# The Secrets and Science Behind Starling Murmurations

By: John Donovan | Updated: Mar 30, 2021

Watching a murmuration of starlings in mid-air is to experience firsthand the power and mystery of the natural world. GEORGECLERK/GETTY IMAGES

Individually, a European starling is little more than a common blackbird. That's it. Starlings are short and thick, with dark feathers and long, pointy bills. You've seen them. They're practically everywhere, more than 200 million are in North America alone, singing their chirpy little songs and becoming, to many backyard growers and full-time farmers, a bit on the pesty side.

Collectively, though, starlings transform into something else entirely. Together, in flight, in mesmerizing flocks that sometimes number in the hundreds of thousands, they are a breath-stealing wonder, a pulsating, swooping, living, harmonized whole, seemingly defying the laws of nature while defining nature itself.

Watching a murmuration of starlings in mid-air — that's what the flocking behavior is called, a murmuration — is to experience firsthand the power and mystery of the natural world.

"I think that the core feeling is a sense of awe," says Mario Pesendorfer, a postdoctoral research associate at the Institute of Forest Ecology at the University of Natural Resources and Life Sciences, Vienna. "The spatial scale of something that is moving very rapidly — which we are utterly unable to do — and the visual patterning that occurs when a lot of individuals are doing the same thing ... really mesmerizes us."

To scientists like Pesendorfer, murmurations do more than that. They spark curiosity. And they spark scientists like Pesendorfer to figure out how swarming animals — like birds and bees and fish — can better our own lives.

## The Secrets Behind Murmurations

In the 1930s, famed ornithologist Edmund Selous suggested that birds moving in murmurations were using some sort of telepathy to transmit their flying intentions. "They must think collectively, all at the same time... a flash out of so many brains," he wrote in his book, "Thought-Transference (or What?) in Birds."

As the years wore on, we found out that's not quite it. In the 1950s, scientists studying insects and fish and other collective animal behavior posited that group movement is more of a stunningly fast response to others in the flock (or the school, or the swarm) rather than some innate mind-reading ability or a command from the group leader.

It's "the rapid transmission of local behavioral response to neighbors" that enables such startling synchronicity, as the authors of a 2015 paper published in the journal

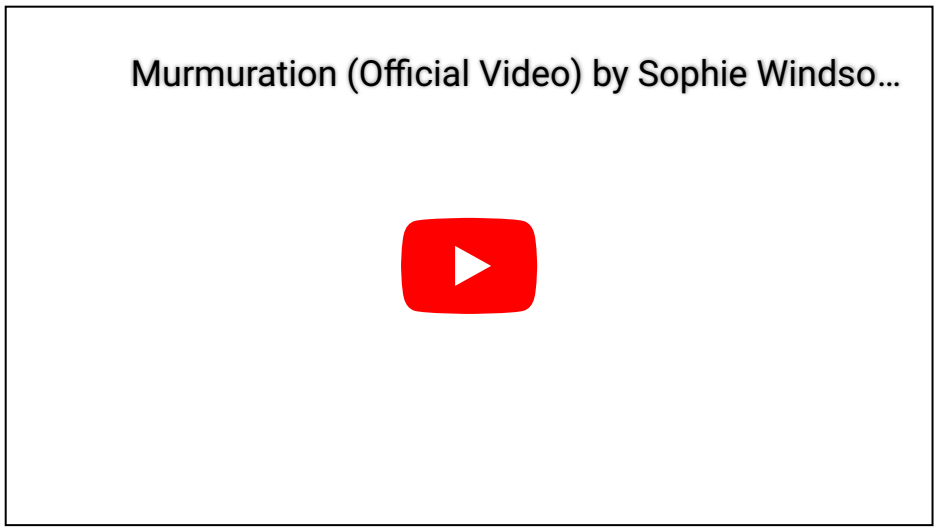
Proceedings of the National Academy of Sciences wrote.

"There's two ways that you can elicit large group behavior. You can have the top-down control, where you have some kind of leadership, or some kind of top-down mechanism. Think of a rock show, you have the rock star in the front and he starts clapping his hands, and the whole stadium starts clapping," Pesendorfer says. "But these murmurations are actually self-organized, meaning that it's the individual's little behavioral rules that make it scale up to the large group. In order to understand this behavior, we have to go from the local scale — what is the individual doing, what are the rules that the individual is following? — to the global scale; what is the outcome?"

In 2013, a mechanical and aerospace engineer and her team from Princeton collaborated with physicists in Italy to study murmurations. "In a flock with 1,200 birds, it is clear that not every bird will be able to keep track of the other 1,199 birds," Naomi Leonard, the Princeton engineer, said back then, "so an important question is 'Who is keeping track of whom?'"

The Italian physicists used more than 400 photos from several videos to find out, plotting the position and speed of birds as they flocked. From that, they built a mathematical model that identified the optimal number of flock-mates for each bird to track.

Turns out the magic number is seven: Each bird keeps tabs on its seven closest neighbors and ignores all else. Considering all these little groups of seven touch on other individuals and groups of seven, twists and turns quickly spread. And from that, a whole murmuration moves. The scientists' findings were published in the journal PLOS Computational Biology in January 2013.




## The Three Things in Control

Though it looks coordinated on a large scale, the individual birds are concerned with only three aspects of their flight and the flight of those around them. These factors have been described in several ways, but they're all very similar. They are, from Pesendorfer:

- **An attraction zone**: "Which means, in this area, you're going to move toward the next guy."
- **A repulsion zone**: "Which means, you don't fly into his lane, otherwise you both fall."
- **Angular alignment**: "So you got to kind of follow his [a bird's neighbor] direction."

"Depending on how you change those three parameters," Pesendorfer says, "you can get everything from those barrel-looking baseballs that you get in ocean fish, to loose-looking insect swarms, to highly, highly organized fish swarms and murmurations. All in those three little parameters."

Scientists believe these birds flock in the first place to confuse and discourage predators, through their sheer numbers, with the noise such a flock makes and, of course, its

motion. Some communication between birds may be happening, too, in murmurations — say, pointing out good food sources — while some researchers believe simply keeping warm may be another reason for the murmurations

What may be most stunning to mere mortals is that these birds react so quickly and do so in such synchronization; if not immediately, within a couple of flaps of a bird's wing. They move almost as one, in a type of lock-step (or, as it were, lock-flap).

How?

"Birds have a much higher temporal resolution than we do," says Pesendorfer, meaning that birds take in certain information around them and process it much more quickly than humans. "They see much faster than we do."

A large flock of starlings swoops off the coast of Brighton on Feb. 22, 2011, in Brighton, England.
MIKE HEWITT/GETTY IMAGES

## Using What We Learn From Starlings

Back in 1986, Craig Reynolds, an MIT-trained computer scientist, built computer models of bird flocking and fish schooling in something he called "Boids." These programs provided the basis for lifelike animation in movies, initially (and notably) a swarm of bats in the 1992 Tim Burton film "Batman Returns."

In applications to real life, the ability to understand the behavioral movements of large groups of starlings (or bats or bees or whatever) and to program swarms of robots into making similar movements has amazing possibilities. "We are trying to draw inspiration from biology," George Young, who was the lead author on the paper produced from Leonard's group, told Princeton University back in 2013, "to understand what measures of animal group performance can help us decide what measures we should use when we design responsive behaviors for robots."

An example: Las Cumbres Observatory has 22 robotic telescopes on seven sites around the world that coordinate with each other to function as one big telescope. From the LCO site:

> *It's called time domain astronomy, which means that we can continually watch phenomena in space as they change. When we get to see the big picture as it unfolds, we are able to learn more, learn it faster, and dramatically increase our understanding of the forces that drive the universe.*

Another example: The emerging field of swarm robotics uses information gleaned from the study of starlings that could, according to the Wyss Institute at Harvard, "enable new approaches for search and rescue missions, construction efforts, environmental remediation, and medical applications."

Swarm robotics also could have use in military applications, like these micro-drones released from fighter aircraft. A swarm of self-driving cars, working together, could help reduce or eliminate traffic jams. The possibilities — cancer-fighting? — are mind-boggling.

All from watching, studying, learning and building on the wondrous flocking of this simple bird.

"As humans who have very complicated decision-making processes, we're not used to looking at simple decision-making processes that scale up to what looks like complex behavior," Pesendorfer says. "These models help us understand these types of patterns."

## Now That's Interesting

The entire population of North American starlings — again, maybe as many as 200 million of them — are descended from a group of 100 brought to the U.S. in the early 1890s and set loose in New York City's Central Park. The people who brought them were Shakespeare fans, who wanted America to be inhabited by all the birds that the bard ever mentioned. From "Henry IV, Part I": "But I will find him when he lies asleep,/And in his ear I'll holla 'Mortimer!'/Nay,/I'll have a starling shall be taught to speak/Nothing but 'Mortimer,' and give it him/To keep his anger still in motion."

## Murmuration FAQ

**What is a murmuration?**

A murmuration is the flocking behavior of starlings in groups of hundreds or even thousands.

**When can I see a murmuration of starlings?**

Starling murmurations occur mainly in the winter season, somewhere between October and March. However, the peak season happens between December and January.

### What is the purpose of a murmuration?

Some scientists think that murmurations are useful for keeping birds safe from predators, confusing the predators with sheer numbers. Others think it is a way for the birds to keep warm.