Effects of compensatory neuroplasticity on negative phonotaxis in *Gryllus bimaculatus*

Will Logue, Class of 2026

The Mediterranean field cricket, *Gryllus bimaculatus*, has developed a specialized auditory system to detect mates and evade predators. Each foreleg has a tympanic membrane connected to an acoustic tracheal system, enabling directional hearing (Celiker et al., 2020). Neurons AN1 and AN2 in the prothoracic ganglion process these signals: AN1 responds to ~5 kHz cricket calls, while AN2 detects 12–100 kHz bat calls. The result is negative phonotaxis, in which crickets turn away from bat calls (Hill and Boyan, 1976; Nolen and Hoy, 1986; Rau et al., 2015).

Remarkably, when a cricket loses an ear, its auditory neurons exhibit anatomical plasticity: severed AN1 and AN2 neurons extend dendrites across the body's midline—an unusual process under normal conditions—and form new synaptic connections with neurons from the intact ear (Brodfuehrer and Hoy, 1988; Horch et al., 2017). This adaptation likely confers survival benefits, though its behavioral significance is not well understood.

Previous studies suggest that crickets deafferented after full auditory development may partially restore sound localization, often reflected in reduced turning angles toward bat calls from the deafferented side. This study investigates this phenomenon by comparing intact and deafferented crickets' turning direction, intensity, and latency throughout adulthood using the machine learning pose estimation software, DeepLabCut

To elicit negative phonotactic behavior, crickets were placed in a custom wind tunnel and suspended in the airstream using a wax mount. Bat calls were played alternately from left or right speakers, and half of the crickets were deafferented (removal of one ear) while the other half underwent a foot removal procedure to control for injury effects. Immediately after deafferentation, crickets consistently turned toward the deafferented side, perceiving all sound through the intact ear. Over subsequent flights, turning responses were tracked to assess behavioral recovery as regrowing auditory neurons established cross-midline connections.

In intact crickets, analysis of abdomen position over time confirmed consistent turns away from the sound source. While analysis is ongoing, deafferented crickets showed no restoration of correct turning behavior, but turn intensity towards the deafferented side may be reduced. In order to understand the typical behaviors of both deafferented and intact crickets, the abdomen position, as tracked by DeepLabCut, of crickets in the same group will be averaged and compared to averages of the other group. By averaging the data from each flight, we hope to produce a more robust quantitative standard for flying behaviors and identify whether deafferents regain any sound localization.

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