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Using digital twins to probe the origins of intelligence

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The origins of perception and cognition have been debated for centuries, with ongoing disagreement about what knowledge and neural structure are hardwired at birth. A major obstacle to resolving this debate is that, until recently, it has been impossible to train formal computational models of intelligence on the same sensory experiences as developing animals. We address this limitation by building digital twins of newborn animals and their environments. We rear newborn animals and "newborn" artificial agents in the same environments, then test the animals and agents on the same tasks. This allows us to provide animals and models with matched learning contexts and test candidate brain models under identical constraints. Using this framework, we show that perceptual and cognitive capacities can emerge from coupling flexible, domain-general neural networks with structured, domain-optimized bodies. Ultimately, this digital-twin framework allows researchers to build formal models of the origins of intelligence, unifying insights across psychology, neuroscience, and artificial intelligence.

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