Learning accelerates the evolution of slower aging, but constrains the evolution of negligible senescence

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Abstract:

The risk of dying tends to increase with age, but this trend is far from universal. For example, human mortality is comparatively high at a young age, declines during juvenile development and increases again during adulthood. For other species, mortality never increases, or even continuously declines with age, which has been interpreted as absent- or reverse-aging. We developed a mathematical model that suggests an alternative interpretation. The model describes the age-dependence of mortality as the sum of two opposite processes. The mortality risk due to physiological decline increases monotonously with age. But old individuals gain survival benefits through processes like growth and learning. This simple model fits mortality dynamics for all human age classes and for species across the tree of life. Simulations revealed an unexpected complexity by which learning impacts the evolution of aging. An ability to learn initially accelerated the evolution of slower aging but constrained the slowest possible rate of aging that can evolve. This constraint occurs when, despite a remaining aging rate, learning reduces mortality during the reproductive period to near negligible levels and thereby eliminates selection for a further slow-down of aging. In conclusion, learning accelerates the evolution of slower aging, but species with strong learning-associated survival benefits cannot evolve negligible senescence.