Letter to Editor

Responses of incubating females to female cuckoo calls in 2 hole-nesting bird species

Chao SHEN\textsuperscript{a,b}, Jiangping YU\textsuperscript{a,c}, Xudong LI\textsuperscript{a,b}, Jing YUE\textsuperscript{a}, Haitao WANG\textsuperscript{a,*,d}, and Wei LIANG\textsuperscript{d, *}

\textsuperscript{a}Jilin Engineering Laboratory for Avian Ecology and Conservation Genetics, School of Life Sciences, Northeast Normal University, Changchun, 130024, China, \textsuperscript{b}Jilin Provincial Key Laboratory of Animal Resource Conservation and Utilization, School of Life Sciences, Northeast Normal University, Changchun, 130024, China, \textsuperscript{c}Ministry of Education Key Laboratory of Vegetation Ecology, School of Life Sciences, Northeast Normal University, Changchun, 130024, China, and \textsuperscript{d}Ministry of Education Key Laboratory for Ecology of Tropical Islands, Key Laboratory of Tropical Animal and Plant Ecology of Hainan Province, College of Life Sciences, Hainan Normal University, Haikou, 571158, China

*Address correspondence to Haitao Wang. E-mail: wanght402@nenu.edu.cn and Wei Liang. E-mail: liangwei@hainnu.edu.cn

Handling editor: Zhi-Yun Jia

Received on 20 October 2020; accepted on 15 December 2020

Key words: antipredator behavior, cinereous tit, “sparrowhawk-like” mimicry, vocal mimicry, yellow-rumped flycatcher

Acoustic signals play an important role in animal communication systems, and these signals can transfer diverse and meaningful information from a signaler to a receiver (e.g., Yu et al. 2019). Animal signals tend to be honest; however, deception can occur when it is beneficial for receivers to send dishonest signals, such as by mimicking alarm calls to steal food from other individuals (Flower et al. 2014). In birds, vocal mimicry is a widespread phenomenon that has 2 major functional explanation categories: intraspecific and interspecific communications (Dalziell et al. 2015). Vocal mimicry in intraspecific communication mainly involves sexual selection and social affiliation (Dalziell et al. 2015). In interspecific communication, studies on vocal mimicry are mostly related to predator–prey interactions (Dalziell et al. 2015). Mimics could mimic calls of predators to scare off other predators or competitors. For example, some species of hole-nesting birds produce a snake-like hissing call to drive nest predators away (e.g., Dutour et al. 2020). Receiver should be particularly sensitive to the deceptive vocals of mimics if failing to respond to an actual model sound is costly. Therefore, the mimics could derive an advantage from mimicking the calls of predators of the receivers. A recent experimental study suggested that the bubbling calls of female common cuckoo \textit{Cuculus canorus} mimic those of Eurasian sparrowhawk \textit{Accipiter nisus}, and they primarily serve to distract regular hosts after laying eggs (York and Davies 2017). However, Xia et al. (2019) found that female cuckoo calls have other functions, including attracting mates and repelling rivals.

Hole-nesting species, such as cinereous tits \textit{Parus cinereus} and yellow-rumped flycatchers \textit{Ficedula zanthopygia}, are sympatric during the breeding period in the Zuojia Nature Reserve of China. This population of cinereous tits showed a 70% egg-rejection rate (Liang et al. 2016), implying that they may be currently parasitized or have historically interacted with parasites. However, yellow-rumped flycatchers generally do not reject foreign eggs (W. Liang et al. unpublished data) and have not been recorded as hosts for various cuckoo species. York and Davies (2017) suggested that the acoustic characteristics of female cuckoo calls are similar to those of sparrowhawk calls and the 2 calls could elicit vigilance behavior in regular hosts and noncuckoo hosts. In this study, we played another sparrowhawk calls types (see Supplementary Figure S1) and female cuckoo calls for cinereous tits and yellow-rumped flycatchers to test whether the functions of female cuckoo calls and sparrowhawk calls are similar. We hypothesized that 1) if the function of the 2 calls is similar, then the 2 bird species should exhibit similar behavior to female cuckoo and sparrowhawk calls; and 2) if the function of the 2 calls is different, then the 2 bird species should exhibit different behavior to female cuckoo calls and sparrowhawk calls.

Playback experiments for 27 incubating yellow-rumped flycatchers and 17 incubating cinereous tits were conducted during the incubation period (April–May for tits and May–June for flycatchers) in 2017 and 2020, respectively. Calls of female cuckoo, male cuckoo, Eurasian sparrowhawk, and Oriental turtle dove \textit{Streptopelia orientalis} (neutral control) were used to study the effect of the 4 call types.
on the antipredator behavior of 2 hole-nesting birds species. Before
the experiments started, it was confirmed that the females were
incubating and inside the nest, and then the researchers conducted
30s playback experiments. We scored the playback response of tits
and flycatchers during 30s of observation and used a generalized
linear mixed model to analyze the difference in response scores of
the 2 birds species to the 4 types of calls (detailed methods are
described in the Supplementary Materials). In the playback experi-
ment for cineereous tits, the playback response scores varied signi-
fi cantly across the 4 types of calls (GLMMs, $\chi^2 = 11.226; P = 0.01; n = 17$). The playback response score to sparrowhawk calls was
greater than that to dove calls or male cuckoo calls (Figure 1; Supplemen-
tary Table S1). Similarly, the playback response score to female cuckoo calls was greater than that to dove calls or male
cuckoo calls (Figure 1; Supplementary Table S1). However, signifi-
cant differences in the playback response scores were not observed
between the female cuckoo calls and sparrowhawk calls or between
the male cuckoo calls and dove calls (Figure 1; Supplementary Table
S1). For yellow-rumped flycatchers, significant differences in the
playback response scores were not observed to the 4 types of calls
(GLMMs, $\chi^2 = 5.747; P = 0.14; n = 27$; Figure 2).

**Figure 1.** Responses of cineereous tit to calls of female cuckoo, sparrowhawk,
dove, and male cuckoo.

**Figure 2.** Responses of yellow-rumped flycatcher to calls of female cuckoo,
sparrowhawk, dove, and male cuckoo.

Our results indicated that the 2 hole-nesting birds adopt different
antipredator strategies when confronted with 4 types of calls. Most
cineereous tits stared at the entrance or had no response in the
nest box and did not leave the nest when hearing the 4 types of calls
(Figure 1). Small entrances could prevent large species (e.g., nest
predators and raptors) from entering hole nests. Therefore, incuba-
ting female tits may not be required to escape from the nest box
when hearing the 4 types of calls. However, sparrowhawk calls still
represent a threat for adults of cineereous tits, and more than half of
female tits exhibited vigilance behavior in the nest after the sparrow-
hawk calls; however, almost all individuals did not respond to the
innocuous calls of the dove and male common cuckoo (Figure 1). In
addition, female tits responded similarly to female cuckoo calls and
sparrowhawk calls, suggesting that the population of tits in our
study area cannot differentiate the “sparrowhawk-like” calls of fe-
male cuckoo and regard them with the same level of risk as the spar-
rowhawk calls. Similar results were found in the studies of York and
Davies (2017). To the human ear, the female common cuckoo call is
quite different from the sparrowhawk call; thus, why are female tits
deceived by this imperfect vocal mimicry? Previous studies found
that superb fairy-wrens *Malurus cyaneus* respond strongly to rela-
tively dissimilar unfamiliar calls because the frequency of these calls
resembles that of a sympatric species call, which suggests that some
similar acoustic characteristics can promote responses to unfamiliar
heterospecific calls (Fallow et al. 2011). Hence, the similar acoustic
features, including the fundamental frequency and rate, between
female cuckoo calls and sparrowhawk calls (York and Davies 2017)
may be sufficient to trick female tits and generate a response to the
female cuckoo “sparrowhawk-like” calls. Vocal mimicry among
heterospecific species generally occurs in the context of predation
pressure (Dalziell et al. 2015), and the receivers will tend to avoid
the truly threatening model and the mimics that they identify as
presenting the same level of risk. Therefore, female cuckoos derive
an advantage from mimicking sparrowhawk calls. However, most
female yellow-rumped flycatchers stepped onto the nest entrance
and left the nest box in response to 4 types of calls (Figure 2).
Yellow-rumped flycatchers are very prudent, and they may not as-

**Ethical Standards**

The experiments comply with the current laws of China. Fieldwork
was carried out under the permission from Zuojia Nature Reserve.
Experimental procedures were permitted by National Animal
Research Authority in Northeast Normal University (approval num-
ber: NENU–20080416).
Acknowledgments
We thank Zuojia Nature Reserve for their support and permission to carry out this study.

Funding
This work is supported by the National Natural Science Foundation of China (31770419 and 31971402 to H.W., 31772453 and 31970427 to W.L., and 32001094 to J.Y.), the Science and Technology Research Project of the Education Department of Jilin Province (JJKH20190281K).

Authors’ Contributions
H.W. and W.L. conceived and designed this study. C.S., X.L., and J.Yue. carried out field experiments. J.Yu and C.S. performed data analyses. C.S. and J.Yu. drafted the manuscript, and W.L. and H.W. involved in discussion and revised the manuscript. All authors read and approved the final manuscript.

Conflict of Interest
We declare that all authors have no competing interest.

Supplementary Material
Supplementary material can be found at https://academic.oup.com/cz.

References
Bouskila A, Blumstein DT, 1992. Rules of thumb for predation hazard assessment: predictions from a dynamic model. Am Nat 139:161–176.
Dalziell AH, Welbergen JA, Iglis B, Magrath RD, 2015. Avian vocal mimicry: a unified conceptual framework. Biol Rev 90:643–668.
Dutour M, Lévy L, Lengagne T, Holveck M-J, Crochet P-A et al., 2020. Hissing like a snake: bird hisses are similar to snake hisses and prompt similar anxiety behavior in a mammalian model. Behav Ecol Sociobiol 74:1.
Fallow PM, Gardner JL, Magrath RD, 2011. Sound familiar? Acoustic similarity provokes responses to unfamiliar heterospecific alarm calls. Behav Ecol 22:401–410.
Flower TP, Gribble M, Ridley AR, 2014. Deception by flexible alarm mimicry in an African bird. Science 344:513–516.
Liang W, Møller AP, Stokke BG, Yang C, Kovařík P et al., 2016. Geographic variation in egg ejection rate by great tits across 2 continents. Behav Ecol 27:1403–1412.
Suzuki TN, 2015. Assessment of predation risk through referential communication in incubating birds. Sci Rep 5:10239.
Xia C, Deng Z, Lloyd H, Møller AP, Zhao X et al., 2019. The function of three main call types in common cuckoo. Ethology 125:652–659.
York JE, Davies NB, 2017. Female cuckoo calls misdirect host defences towards the wrong enemy. Nat Ecol Evol 1:1520–1525.
Yu J, Lu H, Sun W, Liang W, Wang H et al., 2019. Heterospecific alarm-call recognition in two warbler hosts of common cuckoos. Anim Cogn 22:1149–1157.