Inside JEB is a twice monthly feature, which highlights the key developments in the *Journal of Experimental Biology*. Written by science journalists, the short reports give the inside view of the science in JEB.

Inside JEB

BEE BRAINS RECOGNISE HUMAN FACES

It's always a pleasure to pick a friendly face out of a sea of strangers. In fact the ability to recognise a face was believed to single out mammals, with their advanced brains, from other simpler species. How we recognise faces has been hotly debated for at least three decades. Adrian Dyer explains it has been thought that we have specialised brain regions dedicated to facial recognition, but there is currently no conclusive evidence to support this idea. However, a big brain does seem to be the most important asset for facial recognition. Or is it…? It occurred to Dyer that he could test whether a big brain was a prerequisite for facial recognition by trying to find out if insects with tiny brains could also recognise human faces. While working in Christa Neumeyer's lab in Johannes Gutenberg Universität, Germany, Dyer decided to put bee's legendary pattern recognition skills to the test to see whether they could learn to recognise a human face (p. 4709).

Training bees to do such an experiment is far from straight forward. First, you have to focus the bees' attention on the task in hand. Dyer explains that he started out offering the bees a tasty sugar reward whenever they visited the picture of a face they were learning to recognise. But after days of training, Dyer was beginning to despair that the bees would ever get the point; they were still flying in fast and visiting face pictures at random, until he thought of attracting the bees to a spoonful of sugar solution and taking them directly to the picture he wanted them to commit to memory. The bees finally got the point and began studying their subject more closely, flying in slowly and considering the pictures before homing in on their subject and retrieving the reward.

Having caught the insect's eye Dyer was ready to start the painstaking training process, but bees are wily creatures; Dyer knew he had to be sure that the bees had learned to recognise a face rather than using other cues to direct them to their sweet treat. By rearranging the faces on the board Dyer convinced himself that the bees weren't using positional cues. Finally he removed the sugar reward, and offered the bees a choice between two faces; the one they'd been trained to recognise and another face they'd been trained to avoid. The bees continued returning to visit the face they had been trained to recognise. Dyer remembers that it was the end of a long day when he finally realised that bees had learned to distinguish a human face from other faces and that he was so amazed that he called Neumeyer telling her to come quickly because 'no one's going to believe it; and bring a camera!'

Once he was sure the bees could distinguish between faces, Dyer needed to go a step further; could the bees pick out a familiar face from a crowd of strangers? Dyer presented the bees with a choice; the familiar face they had been trained to recognise and a stranger's face they had never seen before. If the bees went straight to the familiar face it must recognise it. Amazingly, the bees kept returning to the familiar face. Even though they have less than 1 million neurons in their brains, bees can still recognize human faces.

10.1242/jeb.01992

Dyer, A. G., Neumeyer, C. and Chittka, L. (2005). Honeybee (*Apis mellifera*) vision can discriminate between and recognise images of human faces. *J. Exp. Biol.* **208**, 4709-4714.

OPEN WIDE

Jaw dropping moments happen to most of us from time to time. Fish, on the other hand, throw their jaws wide every time they spy a tasty snack. Sam Van Wassenbergh explains that how fish coordinate their complex jaws while opening wide was something of a mystery. Some fish species have as many as 60 bones in their heads, joined by complex networks of muscles and ligaments, so opening their mouths is much more complex than simply hinging around a single joint. Van Wassenbergh adds that morphologists had made suggestions about the mechanisms the fish could use to open their gaping jaws, but no one had ever analysed them in the act to see whether the fish used any, or all, of these proposed mechanisms. Puzzled by the feeding habits of the air-breathing catfish *Clarias gariepinus*, Van Wassenbergh and his colleagues Anthony Herrel, Dominique Adriaens and Peter Aerts began putting the fish through their paces and found that although they used some of the mechanisms that had been predicted, they didn't use all (p. 4627).

To find out how the fish orchestrate a gape, the team decided to analyse the fish's jaws with high speed X-ray movies. First Van Wassenbergh and Herrel had to fit the fish's skulls with tiny lead markers so they could track the fish's jaw movements using X-rays while they lunged for lunch. Once the fish had recovered from the surgery, Van Wassenbergh was ready to start filming, but even tempting the fish with chunks of cod and prawns couldn't persuade them to perform; terrified by noise and vibrations from the X-ray machine, they retreated into a corner of the tank and hid. Fortunately, the timid animals eventually became used to the cumbersome kit, and Van Wassenbergh was able to resume filming the fish's jaws as they snapped open.

Having recorded almost 200 jaw-dropping sequences Van Wassenbergh says 'my finger still hurts from manually digitising all those markers'. But with all the data in hand, the team were ready to discover just how the catfish snap their jaws apart. They decided to compare the jaw movements that were predicted by the suggested mechanisms with the movements that the team saw in the X-ray movies. First Van Wassenbergh painstakingly measured the trajectories of several of the head's components involved in opening the jaws. Then he calculated the position predicted for the jaw by each of the jaw opening mechanisms before comparing jaw-fact with jaw-theory to see which mechanisms the fish were using to open their mouths.

Based on the comparison, the team realised that the fish began to open the mouth by rotating the operculum, as had been predicted from the morphology of the fish's head. Next the hyoid bone began retracting to continue the jaw's movement. Finally, the protractor hyoidei muscles, that link the hyoid to the jaw, began contracting to open the mouth fully. Surprisingly, the angulo-ceratohyal ligament, linking the hyoid to the lower jaw, had also been thought to participate in one of the opening mechanisms, but Van Wassenbergh couldn't find evidence that it contributes at all.

Van Wassenbergh is pleased that his observations agree well with some of the mechanisms that had been proposed and is keen to know whether other catfish use the same mechanisms when opening wide.

10.1242/jeb.01991

Van Wassenbergh, S., Herrel, A., Adriaens, D. and Aerts, P. (2005). A test of mouth-opening and hyoid-depression mechanisms during prey capture in a catfish using high-speed cineradiography. *J. Exp. Biol.* **208**, 4627-4639.

LONG TERM HERITABILITY OF BASAL METABOLIC RATE

When it comes to natural selection, variation is the key. One characteristic shared by all organisms that maintain a stable body temperature is basal metabolic rate, 'and since all aspects of life use some form of energy' says Claus Bech from the Norwegian University of Science and Technology, 'energy has been termed the currency of evolution'. Bech explains that basal metabolic rates seem to vary enormously between species, and this was thought to be due to adaptations to different environments; but this assumption has only been tested rarely. Bech explains that for evolution to act on a characteristic 'three fundamental prerequisites have to be met'. First the characteristic must show a consistent variation across the species; second, it must be possible to pass it on genetically; and finally, the characteristic must benefit the organism and make it better suited to its environment. Bech decided to investigate whether or not the variations seen in basal metabolic rate across species could be due to adaptive evolution, but first he needed to test the first prerequisite; were the variations in basal metabolic rate across a flock of birds consistent over a long period of time (p. 4663)?

Bech and his colleagues, Bernt Rønning and Børge Moe, decided to look at basal metabolic rates across a group of zebra finches. Bech explains that zebra finches reproduce rapidly, giving his team the opportunity to investigate the birds' inheritance patterns further down the line. But first, Rønning began working with a smaller group of birds, 18 pairs, measuring each individual's basal metabolic rate over a period of 45 days. Fortunately, Rønning could take metabolic measurements on four birds simultaneously, having constructed four tiny respirometry chambers from paint boxes. Then he and Moe calculated the 'repeatability', which gives an indication of the consistency of the ranking of each individual's basal metabolic rate across the group of birds. The value came out quite high; 0.6. The variation in basal metabolic rate across the birds seemed to be largely due to differences between the individuals.

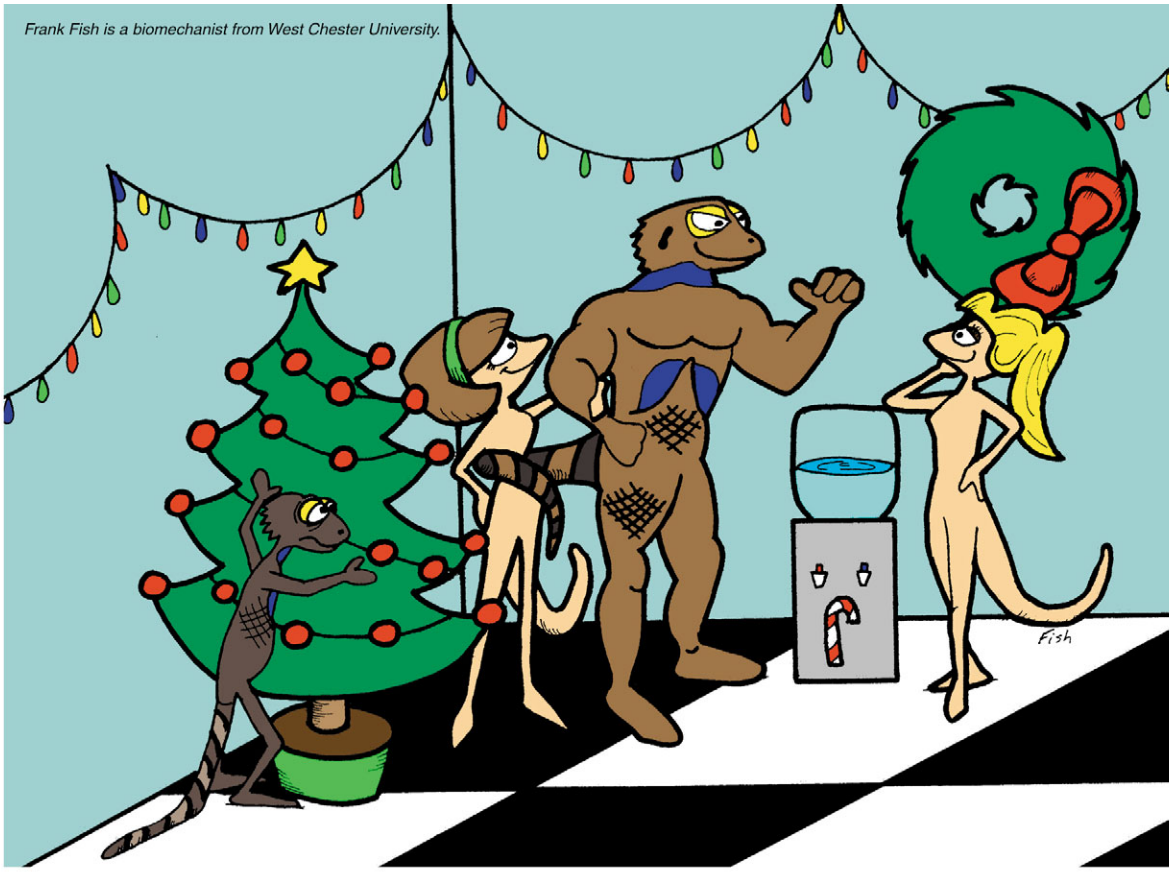
But how would the birds' repeatability fair if their basal metabolic rates were measured again 2 years later? Rønning returned to the aviary, remeasuring the birds' basal metabolic rates and recalculated the repeatability value. The team were astonished when they realised that the value was essentially the same as it had been 2 years before. The bird's repeatability hadn't changed at all; birds with low metabolic rates were still low, while those with higher values were still high. Bech and Rønning admit that this was a surprise, especially given that other measurements of basal metabolic rates in other creatures suggested that repeatability decreased with time.

The Norwegian team's results suggest that there are consistent differences between basal metabolic rate between individuals, so they have satisfied the first criterion for basal metabolic rate to be prone to natural selection. Bech and his team are now focusing on the next criterion that must be met, genetic inheritance. However, he adds that he can only test the genetic effects of evolution in a much larger group of birds where he knows their family tree, and that will take a long time to reconstruct.

10.1242/jeb.01993

Rønning, B., Moe, B. and Bech, C. (2005). Long-term repeatability makes basal metabolic rate a likely heritable trait in the zebra finch *Taeniopygia guttata*. *J. Exp. Biol.* **208**, 4663-4669.

CAN TESTOSTERONE INHIBIT GROWTH?



Bernie wished he could look more impressive for this year's holiday party, but hormone therapy was out of the question as he was the wrong species

Ever since Darwin published *The descent of man, and selection in relation to sex*, people have been puzzled about the forces that drive sexual differences in body size. But as Robert Cox and Henry John-Alder point out in this issue of *The Journal of Experimental Biology* ‘relatively little is known about the proximate physiological mechanisms underlying sex differences in growth’. While males are large and females small in many vertebrate species, a few species buck this trend; female *Sceloporus virgatus* lizards are larger than their males. Knowing that testosterone promotes growth in many species, the team suspected that testosterone actually inhibits growth in *S. virgatus* males. Cox and John-Alder decided to test the effects of testosterone on *S. virgatus* males and compare the steroid hormone’s effects on *Sceloporus jarrovii* lizards, whose males are larger then their females (p. 4679).

Collecting juvenile males of both species from the Chiricahua Mountains in Arizona, the team divided both species into three further groups; one that was castrated and received a testosterone implant, another that was castrated and received a placebo implant and a control group that was not castrated and received a placebo implant. Having measured each male’s length, the team released the males back into the wild, leaving them for just over 40 days before recapturing them again.

Sure enough, the castrated *S. virgatus* males that didn’t receive testosterone were larger than the males that were exposed to testosterone. On the other hand, the castrated *S. jarrovii* males that carried placebo implants were smaller than the castrated males whose implants carried testosterone. Testosterone inhibits growth in *S. virgatus* while stimulating it in *S. jarrovii* males.

But why does testosterone have the opposite effect on *S. virgatus* males than *S. jarrovii* males? Cox and John-Alder suspect that reproduction may be an energetically costly process for the *S. virgatus* males, so they may have traded a smaller stature for their higher reproductive costs.

10.1242/jeb.01990

Cox, R. M. and John-Alder, H. B. (2005). Testosterone has opposite effects on male growth in lizards (*Sceloporus* spp.) with opposite patterns of sexual size dimorphism. *J. Exp. Biol.* **208**, 4679-4687.

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