English abstract

An animal's perception of the world goes necessarily through its senses and an animal primary sensory modality shapes the way it interacts with the environment. Bats are famously known to actively use sound to perceive their surroundings, an ability called echolocation. But contrary to popular belief echolocating bats are not blind. All known species of bats possess eyes, and evidence shows that eyes that are not used degrade over evolutionary periods of time. Therefore, vision must be of ecological relevance to all bats. Non-echolocating bats use vision to forage and navigate. Echolocating bats by contrast use their vision mainly to navigate, and blinded bats are less likely to find their way back to a roosting site than non-blinded bats. Moreover, some echolocating bats, when foraging near vegetation, will use vision rather than echolocation to catch their prey, and in some cases echolocating bats give precedence to visual cues over auditory cues even if it is detrimental to them.

In this doctoral thesis I studied vision in both echolocating and non-echolocating bats. With colleagues I explored the evolution of echolocation and vision by measuring ocular and auditory investment in a large number of bat species and found evidence that the common ancestor to bats was probably able to use echolocation, and that echolocating bats have smaller eyes than their non-echolocating counterparts. We found that echolocating bats probably evolved to rely more heavily on echolocation, whereas non-echolocating bats evolved to rely more heavily on vision. We also studied behaviourally the absolute visual threshold of an echolocating bat (*M. daubentonii*), and found that its threshold of vision was low enough for it to be able to effectively use vision at night. Finally, we compared the number and distribution of retinal ganglion cells in four species of bats; two herbivorous species that are unable to use echolocation, one herbivorous species that uses tongue-click echolocation, and an insectivorous species that uses laryngeal echolocation. We find that the herbivorous bats have a retinal specialisation that allows them to have better resolution of objects directly in front of them, whereas the insectivorous bat has two specialisations; one to have a better resolution of the sky and the other to have a better resolution of what is below it. The former specialisation has been described in bats previously, but the latter is a new discovery and might be explained by the ecology of this bat; hunting insects on or close to water surfaces. Further studies of vision in both echolocating and non-echolocating bats will help us understand more extensively the potential trade-offs between vision and echolocation.