finches (Takahasi, et al, 2010; Kagawa et al, 2014).

Furthermore, recent suggestion of neural crest hypothesis that might account for the "domestication syndrome" fits well with the properties of Bengalese finches (Wilkins, et al., 2014). For example, Bengalese finches are sooner to recover from tonic immobility test than white-rumped munias (Suzuki, et al., 2013. Feces corticosterone level is lower in Bengalese finches (Suzuki, et al., 2014). Biting force is stronger in white-rumped munias than Bengalese finches, and time required to come back to the food cup after a foreign object was placed was quicker in Bengalese finches (Suzuki et al., in prep; Ikebuchi et al., in prep). All of these result suggest that the difference between Bengalese finches and white-rumped munias in socio-emotional factors might be related with the limited diffusion of the neural crest cells, since these properties are controlled by cells derived from the neural crest cells (Wilkins, et al,. 2014).

Thus, evolution of song complexity involves not only factors related with strengthen of sexual selection and relaxation of species identification, but also socio-emotional factors due to domestication. These results on Bengalese finches must be useful in discussing possible biological origin of human speech in terms of proximate and ultimate factors. (Work supported by Kakenhi #15K14581)

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