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Digest: New insight into sensory trade-off in phyllostomid bats*

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Do the relative size of the olfactory bulb, cochlea, and orbit correlate with diet in phyllostomid bats? Hall et al. (2021) found that the degree of frugivory is positively correlated with the relative size of the olfactory bulb and the orbit. The degree of animalivory is negatively correlated with the relative size of the olfactory bulb and the orbit. Finally, the degree of nectarivory is negatively correlated with the relative size of the cochlea.

The relative size of one particular sensory organ is generally discussed in the light of ecological, phylogenetic, and developmental constraints. However, very few studies have included several sensory structures and properly tested for potential trade-offs (e.g. Martinez et al. 2020). Previous studies demonstrated that some nectar-feeding phyllostomid bats used a combination of olfactory and acoustic (echolocation) cues to detect and localize open flowers (e.g. Gonzalez-Terrazas et al. 2016). However, nothing is known on the co-variation and the potential trade-off between the three key sensory structures: the olfactory bulb, the orbit, and the cochlea (Fig. 1).

In their study, Hall et al. (2021) used diffusible iodine-based contrast-enhanced computed tomography (diceCT) on 79 bats. This method enables the contrast enhancement of soft tissues, allowing them to be isolated (segmentation) and their volume to be extracted. However, due to the constraints of the method, such a large dataset is extremely rare. Based on the extracted volume, the authors sized sensory structures with cranial centroid size using phylogenetic generalized least squares (PGLS).

Hall et al. (2021) demonstrated a relationship between diet and these sensory structures. Indeed, among phyllostomids, the

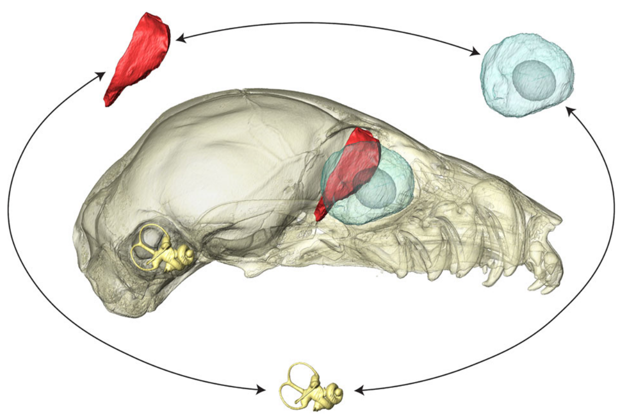

Figure 1. **Sensory structures may differentially covary with each other and between bat species. Sagittal view of the skull of Davy's naked-backed bat (*Pteronotus davyi*) with 3D representations of olfactory bulb (red), orbit (gray), and cochlea (yellow). Raw data has been extracted from the open data-based morphosource (Boyer et al. 2017). Segmentation and illustration: Quentin Martinez & Arthur Naas.**

average proportion of the olfactory bulb and cochlea is the highest in animalivores (Hall et al. 2021, Fig. 4). Also, the average proportion of the orbit is the highest in frugivores (Hall et al. 2021, Fig. 4). However, at a finer scale, the pattern of covariation is complex and not only explained by diet. As an example, for a given relative size of orbit, animalivores could have a similar or very different relative size of olfactory bulb (Hall et al. 2021,

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Fig. 2). Similarly, for a given relative size of olfactory bulb, animalivores could have a similar or very different relative size of cochlea (Hall et al. 2021, Fig. 2). Overall, their results demonstrated that these three sensory structures may differentially covary with each other and between bat species. This may be the result of different selective pressures. As an example, the masticatory apparatus arises early during ontogeny and may constrain the subsequent development of sensory structures as well as the general skull shape (Smith et al. 2021). Finally, different patterns of modularity have been found between visually oriented nonecholocators and echolocators bats (Arbour et al. 2021). In the light of these results, the patterns shown by Hall et al. (2021) might suggest an interaction between sensory structures and the overall skull shape.

Further investigations and statistical approaches will be necessary to know if some species are less affected by sensory tradeoff than others. Finally, more performance studies are needed to understand how the relative size of the sensory structures affects species abilities. This is particularly necessary for the olfactory bulb.

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