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The Secret Logic of Cows

A new mathematical model explores the complex reasons herd animals stay with a group or leave it.

"Should I stay or should I go?"

Stephane Mahe / Reuters

VERONIQUE GREENWOOD | SEP 8, 2017 | SCIENCE

A cluster of cows browsing under the summer sun might look like they haven't a care in the world. But the life of a herd animal is filled with trade-offs and decisions. Although they seem interchangeable, each one is an individual with its own particular desires. If a cow isn't finished eating or lying down digesting by the time the herd picks up and moves, it may have to go along anyway.

There are benefits to staying together, in that it means less danger from predators. But research has shown that cows that are made to move more frequently than they'd like grow more slowly, perhaps from the stress of not being able to follow their desires. There is a cost to not doing as one pleases.

In a sense, this is a challenge common to any species that lives in groups. Attracted by the conundrum, a group of mathematicians and biologists have created a mathematical model that simulates how groups of grazing cows might behave in a variety of situations, moving with a big group, staying on their own, or forming a smaller group of like-minded individuals. They recently published a paper in the journal *Chaos* in which they describe the model and how it might be used to explore the perhaps startlingly nuanced behavior of cows.

The idea came to some of the collaborators many years ago, says Mason Porter, a senior author of the paper and an applied mathematician at the University of California, Los Angeles. He and Marian Dawkins, a zoologist at University of Oxford, had started talking about the difficulty of creating realistic mathematical models of biology, and the subject of cows came up. "They aren't simple at all, really," Porter says. And so the researchers began to put together mathematical sketches of the relationships between different variables in cows' lives and the many ways they might respond to them. They were quite detailed at first, including lots of information about cow biology. But in an effort to understand the issue more deeply, eventually the group arrived at a more abstract approach.

In this version, which has just a small number of variables, the imaginary cows each are given their own levels of hunger and of the desire to lie down and ruminate, which change over time depending on what the cow is doing at the moment—eating, standing, or lying down. Each cow has unique preferences at any given moment, but is also susceptible to social pressure of a sort. If they see others getting up and leaving, they will feel a pull to leave as well. In math terms, they function like oscillators—they go back and forth, between different states.

They could directly link the behavior they see in the model to real cows.

The researchers used the relationships between all these features to craft a mathematical description of the costs and benefits of the cows' behavior, called a cost function. This allows them to say how harmful it is for a cow to move when it's not ready, for instance, and to twiddle with how tightly cows' desires depend on each other and see how that affects their behavior. The researchers also asked whether making the animals two different sizes, as would happen in herds of mixed male and female cattle, would result in the eventual division into two groups. They found that this did happen, but apparently not always for good: Sometimes a cow would go back over the line, suggesting that the benefits aren't so clear as to outweigh other considerations.

This particular study focused on the question of how group size might change in a limited number of scenarios. But going forward, for instance, the group could run simulations many times to see how much of the time cows will split off under certain conditions, generating a distribution of potential outcomes. They could explore the best-possible group size to minimize stress. And they could seek to directly link the behavior they see in the model to the behavior of real cows.

"We constructed the models on purpose to make them flexible, so that you could just insert real data and look at that," says Porter. "In fact after this latest paper, we've actually gotten some contact from some people—one person in New Zealand who may have actually some very interesting data to try using."

Looking ahead, one particular focus will be to explore just how much social influence works on cows, Porter says. "That's one of the key questions. We have the same types of questions in human beings as well. When we see behavior changing online, how much of it is because somebody influenced somebody else, and how much of it is because they happened to do the same thing for a similar reason, but did it at a different time?" Cows and people—more similar than we might realize.

ABOUT THE AUTHOR

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