"They Not Like Us"
The Science of Bird Movement and Optic Flow

By Avery Mizrahi

When I was learning how to bike, there was one thing I was told repeatedly: do not look at the tree. As I learned the hard way, when you look at the tree, you steer into the tree. This would not be the case if a bird wanted to pick up the sport.

As humans, we use our retinas to point towards our desired destination. This is mostly due to the position of our eyes. Pointed into the same direction at the front of our face, we experience overlap with a small peripheral view. This is known as a binocular field. We look in the direction we want to go, and our landscape expands outwards as we move forward. However, birds have a monocular field. Because their eyes are mostly on the side of their head, they experience small overlap with their visual field and experience sight peripherally. As they move, their landscape does not expand outward, but moves horizontally away from them. As professor Dr. Georg Striedter from the University of California, Irvine, writes in a forthcoming book, **humans move into the world while birds move through the world.** This concept is called **optic flow** (Bhagavatula et al., 2011).

A Great Blue Heron takes off for flight at the Bolsa Chica Wetlands. Photo by Avery Mizrahi.

When birds steer, they use the rate of the world moving past each eyeball to gauge where they are in space. The closest experience humans get to this is watching flight in fictional films like Star Trek or Star Wars - think warp speed. We speed through the universe and the stars fly past equally on each side of the screen, rather than expanding outward. Generally speaking, humans are steering in a simplistic manner. Birds are not. They can move their wings in most any direction, kind of like winding an arm around. This is particularly interesting in the context of a highly-specialized bird like the hummingbird.

Hummingbirds are unique because they are one of the very few bird species that can hover, perfectly still, for an extended period of time. Evolving from a need to drink nectar, this skill is possible through wings that move in unusual ways. Hummingbirds do not use sensory feedback from the flower to hover perfectly still, but rather optic flow (Goller & Altshuler, 2014). By sensing the movement of the flower in their monocular field, they are able to hover and adjust by flying backward or forward. As an aspiring neuroscientist, I am enthralled by the unusual anatomy of a hummingbird. Despite their brains being small, they have an enlarged area called the nucleus lentiformis mesencephali (LM). Recent research suggests the brain cells in the LM fire strongly in response to optic flow. This area helps the hummingbird process incoming visual information and keep their head in the same position. Despite rapid movements being so common in the bird world, keeping the eyes and head stable is crucial for birds to process the world around them.

A Rufous Hummingbird takes a break from his feast by resting precariously on a palm tree. Photo by Avery Mizrahi.

Have you ever asked yourself why a pigeon bobs its head? This phenomenon is known as the **optocollic reflex.** In order to have the best sense of sight, birds must keep their heads level. Imagine trying to spot a small fish in the water with your head constantly wobbling. Probably pretty difficult. One theory is by controlling their neck movement to stay still until the very last second, where the head shoots forward, vision is stabilized. Same for flight, as the wings flap up and down, the head stays along the same plane.

Another theory for why birds bob their heads is for stability, just like humans use arms to stabilize themselves while walking (Archer, 2022). In this case, a specialized organ is involved called the **lumbosacral organ.** Humans balance through semicircular canals in the ears, which are filled with fluid. When a human moves, the fluid lags behind and this information goes to the brain - which determines where we are in space. This is similar to birds' lumbosacral organs. Located in the spine, it is also filled with fluid and is responsible for informing the brain where the neck and head are. This is important because having only two legs in the animal kingdom is hard. Two legs and a massively long neck? Unheard of and impressive in the context of many complex bird maneuvers, like standing on one leg for hours. Right now, scientists hypothesize birds have a special locking mechanism in their legs to make this possible.

Two Black-necked Stilts from Bolsa Chica balance on one leg in the chilly water. Photo by Avery Mizrahi.

The more I learn about birds, the more impressed I am by their complex anatomy, and the more bemused I get by how little we know. By continuing to understand the function of bird brains, we are not only on the path to understanding our own, but sympathizing with these creatures. As climate change, pollution, and habitat shrinkage affect this population more and more (Heisman, 2022), I hope to build respect for this incredible animal. Even though they "not like us", "we ain't got no time to waste" in our advocacy for them. (Kendrick Lamar, Love).

See the birds and behaviors in this article!

- [ ] Great Blue Heron
- [ ] Rufous Hummingbird
- [ ] Black-necked Stilt
- [ ] Balancing on one leg
- [ ] Hummingbird feeding
- [ ] Bobbing head while walking

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Citations

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