Live fast die young: Updating signal detection theory

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Signal Detection Theory is a popular and well-established idea that has

influenced behavioral science for around 50 years. Essentially, the theory holds that in a predator-prey relationship, prey animals will show more wariness and be more prone to flee as predators become more common. Danger signals are ambiguous, so in what appears to be a threatening situation, animals are better off running than hanging around to see if a predator really does strike.

Now Pete Trimmer, a postdoctoral research at UC Davis, has taken a fresh look at signal detection theory and come up with what at first look like counterintuitive results. In many cases, he says, animals should actually become less cautious as the risk of predation rises.

The problem with conventional signal detection theory, Trimmer says, is that it only considers one decision at a time, in isolation. But in reality, animals may have to make multiple connected decisions and have to take into account the effects of decisions over time.

Trimmer, graduate student Sean Ehlman and Professor Andy Sih at UC Davis, with mathematician John McNamara at the University of Bristol, U.K. developed a new model that they call state-dependent detection theory or SDDT. The work is published Oct. 18 in the journal *Proceedings of the Royal Society B*.

A browsing animal detects that a predator may be near. Keep feeding or flee? Conventional theory only considers that decision. But what if the animal is near starvation? Fleeing too soon might save its life in the short term, but it might die of hunger later.

The new theory takes those factors into account by setting a threshold that depends on the energy "reserves" of the prey. When an animal's reserves are high, it can afford to miss a feeding opportunity and is more likely to flee but if it is hungry, it is more likely to stay.

More Predators, Less Caution

State-Dependent Detection Theory generates another surprise result: Trimmer and colleagues found that as the probability of danger rises, the threshold to flee actually goes up so animals will tolerate higher danger signals before fleeing.

But on second look, there's sound logic to this, Trimmer says. When your overall risk of dying on the claws of a predator is high, your life is going to be shorter and your reproductive success less. So the payoff for any single time that you flee is lower: you're just postponing the risk to a later time. You might as well take the risks, live fast and die young.

"Put another way, if predators are rare, when an organism receives a signal of possible danger, it can afford to flee because it should have plenty of opportunity to make up for lost energy at a later time. In contrast, if predators are very common, the organism cannot afford to flee everytime it receives a signal of possible danger," the authors write.

The new model could have wide implications, from how careful animals are about possibly toxic foods to how easily the immune system is triggered by an infection or allergy. It could also help in understanding animal welfare: an animal that is generally comfortable might show more alarm in response to some signal than an animal that is more stressed overall.

More information: The erroneous signals of detection theory, *Proceedings of the Royal Society B*, rspb.royalsocietypublishing.or … .1098/rspb.2017.1852

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