

component to allow for intracellular action. Clinical trials have been launched in recent years to validate their therapeutic benefits.

**What remains to be studied about galectins?** Several aspects of galectin glycobiology remain relatively underexplored. In many tissues more than one galectin subtype is expressed: what is the relationship between these galectins and how might they compensate for each other's functions? On the structural level, it is still unclear how ligand binding and structural alterations affect galectin-dependent clustering of glycolipids or glycoproteins. The fate of galectin-carrying extracellular vesicles and their role in the whole organism also await further study. Clarifying these issues should help in the development of therapeutic strategies for galectin-associated diseases.

#### Where can I find out more?

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## Correspondence

# Bats mimic hymenopteran insect sounds to deter predators

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Mimicry is one of the most fascinating phenomena in nature<sup>1</sup>. Mimicry traits often reflect complex, finely tuned, and sometimes extravagant relationships among species and have evolved to deceive predators or prey. Indeed, mimicry has most often evolved to discourage predation: the 'mimic' exhibits phenotypic convergence towards a non-related 'model' organism which is inedible or harmful, so that a given predator, or 'receiver', will refrain from attacking or ingesting the mimic. Traditionally, mimicry is mainly evident and has been mainly studied in the visual domain. Here, we report experiments that document the first case of interspecific acoustic mimicry in a mammal and demonstrate that the distress calls the greater mouse-eared bat (*Myotis myotis*) broadcasts when handled imitate sounds of stinging bees or wasps to discourage the bat's avian predators.

Among animals, mimicry is well-known<sup>2,3</sup>, yet in most cases, it only concerns visual resemblance between mimics and models. Despite the importance of acoustic signals in animal communication, antipredatory acoustic mimicry has been long neglected. Acoustic mimicry occurs when the receiver alters its behaviour after detecting the acoustic resemblance between the mimic and the model such that it confers a selective advantage to the mimic. Establishing the different mechanisms by which sound deters predators is based on how receivers respond to the signal, and on the existence of a model<sup>4</sup>. Aposematism is the exposure of characteristics or behaviours associated with unpalatability and requires a predator to learn such associations<sup>5</sup>. In turn, mimicry exploits the experience gathered by the receiver during interactions with an aposematic signaller, and it may (Müllerian mimicry) or not (Batesian mimicry) be

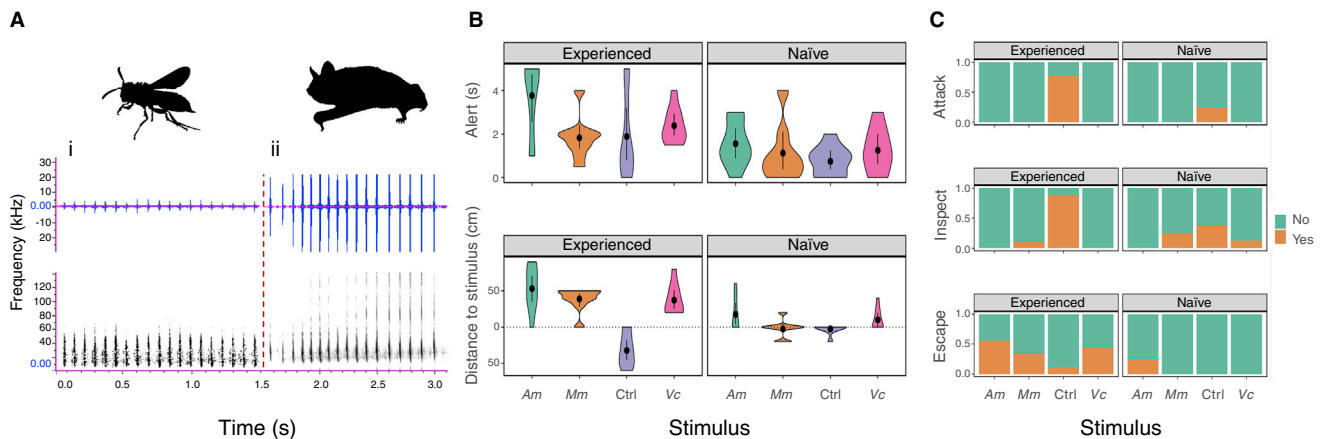
associated with unpalatability. Finally, startling sounds discourage the receiver from attempting predation for the short time the prey needs to evade the attack<sup>6</sup> and require no learning by the receiver.

In our experiments, we first compared the acoustic similarity between the buzzing sounds emitted by distressed *M. myotis* and those four species of social hymenopterans produce when handled by exploring the degree of multivariate separation in acoustic structure. We next conducted playback experiments by broadcasting bat, hymenopteran and control sounds to captive adult owls (eight barn owls, *Tyto alba*, and eight tawny owls, *Strix aluco*). Each owl was exposed once to each treatment (a buzz from *M. myotis*, from honeybees, *Apis mellifera*, from hornet, *Vespa crabro*, and a non-buzzing bat sound as control). We video recorded the owls' behaviours during and after each playback and tested whether behavioural responses differed according to treatment. We scored owls' specific behaviours (classified as 'alert', 'attack', 'escape' and 'inspection'; Supplemental information) as well as their spatial response ('avoidance' or 'attraction'). To assess if mimicry actually occurred, we included as experimental subjects both wild owls, expected to be potentially experienced with bats and hymenopterans, and captive-raised individuals (four individuals per species), considered as fully naïve to the selected stimuli.

When handled, bats and insects readily produced distress buzzes (sequences of steep frequency-modulated calls/clicks at high repetition rates; Figure 1A and Data S1A). Multivariate discrimination among bats and hymenopterans, yet this measure dropped to 53.7% when only call variables comprised within the owl's hearing range were considered, with higher confusion rates between calls of *M. myotis* and sounds of *V. crabro*. Namely, *M. myotis* signals were, overall, misclassified in 15.2% of cases, 88.9% of which as *V. crabro*; the latter species was misclassified in 50.7% of cases, 68.8% of which as *M. myotis* (Data S1B).

Behavioural responses by owls were significantly influenced by individual experience, stimulus type, and their interaction (Data S1C). Owls consistently reacted to hymenopteran and bat buzzes in the same way, by increasing the distance from the speaker, whereas





**Figure 1. Structural resemblance between bat and hymenopteran buzzes, and behavioural responses of owls towards buzzes and control stimuli.** (A) Oscillogram (upper row) and spectrogram (lower row) of buzzes emitted by distressed (i) European hornets (*Vespa crabro*), and (ii) Greater mouse eared bats (*Myotis myotis*); the dashed vertical line indicates species separation. (B,C) Behavioural responses by 16 captive owls (*Tyto alba*, n = 8; *Strix aluco*, n = 8) to the playback of four acoustic stimuli (Am: buzz of domestic bee *Apis mellifera*; Ctrl: control stimulus, a social call by European free-tailed bat *Tadarida teniotis*; Mm: distress buzz of Greater mouse-eared bat *Myotis myotis*; Vc: buzz of European hornet *Vespa crabro*), separately for experienced (n = 8) and ‘naïve’ (n = 8) individuals. Scored behaviours include both quantitative responses (B) and occurrence rates (C). Statistical significance of post-hoc pairwise comparisons between Control and each other stimulus: \*: p < 0.05; \*\*: p < 0.01; n.s.: non-significant.

they approached the latter in response to the control stimulus, as expected from a non-mimetic vocalization produced by potential prey. This spatial response was more pronounced in experienced vs. naïve owls (Figure 1B). The stimulus type *per se* influenced the behaviour of potential predators — control sounds elicited such behaviours more frequently than did buzzes. Moreover, experienced owls inspected the stimulus source and performed escape attempts more often than naïve individuals (Figure 1C). In all cases, post-hoc comparisons resulted in significant differences among responses to control *versus* each of all other stimuli (all p < 0.05; Data S1D).

We show that the buzzes emitted by a distressed bat resemble those of noxious hymenopteran insects when the acoustic parameters taken for comparison are those falling within an owl’s hearing range, and also that insect and bat buzzes exert a consistent avoidance reaction in avian predators. We thus provide strong support for a novel Batesian acoustic mimicry system, involving a mammal as the mimic, insects as models, and predatory birds as receivers. This represents the first documented example of mimicry between mammals and insects and is one of the few examples of acoustic mimicry systems known to date.

Our results fit into a framework<sup>7,8</sup> according to which mimetic systems comprise three actors (model, mimic and receiver), and show that mimicry

may be tuned to the species-specific perceptual abilities of one or more receivers, conspecifics included, to elicit behavioural or physiological responses.

Several bat species emit buzzes, usually at higher frequencies than those of *M. myotis*<sup>9</sup>. Other animal species inhabiting tree or rock cavities also buzz when disturbed at their nest, and their sounds have been sometimes described as similar to those of bees, as in North American flickers (*Colaptes auratus*)<sup>10</sup>. Therefore, the system we describe may represent an example of a more common phenomenon. However, whether other taxa play a role in a widespread acoustic mimetic system, with vertebrates mimicking insect models, has yet to be tested, opening new avenues for further research on the ecological interactions that lead to signal evolution in animal interspecific communication.

#### SUPPLEMENTAL INFORMATION

Supplemental information including one figure, acknowledgements, inclusion and diversity statement, experimental procedures, one data file and supplemental references can be found at <https://doi.org/10.1016/j.cub.2022.03.052>.

#### DECLARATION OF INTERESTS

The authors declare no competing interests.

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