In nature -- and maybe the corner office -- scientists find that generalists can thrive

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The assignment of duties in a single cell, ocean life or even a small business does not have to be defined by a division of labor where every individual has a specific role, according to biologists at Ohio State University.

The scientists have designed a mathematical model to describe circumstances that would allow generalists to endure in what is typically expected to be a specialist-only society, according to theory.

Existing biological theories about the division of labor suggest that individual members of a group gravitate to specialization to perform specific tasks toward a common goal.

According to this new model, which tweaks two assumptions of the existing theory, there is a place in small groups for generalists to exist and possibly even to thrive.

Because the model they designed pertains to biological systems with just a few individuals, the researchers caution against reading too much into its potential application to humans. But in a socially and economically complex world, they admit they find comfort in the model's implications about humankind nonetheless.

"What this modeling showed me is that there are conditions under which it actually helps to have some generalists, especially for fairly small groups, some individuals that you might think of as Jacks- or Jills-of-all-

trades or multitaskers," said Tom Waite, associate professor of evolution, ecology and organismal biology at Ohio State and co-author of the study.

"You might actually have to pay them more and they might often do the wrong task, but if you don't have them, this whole notion of specialization leading to greater economic productivity might actually be wrong."

The research appears online in the *Journal of Theoretical Biology*.

Waite and doctoral candidate Anthony D'Orazio, lead author of the study, started with an established mathematical model in current biology literature that leads to complete division of labor. In their design, they relaxed two assumptions, making inefficiency less costly and allowing generalists to make mistakes.

The researchers determined the worth of generalists to small systems by designing mathematical equations and creating a computer program to run the equations with various values for different generalist and specialist behaviors. They carried the computation out to the point at which the system had completely evolved.

Waite and D'Orazio realized they were wading into treacherous theoretical waters. The notion of division of labor among humans dates to the Greek philosopher Plato, who argued that societies require specialization to be productive and efficient. Later intellectuals expressed concern that the inflexibility associated with division of labor would destroy the human spirit.

In ecology, the literature is comparatively thin. But theoreticians agree that no perfect mathematical model exists, Waite said. A model is either too broad to provide useful insights for any given system or too specific

to apply beyond a single defined system.

“We wanted to define a fair model that isn’t too biased toward one group or one outcome,” D’Orazio said.

D’Orazio initiated the development of a new model with the hopes of determining what he can expect in his study of sea anemones. He was surprised to find that even using a simple model, he is unable to clarify why these marine animals behave as they do.

The species D’Orazio studies are members of a clonal aggregation, meaning they are all genetically identical. But these sea anemones exhibit two distinct types of roles: warriors or reproducers. Warriors tend to congregate on the outer edges of their groups to protect the masses, while within the group, others focus on reproducing.

D’Orazio hoped to create a model that would help determine the optimal allocation of these two types of specialists to ensure the group’s survival. And yet, even these brainless creatures confounded his plan.

“Sea anemones are simple, and yet we see complex behavior with them. If you put them in a lab, sometimes they attack, sometimes they don’t. Sometimes they attack and run away. Sometimes they do nothing but attack. Sometimes they get attacked and don’t defend themselves. For something that you would think would be so simple, it’s much more complex. Behavior can’t be predicted even in this one group,” he said.

And that’s why it’s attractive to apply this concept of incomplete division of labor to humans, Waite said. Humans are, after all, animals that might be driven mainly by biological urges. But the superimposed culture, rules, laws, race, class and gender make it hard to know for sure.

D’Orazio and Waite use a small cookie business to illustrate their

findings. If three individuals work in a group and all are specialists, two members make cookies and the other sells cookies. If the seller is out sick, the whole operation must shut down under previous assumptions about division of labor.

The business could hire a fourth person who can bake and sell, but that's an expensive option. Another possibility is sticking with three employees but training one of them to do two tasks.

"So now you have a generalist," Waite said. "You've lost something in terms of time and profit initially because you have to invest in training this person. You might even train all three people. But if you have even just one generalist, then you're safeguarded against the possibility that the specialists don't complement each other."

For Waite, the findings reinforce his broader world view. "We should value each other much more. We should value people who have a diversity of skills and interests. They might not have really recognizable specific skills but they might be good at doing lots of things," he said.

For biological purposes, the new model will set a standard for future work, D'Orazio noted.

"We were trying to clarify confusion in the literature. We're not saying any system should strive for incomplete division of labor, but that it exists and this is an example of it."

Source: Ohio State University

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