BEHAVIOR

Insect Swarm Intelligence

Lars Chittka and Alex Mesoudi

The swarming behavior of honeybees constitutes one of the most astounding phenomena in group decision-making among animals: When a new queen is raised in the honeybee hive, her predecessor departs along with approximately 10,000 workers. Rather than en masse erratically searching around for a new location (as a group of vertebrates might), the bee swarm does something remarkable. It acts, in a sense, like a single being: pausing, collecting information, carefully considering its options, and then making a unanimous decision about where to move. The consensus can take days to reach. Several hundred scouts fan out across a territory of up to 70 km^2 seeking a potential home, such as a hollow tree with a knothole entrance. Successful scouts return to the swarm and advertise the location of their discovery, but there is initially much disagreement among scouts and difference in the quality of sites found. The swarm must come to an agreement, however. Individual bees won't survive on their own, nor will groups of bees without their queen. If the polling about where to move takes too long, the swarm risks exposure to severe weather conditions that may spell the end of the whole endeavor. And if the group chooses a poor-quality site, the colony will not survive the winter. When Martin Lindauer, Nobel laureate Karl von Frisch's most successful student, first described the debate among scouts to his mentor, von Frisch exclaimed: "Congratulations! You have witnessed an ideal parliamentary debate; your bees can evidently change their decision when other scouts have to announce a better nesting site" (*1*). Having dedicated decades to the study of this unique, pluralistic decision-making process, Tom Seeley offers an engaging and fascinating account of it in *Honeybee Democracy*.

Honeybee Democracy
by Thomas D. Seeley
Princeton University Press, Princeton, NJ, 2010. 279 pp. $29.95. ISBN 9780691147215.

Seeley writes with infectious enthusiasm, and indeed there is much to be enthusiastic about. When he took over the study of collective bee decision-making from Lindauer in the 1970s, many mysteries remained. How is a cohesive relocation of several thousand worker bees and a reluctant queen that hasn't seen daylight since her nuptial flight at least a year earlier initiated? How do scouts explore the landscape and evaluate the suitability of cavities for nesting sites? Back at the swarm, how do they convey the quality of their discoveries? How is agreement reached in the absence of any top-down, centralized moderation of the debate? What ensures that the consensus converges on the best option? What is the signal for lift-off? Once the swarm is airborne, how can some hundred informed scouts guide a "school-bus sized cloud," containing several thousand individuals, over a distance of several kilometers to an inconspicuous knothole? Incorporating findings from innumerable ingenious experiments by the author, *Honeybee Democracy* includes answers to all the above questions.

Some ingredients of Seeley's approach are worth highlighting. He strongly advocates starting an investigation with the inductive (bottom-up) approach used by von Frisch and Lindauer before him. Carefully observing your study organism in its natural setting, taking everything in, you get to know your study organism thoroughly from many angles—and let unexpected or inexplicable phenomena pop out for you. Only then do you develop testable hypotheses and rigorous experiments to zero in on how particular processes might be explained. Surprisingly, even though many great behavioral biologists have adhered to this philosophy, it is now fashionable to use instead a top-down, hypothesis-driven approach: starting with what you and pretty much everyone else expects and either confirming or rejecting that. It is hard to see how one would ever explore genuinely new territory in this way. Seeley's simple message is, keep your eyes open for the unexpected.

Another ingredient of the author's success is the elegance and simplicity of his experiments. In times when researchers are often assessed not by intellectual contribution or productivity but instead by the amount of funding they secure, Seeley shows that cutting-edge science can be produced with "equipment obtainable from the local shopping mall" (as Francis Ratnieks observes on the book's dust jacket). Indeed, many of the experimental procedures he used are simple like sushi (and equally exquisite). Some require considerable courage, however: one simultaneously exposed Seeley to the risk of falling from a tree, being attacked by angry bees, and being killed by cyanide gas. One senses that he carried out experiments in the golden age before the blight of "health and safety" and "risk assessment." The book is also pleasantly free of any pretense of an applied justification for the work. Although at one point Seeley inadvertently defused a tense cold war confrontation between the United States and the Soviet Union by pointing out that what was thought to be chemical weapons residue was actually bee excrement, his work was inspired entirely by the quest for scientific discovery. Funders and policy-makers today need reminding that pure, blue-skies research is a component of any healthy society.

Pondering collective intelligence. Tom Seeley during a 1974 pilot study of a swarm choosing its home.

CREDIT: JOHN G. SEELEY/COURTESY THOMAS D. SEELEY

Nonetheless, the work might have considerable implications beyond the question of how honeybee swarms move house. Seeley argues that human groups—juries, committees, governments—could learn from how bees make decisions. He suggests minimizing a leader's influence, allowing each group member to contribute their opinions in an independent and unbiased manner, and only reaching a single group decision once a

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democratic quorum has been reached. Seeley even put these rules into practice as head of Cornell University's Department of Neurobiology and Behavior by minimizing his own influence, encouraging minority views, and making decisions through secret ballot.

Yet we should not ignore the disanalogies between human and bee decision-making. Human groups are frequently not united by common interest in the way that honeybee swarms are united by shared kinship. The former often comprise conflicting factions each fighting for their own self-interest. And when human groups do act as cohesive units, they are often too cohesive, with their members rarely acting as independent decision-makers like honeybee scouts. Conformity prevents dissenting views and conflicting evidence from being considered, often with disastrous consequences—such as when NASA ignored warnings that a component on the Challenger shuttle was faulty and went ahead with its doomed launch (*2*). Moreover, whereas honeybee swarms are cooperative by virtue of shared kinship, groups of people are cooperative partly through conformity (*3*). Eliminating conformity may eliminate decision-making errors, but it may also reduce the cohesiveness that maintains human groups in the first place.

It is to Seeley's credit that he stimulates such a wide-ranging debate over the similarities and differences in group decision-making among species. In addition, *Honeybee Democracy* offers wonderful testament to his career of careful investigation of a remarkable natural phenomenon. The breadth and depth of the studies reported in it should inspire all students of animal behavior.

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BIOETHICS

An Embarrassment of Riches

Tim Lewens

Leon Kass—recently retired from the University of Chicago—chaired the President's Council on Bioethics (henceforth the Kass council) from its establishment by President George W. Bush in November 2001 until Kass stepped down in 2005. Kass's own academic work is sometimes regarded by scientists and ethicists as reactionary. He is known, for example, for his defense of what he calls "the wisdom of repugnance." Conservative thinkers take this work to explain why we should heed the instinctive aversion that many people feel when confronted by new technological developments, whether those involve the overhaul of traditional parenting structures in the face of new reproductive technologies or the pharmaceutical enhancement of human bodies and minds. For others, there is no wisdom in repugnance itself: to claim otherwise is simply to offer a flimsy legitimation of irrational distaste in the face of progress.

A Rich Bioethics
Public Policy, Biotechnology, and the Kass Council
by Adam Briggle
University of Notre Dame Press, Notre Dame, IN, 2010. 230 pp. Paper, $30. ISBN 9780268022211. Studies in Medical Ethics.

The Kass council's reports, even more than Kass's own work, became, in Adam Briggle's words, "a lightning rod for political controversy." In particular, the council attracted criticism from many that its membership had been stacked to reflect Bush's own conservative views and that it was insufficiently attentive to the existence of disagreement among its own members. In his brief and breezy *A Rich Bioethics*, Briggle (a philosopher at the University of North Texas) sets out to give an account of the council's fundamental conception of bioethics and to evaluate its performance against that conception. Lest one think the book is an unadulterated apologia, let me say that Briggle's verdict on the Kass council is not uniformly positive. He argues, for example, that Kass's own appointment as chairman should have been conducted in a more open manner. He also argues that some of the council's reports were "noticeably deficient when it comes to conveying dissent." Briggle accepts that these factors justify some of the political criticism Kass's council received. However, his main goal is to vindicate the council's underlying vision of a "rich bioethics," and he argues that in the main the council was true to that vision.

What, then, is rich bioethics? It has a number of strands, some very sensible, some far more questionable. It seeks to articulate the concerns that diverse constituencies feel when presented with technological innovations. It also involves a rather more sophisticated recognition that we cannot simply set society up in such a way that different individuals, with different ethical outlooks, can all have equally good chances of living in the ways that they wish. The decisions that government makes, Briggle argues, cannot be thoroughly neutral across varying conceptions of the good life. This, again, is quite correct: Outlawing the use of cognitive-enhancing drugs affects the ability of those with a commitment to a certain vision of self-improvement to achieve their goals. If government permits such drugs to be used, broad societal changes (in terms of norms of performance, for example) negatively affect the lives of those whose commitment to a certain conception of "genuine" achievement makes them oppose the use of the drugs. For that reason, we need to be aware of the ways in which regulatory choices—even apparently "liberal" policies, which allow everyone a supposedly personal sphere of action—can promote some conceptions of a good life while disadvantaging others.

Briggle's rich bioethics becomes more questionable once we move beyond these foundational points. First, he seems to imply that while a bioethics council can articulate and explain the ethical standpoints of diverse groups, it is not appropriate for such a council to suggest pragmatic ways in which the ethical concerns of all might be reasonably, or partially, met. Yet even if one is convinced by Briggle's arguments that there is no wholly ethically neutral framework for the regulation of new technologies, it does not follow that a properly rich bioethics should refrain from defending pragmatic political solutions to the problem of reasonable conflict among those stances. Second, Briggle believes (if I understand him correctly) that the Kass council was the first to appreciate the importance of rich bioethics. But once we realize that bioethics can be at the same time decisive in its policy recommendations, mindful of the

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