Grandmas made humans live longer

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Computer simulations provide new mathematical support for the "grandmother hypothesis" – a famous theory that humans evolved longer adult lifespans than apes because grandmothers helped feed their grandchildren.

"Grandmothering was the initial step toward making us who we are," says Kristen Hawkes, a distinguished professor of anthropology at the University of Utah and senior author of the new study published Oct. 24 by the British journal Proceedings of the Royal Society B.

The simulations indicate that with only a little bit of grandmothering – and without any assumptions about human brain size – animals with chimpanzee lifespans evolve in less than 60,000 years so they have a human lifespan. Female chimps rarely live past child-bearing years, usually into their 30s and sometimes their 40s. Human females often live decades past their child-bearing years.

The findings showed that from the time adulthood is reached, the simulated creatures lived another 25 years like chimps, yet after 24,000 to 60,000 years of grandmothers caring for grandchildren, the creatures who reached adulthood lived another 49 years – as do human hunter-gatherers.

The grandmother hypothesis says that when grandmothers help feed their grandchildren after weaning, their daughters can produce more children at shorter intervals; the children become younger at weaning but older when they first can feed themselves and when they reach adulthood; and women end up with postmenopausal lifespans just like ours.

By allowing their daughters to have more children, a few ancestral females who lived long enough to become grandmothers passed their longevity genes to more descendants, who had longer adult lifespans as a result.

Hawkes conducted the new study with first author and mathematical biologist Peter Kim, a former University of Utah postdoctoral researcher now on the University of Sydney faculty, and James Coxworth, a University of Utah doctoral student in anthropology. The study was funded by the National Science Foundation and the Australian Research Council.

How Grandmothering Came to Be

Hawkes, University of Utah anthropologist James O'Connell and UCLA anthropologist Nicholas Blurton Jones formally proposed the grandmother hypothesis in 1997, and it has been debated ever since. Once major criticism was that it lacked a mathematical underpinning – something the new study sought to provide.

The hypothesis stemmed from observations by Hawkes and O'Connell in the 1980s when they lived with Tanzania's Hazda hunter-gatherer people and watched older women spend their days collecting tubers and other foods for their grandchildren. Except for humans, all other primates and mammals collect their own food after weaning.

But as human ancestors evolved in Africa during the past 2 million years, the environment changed, growing drier with more open grasslands and fewer forests – forests where newly weaned infants could collect and eat fleshy fruits on their own.

"So moms had two choices," Hawkes says. "They could either follow the retreating forests, where foods were available that weaned infants could collect, or continue to feed the kids after the kids are weaned. That is a problem for mothers because it means you can't have the next kid while you are occupied with this one."

That opened a window for the few females whose childbearing years were ending – grandmothers – to step in and help, digging up potato-like tubers and cracking hard-shelled nuts in the increasingly arid environment. Those are tasks newly weaned apes and human ancestors couldn't handle as infants.

The primates who stayed near food sources that newly weaned offspring could collect "are our great ape cousins," says Hawkes. "The ones that began to exploit resources little kids couldn't handle, opened this window for grandmothering and eventually evolved into humans."

Evidence that grandmothering increases grandchildren's survival is seen in 19th and 20th century Europeans and Canadians, and in Hazda and some other African people.

But it is possible that the benefits grandmothers provide to their grandchildren might be the result of long postmenopausal lifespans that evolved for other reasons, so the new study set out to determine if grandmothering alone could result in the evolution of ape-like life histories into long postmenopausal lifespans seen in humans.

Simulating the Evolution of Adult Lifespan

The new study isn't the first to attempt to model or simulate the grandmother effect. A 1998 study by Hawkes and colleagues took a simpler approach, showing that grandmothering accounts for differences between humans and modern apes in life-history events such as age at weaning, age at adulthood and longevity.

A recent simulation by other researchers said there were too few females living past their fertile years for grandmothering to affect lifespan in human ancestors. The new study grew from Hawkes' skepticism about that finding.

Unlike Hawkes' 1998 study, the new study simulated evolution over time, asking, "If you start with a life history like the one we see in great apes – and then you add grandmothering, what happens?" Hawkes says.

The simulations measured the change in adult longevity – the average lifespan from the time adulthood begins. Chimps that reach adulthood (age 13) live an average of another 15 or 16 years. People in developed nations who reach adulthood (at about age 19) live an average of another 60 years or so – to the late 70s or low 80s.

The extension of adult lifespan in the new study involves evolution in prehistoric time; increasing lifespans in recent centuries have been attributed largely to clean water, sewer systems and other public health measures.

The researchers were conservative, making the grandmother effect "weak" by assuming that a woman couldn't be a grandmother until age 45 or after age 75, that she couldn't care for a child until age 2, and that she could care only for one child and that it could be any child, not just her daughter's child.

Based on earlier research, the simulation assumed that any newborn had a 5 percent chance of a gene mutation that could lead to either a shorter or a longer lifespan.

The simulation begins with only 1 percent of women living to grandmother age and able to care for grandchildren, but by the end of the 24,000 to 60,000 simulated years, the results are similar to those seen in human hunter-gatherer populations: about 43 percent of adult women are grandmothers.

The new study found that from adulthood, additional years of life doubled from 25 years to 49 years over the simulated 24,000 to 60,000 years.

The difference in how fast the doubling occurred depends on different assumptions about how much a longer lifespan costs males: Living longer means males must put more energy and metabolism into maintaining their bodies longer, so they put less vigor into competing with other males over females during young adulthood. The simulation tested three different degrees to which males are competitive in reproducing.

What Came First: Bigger Brains or Grandmothering?

The competing "hunting hypothesis" holds that as resources dried up for human ancestors in Africa, hunting became better than foraging for finding food, and that led to natural selection for bigger brains capable of learning better hunting methods and clever use of hunting weapons. Women formed "pair bonds" with men who brought home meat.

Many anthropologists argue that increasing brain size in our ape-like ancestors was the major factor in humans developing lifespans different from apes. But the new computer simulation ignored brain size, hunting and pair bonding, and showed that even a weak grandmother effect can make the simulated creatures evolve from chimp-like longevity to human longevity.

So Hawkes believes the shift to longer adult lifespan caused by grandmothering "is what underlies subsequent important changes in human evolution, including increasing brain size."

"If you are a chimpanzee, gorilla or orangutan baby, your mom is thinking about nothing but you," she says. "But if you are a human baby, your mom has other kids she is worrying about, and that means now there is selection on you – which was not on any other apes – to much more actively engage her: 'Mom! Pay attention to me!'"

"Grandmothering gave us the kind of upbringing that made us more dependent on each other socially and prone to engage each other's attention," she adds.

That, says Hawkes, gave rise to "a whole array of social capacities that are then the foundation for the evolution of other distinctly human traits, including pair bonding, bigger brains, learning new skills and our tendency for cooperation."

Provided by University of Utah

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