

**OUTSIDE JEB****Head-bobs in birds: the eyes have it**

The term head-bobbing, used for the apparent back and forth movement of the head of some birds while walking on the ground (think pigeons), is a bit of a misnomer. These birds don't actually bob their heads back and forth – instead, they move their body forward, leaving the head behind, then thrust their head forward past their body (hold, high-speed thrust!). This innate behaviour is believed to help several key aspects of vision during locomotion and foraging. While the head is still, images are stabilized on the retina and moving objects become clear against the background, and during the thrust phase, depth perception becomes more accurate. Although the benefit to vision may be clear, there remains some debate as to whether head-bobs and leg movements are synchronized or coordinated during terrestrial locomotion in birds, and how head and leg movements may affect each other. In a recent paper in *Ibis*, Jennifer Hancock of Marietta College, USA, and colleagues Nancy Stevens and Audrone Biknevičius of Ohio University Heritage College of Osteopathic Medicine, USA, studied heartily head-bobbing, rapidly running elegant-crested tinamous in order to shed light on this kinematic conundrum.

To test whether head-bobbing and leg movements during terrestrial locomotion were synchronized or coordinated in birds, Hancock and her colleagues filmed three elegant-crested tinamous as they moved at a range of speeds across a track, and recorded the forces of each foot movement. They then analyzed the timing of the beginning of each type of

event (head hold and thrust phases, and touchdown and liftoff of each foot) to determine the relationship between head and leg movements. They also estimated the pitch of the body during walking and running, to determine whether head-bobbing tilted the bird's body forward or backward during locomotion.

Hancock and her colleagues found that as the tinamous ran faster, the hold phase of the head-bob did not occur. Essentially, they ran with their head thrust forward, a result also seen in pigeons. The most striking finding, however, was that head-bobbing and leg movements were not well coordinated in most of the trials they performed. Interestingly, although the head and leg movements of Tinamous were not coordinated in this study, head-bobbing did appear to affect locomotion. When tinamous walked slowly, the steps that coincided with a hold phase of the head were held for longer – to help smooth out that stride while images were being stabilized on the retina. Lastly, they found that the body pitched forward, again during the critical hold phase, to help stabilize the head.

This study showed no evidence of synchronicity between head-bobbing and leg movements during locomotion in tinamous, a finding that contradicts an often-assumed theory that these two events are synchronized. However, what Hancock and her colleagues did find was that locomotion appears to be constrained by head-bobbing, or rather by the visual constraints that trigger head-bobbing. Although this study only examined the relationship between head-bobbing and locomotion in tinamous, it sheds new light on an old theory. Perhaps there is more to head-bobbing than once thought, and maybe it needs a new name.

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**Hancock, J. A., Stevens, N. J. and Biknevičius, A. R.** (2014). Elegant-crested tinamous *Eudromia elegans* do not synchronize head and leg movements during head-bobbing. *Ibis* **156**, 198-208.

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**Shedding (orange) light on to cognitive brain function**

We are used to thinking about our eyes as organs for vision. They are light-sensitive organs that allow us to create images of our surroundings, helping us navigate our environment; cones and rods, the photoreceptors at the base of the retina, make this possible. If we think a little past this vision function, we may contemplate the importance of photoreception for the regulation of circadian rhythms and the sleep-wake cycles, a function mediated by another type of photoreceptor located in the retina, the intrinsically photosensitive retinal ganglion cells (ipRGCs), which express the photopigment melanopsin. However, very few of us will consider increasing cognitive function as one of our eyes' functions, let alone the role of melanopsin as a cognitive stimulant. This is probably because the evidence supporting the role of this photopigment in the facilitation of cognitive processes has been only indirect; that is, until now. A recent study published in the *Proceedings of the National Academy of Sciences* by Sarah Chellappa and her colleagues at the University of Liège in Belgium and the French Institute of Health and Medical Research in France provides support for the hypothesis that melanopsin is indeed involved in our capacity to remember things in the short term.

Melanopsin exists in two different states; a photosensitive or 'active' state and a photoinensitive or 'passive' state. Long wave light (i.e. orange) triggers the transformation of melanopsin from the

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photoinsensitive to the photosensitive state, while shorter wavelengths (i.e. blue) do the opposite. This means that orange light increases the amount of 'active' melanopsin units in the retina while blue light increases the number of 'inactive' units. Chellappa and her colleagues used this information to try to understand whether melanopsin does indeed influence cognitive brain function. If so, exposure to orange as opposed to blue light would increase performance of cognitive tasks because a larger proportion of photosensitive melanopsin would be present in the retina.

To test the effects of different light wavelengths on cognitive function, the researchers exposed 16 participants to 10 min of blue or orange light. The volunteers were subsequently blindfolded for a period of 70 min and then asked to perform memory tasks while in a magnetic resonance imaging (MRI) scanner, which allowed the scientists to see what parts of the brain were stimulated while the participants performed the tests. The MRI scans showed that, compared with blue light, pre-exposure to orange light had a significantly higher impact in several regions of the prefrontal cortex and other regions of the brain crucial for the regulation of cognition, arousal and even emotional processes. Although more research is required, these results suggest that melanopsin is involved in the facilitation of cognitive processes and that the impact of light on cognition rises with orange light by increasing the 'active' state of the photopigment.

Our eyes do a lot more than seeing and helping us learn is one of these functions. With the help of orange light our eyes might help us to better retain information and perhaps, in the long term, improve our cognitive abilities. Perhaps next time we change the lighting for our office we should choose orange lights.

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## Invasive toads don't need woolly jumpers!



Throughout the world, invasive species remain one of the most serious threats to native wildlife. Perhaps the most infamous example of such an alien invasion is that of the cane toad (*Bufo marinus*) in Australia. Released in 1935 to combat sugarcane pests, cane toads proved themselves to be adept at reproducing rapidly in their new environment and, worse still, took quite a fancy to many of Australia's native wildlife, viewing them as a tasty snack. A recent study, by Rick Shine and his team at the University of Sydney, Australia, demonstrates that a barrier that once was thought would slow down the toads' expansion – low temperatures at high altitudes – is actually dealt with rapidly and successfully by the toads, their secret trick being incredibly rapid cold acclimation.

The study, published in *Functional Ecology*, noted that cane toads were being recorded up to 1100 m above sea level, with the animals experiencing considerably colder conditions than their native counterparts in central and southern America. Collecting animals from the field, Shine found that the critical thermal minima ( $CT_{min}$ ), which identifies the temperature at which toads lose their righting reflex, was lower for high-elevation toads than for low-elevation toads – by a significant 2°C. However, a quick stay in a temperature-controlled laboratory abolished this difference in  $CT_{min}$  between the high- and low-elevation groups. This is because the ability to cope with the cold, it turns out, is achieved through acclimation, not adaptation. Surprisingly, a toad's  $CT_{min}$  in the laboratory was not affected by collection site, or 1 month's exposure to warm (24°C) or cool (12°C) conditions. Instead, a toad's  $CT_{min}$  was

determined by the conditions it experienced over the previous 12 h, prior to experimentation.

These mountaineering toads at the forefront of their expanding range make rapid changes to their thermal tolerance, being able to adjust to cooler temperatures within only a few hours of exposure. Not a few months, a few weeks, or days even, but just a few hours. Such rapid physiological plasticity is highly impressive and suggests that many aspects of the toads' physiology warrant further investigation. What Shine and his team have achieved is to identify a mechanism by which an invasive species can continue to expand its population into significantly colder regions than were previously thought possible. Moreover, the cold acclimation that accompanies this expansion occurs at incredibly fast speeds. Shine explains, 'It's the speed of the acclimation that is so incredible. Other amphibian species have evolved to tolerate low temperatures or acclimate over a time course of weeks, but the toads are really impressive.'

This study suggests physiological adaptations must be taken into account when predicting the range expansion of alien species and, in particular, the speed at which such adaptations can occur. For now, it looks like the cane toads will continue their march through Australia, with no thermal underwear required. Asked whether nowhere is safe from the toads, Shine says, 'I think the polar bears are safe... at least for now'.

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## Forgot who you are? Ask an elephant



It is a tough time to be human. After centuries of congratulating ourselves on being unique, the qualities we once thought only we possessed are being found, one by one, in other animals. No longer are we alone in making tools, engaging in complex social interactions or adhering to a moral code. Now, a recent study published in the *Proceedings of the National Academy of Sciences* has taken our fall from grace one step further: we aren't even the best at telling ourselves apart.

As dealing with threats from predators is energetically costly, it is important that only those animals that really pose a threat are met with the appropriate fight-or-flight response. However, the threat posed by humans is difficult to gauge, as not all members of our species are dangerous. A team of researchers based in the UK and Kenya, working on groups of free-ranging African elephants, therefore

wondered: can animals correctly classify different groups of humans based on the level of threat they pose to them?

They decided to focus on acoustic signals, as these can be used to distinguish predator from prey from long distances. African elephants most frequently meet with two groups of human predators: Maasai pastoralists, who occasionally attack elephants, and Kamba farmers, who generally do not. The team decided to test whether elephants can distinguish between these two groups and the different languages that they speak by playing back recordings of adult men saying, 'Look, look over there, a group of elephants is coming', in the two languages and assessing the behavioural response of different groups of elephants.

They found that elephants are significantly more likely to display defensive behaviours (such as investigative smelling and defensive bunching) in response to recordings of Maasai men than to recordings of Kamba men. This suggests that, amazingly, elephants can pick up differences in sound that are the result of differences in the language that is being spoken. However, if elephants should indeed be capable of accurately assessing threat level, they ought to be able to distinguish men from women, as Maasai women never attack elephants. The authors therefore repeated their experiment with sound clips of adult Maasai men and adult Maasai women.

The elephants again were more likely to be defensive in response to the clips of Maasai men. Could it be that this difference in behaviour is simply a response to differences in tone and pitch of the male voices? To test this possibility, the team resynthesised the audio clips to mimic sex differences, changing them in such a way as to make the male clips – to the human ear – indistinguishable from female clips, and vice versa. Incredibly, the elephants still responded defensively to the clips that were originally from Maasai men, but mostly ignored the female-to-male resynthesised clips. The altered clips therefore still contained cues that allowed the elephants to assess whether they were in danger or not.

This study is the first to show that elephants are capable of accurately distinguishing between different subgroups within a species of predator on the basis of acoustic cues, and meeting them with the appropriate behavioural response. Moreover, it shows that elephants are capable of detecting the gender of humans more accurately than we are. So much for our prime position in the animal kingdom, then.

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