Researchers determine how groups make decisions

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Temnothorax rugatulus. Credit: Arizona State University

From Beats headphones' rise to prominence or a political candidate's surge in the polls to how ants and bees select a new nest site, decisions emerging from groups frequently occur without a leader.

Researchers from Carnegie Mellon University have developed a model that explains how groups make collective decisions when no single member of the group has access to all possible information or the ability to make and communicate a final decision. Published in *Science Advances*, the de-centralized decision-making model shows how positive feedback during the exploration process proves useful for making good and quick decisions.

"Throughout the presidential primary process, people are trying to find an ideal candidate in a crowded landscape. The person in the lead - say Donald Trump - gets more media coverage and attention, which could lead to more people thinking about voting for him based on name recognition," said David Hagmann, a Ph.D. student in CMU's Department of Social and Decision Sciences. "Eventually, the added exposure could highlight information that people do not like, causing a candidate to fade in the polls."

Hagmann, along with Russell Golman and John H. Miller, developed the mathematical model based on two elements: recruitment with positive feedback, where initially popular options get reinforced, and quorum sensing, where enough support for a given choice triggers a final decision. Using a Polya urn scheme - a statistical model in which balls of different colors are repeatedly drawn from a container and previously picked colors become more likely to be drawn again - the researchers were able to look at how long it takes to make decisions and calculate their accuracy.

"We found that the model is pretty robust across how it is implemented," said Golman, assistant professor of social and decision sciences. "Most interesting, when one choice has more variation in how it is perceived, it's chosen less frequently, establishing systemic risk aversion."

Being a bit risk-averse when deciding on, say, where to relocate thousands of bees, is the evolutionarily safe choice.

"When everyone has to do the same thing, you want to be slow and steady to avoid extreme choices," Golman said.

The process could also be used to explain how the brain's neurons work.

"The way the brain works, you need to get a certain amount of neurons

to be active in order to make a decision. Current theories on neuronal decision-making don't take the process of positive feedback into account. But, neuroscience generally recognizes that neurons are connected in recurrent networks, which allow for positive feedback," Golman said.

The model also helps explain how trends take off, such as the popularity of Beats headphones, and the success of word-of-mouth marketing tactics.

"Early adopters are walking advertisements for the products they buy. Choosing the most popular headphones is not necessarily the best option," Golman said, "but it's not a bad rule of thumb."

More information: "Polya's bees: A model of decentralized decision-making" *Science Advances*, advances.sciencemag.org/content/1/8/e1500253

Provided by Carnegie Mellon University