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The joint evolution of sensory systems and decision policy allows cognition

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Abstract

For cognition to evolve, environmental cues must be sufficiently reliable to allow an animal to regularly make correct decisions. For example, the sound of rustling must covary with prey for attempting to detect prey to be possible. However, the reliability of information is not solely a property of the environment, but also results from the sophistication of an animal's sensory systems. Here, we extend signal detection theory to examine how selection acts on sensory systems, alongside an animal's policy for using information. Our model finds cognition can still be favored if sensory systems are poor, by compensating with greater bias to avoid costly errors. Yet, investing in reliable information and bias are not always alternatives, and can coevolve in order to be doubly protected from important errors. Sophisticated sensory systems evolve when the environment is complex, metabolic costs are low, and both false alarms and missed detections are moderately costly.