Swarmlike collective behavior in bicycling

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The picture shows the peloton of the 2005 Tour de France on July 9 just out of Karlsruhe. Credit: Public Domain via Wikimedia commons

Whether it's the acrobatics of a flock of starlings or the synchronized swimming of a school of fish, nature is full of examples of large-scale collective behavior. Humans also exhibit this behavior, most notably in pelotons, the mass of riders in bicycle races.

During the American Physical Society's Division of Fluid Dynamics 71st Annual Meeting, which will take place Nov. 18-20 at the Georgia World Congress Center in Atlanta, Georgia, Jesse Belden, a researcher at the Naval Undersea Warfare Center, will describe the research he and his colleagues have been conducting on collective behavior in pelotons.

Using aerial video footage of bicycle races, Belden and colleagues analyzed peloton motion to determine what causes changes in the group's large-scale collective behavior. They found that riders move through the peloton in a manner similar to circulation in a fluid and observed two types of propagating waves within pelotons. "You see all these patterns and motion behaviors emerge," said Belden.

The researchers found two types of waves affect the structure of a peloton. First, the researchers found a wave that moves back and forth along the peloton, usually due to a rider suddenly hitting the brakes and others slowing to avoid a collision. The other type of wave is a transverse wave caused when riders move to the left or right to avoid an obstacle or to gain an advantageous position.

Pelotons maintain a persistent structure, and researchers previously thought this form was driven by individual riders seeking an aerodynamic advantage. However, aerodynamics only come into play at the outside edges of the peloton. Instead, the researchers found that peloton dynamics are likely driven by rider vision, with each rider keeping other riders within a range of peripheral vision that is most sensitive to motion. Additionally, wave propagation speeds were consistent with human reaction time rather than conscious cognitive decisions like improving aerodynamics.

These findings shed new light on large-scale collective behavior in humans and could apply to varied topics including traffic and crowd management. Additionally, understanding the role of sensory input in

collective behavior is important to building better autonomous vehicles like self-driving cars. This research has also given insights into the cognitive processes involved with individual rider actions and their effects on broader peloton dynamics. "Unlike birds or fish, you can talk to the cyclists," Belden said.

More information: Presentation E17.5, "Continuum behavior in cycling pelotons" by Jesse Belden, Mohammad Mansoor, Aren Hellum, Andrew R. Meyer, Rafid Rahman, Christopher Pease, Scott Koziol and Tadd T. Truscott, will be Sunday, Nov. 18, 6:02 p.m. in Room B304 of the Georgia World Congress Center in Atlanta. Abstract: meetings.aps.org/Meeting/DFD18/Session/E17.5

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