

# Microorganisms offer lessons for gamblers and the rest of us

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When it comes to gambling, many people rely on game theory, a branch of applied mathematics that attempts to measure the choices of others to inform their own decisions. It's used in economics, politics, medicine -- and, of course, Las Vegas. But recent findings from a Tel Aviv University researcher suggest that we may put ourselves on the winning side if we look to bacteria instead.

According to Prof. Eshel Ben-Jacob of Tel Aviv University's School of Physics and Astronomy, current [game theory](#) can't account for bacteria's natural decision-making abilities -- it's just too simplistic. Understanding bacteria's reactions to stressful and hazardous conditions may improve decision-making processes in any human arena from everyday life to political elections.

In a recent article published in the [Proceedings of the National Academy of Sciences](#) (*PNAS*), Prof. Ben-Jacob and his fellow researchers outline how decisions made by communities of bacteria trump game theory. "When human beings make a decision," he says, "they think they're being rational. We now understand that they're influenced by superfluous 'noise,' such as their cognitive state and the influence of others." Bacteria, he explains, are both simpler and more sophisticated -- they can more effectively control this superfluous noise and make group decisions that contribute to the well-being of the entire bacterial colony.

## Looking out for the whole

Bacteria live in complex colonies that can be 100 times as numerous as the population of Earth. Under stressful circumstances, bacteria have demonstrated a capacity to assess the noisy and [stressful environment](#) around them, filter out what's relevant and what's not, and make decisions that ensure the survival of the colony as a whole.

For example, one bacterial response to starvation or poisoning is that a fraction of the cells "sporulate," enclosing their DNA in a capsule or spore as the mother cell dies. This, says Prof. Ben-Jacob, ensures the survival of the colony -- when the threat is removed, the spores can germinate and the colony grows again.

During this process, the bacteria "choose" whether or not to enter a state called "competence," in which bacteria change their membranes to more easily absorb substances from their neighboring, dying cells. As a result, they recover more quickly when the stress is gone. According to Prof. Ben-Jacob, it's a difficult choice -- in fact, a gamble. The decision to go into a state of competence only pays off if most of the cells decide to sporulate.

Indeed, observations show that only about 10% of cells decide to go into competence. So why don't all bacteria attempt to save themselves? Bacteria don't hide their intentions from their peers in the colony, he explains -- they don't lie or prevaricate, but communicate their intentions by sending chemical messages among themselves. Individual bacteria weigh their decisions carefully, taking into account the stress they are facing, the situation of their peers, the statistics of how many cells are sporulating and how many are choosing competence.

## **Facing tough choices**

There are many times in life when humans face similar decisions, says Prof. Ben-Jacob. One example is choosing whether or not to be

inoculated during flu season. Do you take the risk of the side effects and get inoculated, or do you trust that most of the people around you will get the vaccine and risk possible illness, sparing you both the disease and the side effects from the vaccine? How do politicians make decisions on key issues, such as national debt, that can harm and benefit society?

There will always be "noise" surrounding [decision](#) making, says Prof. Ben-Jacob, but like bacteria, we can use this information to make an action plan. Though [bacteria](#) react individually, he notes, there is coordination between the cells. It's important to make choices that both benefit us as individuals but also as a group.

"Sometimes we need the restraint of the community," says Prof. Ben-Jacob. "As individuals we need to set some boundaries, and not just boost ourselves at the expense of others."

Provided by Tel Aviv University

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