

# OLD AGE IS OVER!

**IF YOU WANT IT**

Get ready for  
the first anti-aging  
drugs, p. 22

Design for seniors  
that doesn't suck,  
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immortality's true  
believers, p. 70



It's 2035, and at your 60th-birthday checkup your doctor lays out an appealing menu of options. You seem to be getting the sniffles more often these days—how about some rapamycin to shore up your immune system? The second generation of senolytics has just come out, and your Aunt Sandra said they're already doing wonders for her joints. Or how about some epigenetic smoothing? It's supposed to completely do away with Alzheimer's, and even though your polygenic score says your risk of developing it is only 7% higher than average, you can't be too careful ... And then, says your doctor, leaning in confidentially, apparently there's a whole new class of mTOR inhibitors, and they're looking for volunteers for the first human trial. Of course, it'll be years before you know if it works, but just imagine—you could live to 115, or 120, or even more!

You're torn. On the one hand, yes, it would be lovely to see the great-great-grandchildren grow up. And keeping yourself serviceable for a bit longer is certainly wise—after all, they just raised the retirement age again, and you lost a good chunk of your savings on that oceanfront property that's now an ocean property. On the other hand, your kids (and their kids) will have it hard enough managing their own retirements without also taking care of you. Politics is getting ugly; some people think the solution to the national debt crisis is to stop Social Security and Medicare for anyone over 85, and everyone's seen the footage from the age riots in Japan. And besides, do you really want to see what the world looks like after another few decades of climate change?

This issue of MIT Technology Review is about big advances in longevity medicine that may be coming soon—some of which I've alluded to above, and which you can read about mostly on pages 14–29—as well as the challenges and opportunities of a world in which people live longer and healthier lives.

As David Rotman (page 8) argues, for such a world to be prosperous and harmonious, society needs to shed stereotypes of older people as unproductive, inflexible, and technologically challenged. Indeed, as Joseph Coughlin (page 32) explains, our very notion of “old age” was invented around the same time as the theory of eugenics and is about equally valid. Groups like the Longevity Explorers (page 76) and Senior Planet (page 58) give the lie to the idea that older people can't start new ventures or learn to use technology. They can also show how to design technology for seniors that—unlike most of what's on offer now—both suits their needs and doesn't have “OLD” written all over it.



Gideon Lichfield is editor in chief of MIT Technology Review.

(Coughlin, by the way, is speaking at EmTech MIT, our annual conference on the biggest topics in technology on September 17–19. So is Joan Mannick, interviewed on page 22, who is leading development of one of the most promising potential

anti-aging drugs. For details, visit [emtechmit.com](http://emtechmit.com).)

But there's also a version of the future in which we've failed to adapt to an aging world, just as we are currently failing to adapt to global warming. It's a future in which many older people, facing the prospect of a longer life and slower final decline, are forced to delay retirement so their savings don't run out; they continue to face ageism and pressure to quit their jobs; those still working have to support a ballooning health and welfare system; and urban infrastructure proves woefully inadequate to the needs of a growing generation of seniors.

And, just as with global warming, which future we get depends on choices we make today. I hope you'll find this issue a useful guide to some of those choices.

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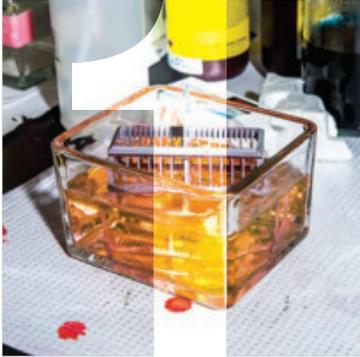
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Don't  
fear  
the

Many worry that aging populations will doom the world economy and make life miserable for everyone. Those fears are born of an ageism that isn't rooted in facts. By David Rotman

gray

tsunami

In many countries, particularly in Europe and North America, people 65 or older make up an increasing percentage of the population.

Key: 5 10 15 20 25 30 35%

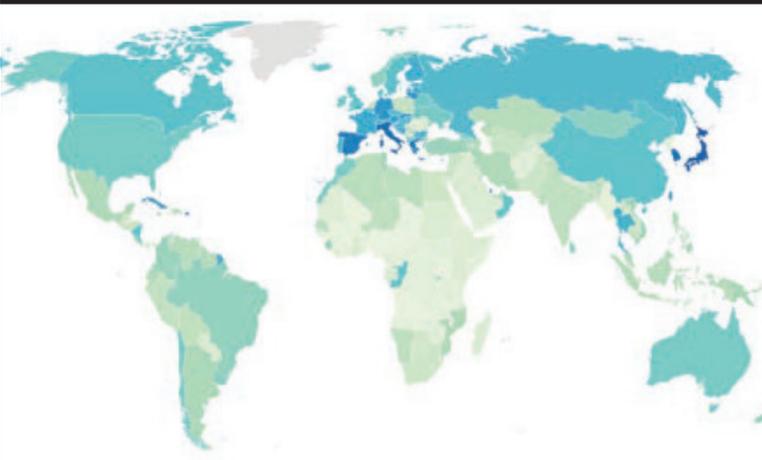
1980



2020



2060



SOURCE: UN WORLD POPULATION PROSPECTS 2019

The aging of the world is happening fast. Americans 65 and older are now 16% of the population and will make up 21% by 2035. At that point, they will outnumber those under 18. In China the large numbers of people born before the one-baby policy was introduced in 1979 are swelling the ranks of older people, even as younger age groups shrink. Other countries are even older. Japan leads—more than a quarter of its population is 65 or older—but Germany, Italy, Finland, and much of the rest of the European Union aren't far behind. A quarter of the people in Europe and North America will be 65 or older by 2050.

This trend is being driven by lower fertility rates (women in almost all countries are having fewer babies) and longer lives. While life expectancy has slowed its increase in some advanced countries in recent years, it continues its upward trend worldwide. A female baby born today in Japan is expected on average to live to 87.

Not only is the overall population aging; you will probably spend much more of your life being old. In 1960, if you were 65, you could expect to live to around 79. These days, you're expected to live to nearly 85. If you're already 75, you should expect to live until 87.

It's a huge shift that is changing our economy, our social and cultural values, and even the way we perceive and plan our lives.

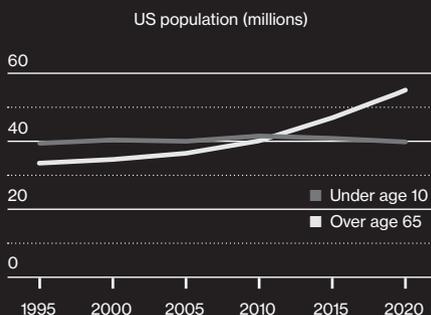
The conventional wisdom is that an aging population is toxic for economic growth. Who will do all the work? How will we pay for all those old people's medical and welfare programs? Economists like to call it the dependency ratio: the size of the working-age population relative to those too old (or too young) to have a job. And they like to show scary projections of how this demographic crisis is coming to get us.

The warnings sound ominous. The gray tsunami. The demographic cliff. The demographic time bomb. But maybe what's truly not aging well is all the fretting about an inevitable crisis.

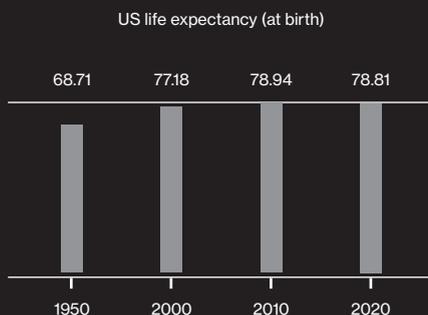
Those 65 and older in the US now outnumber those under 10 for the first time.

Life expectancy has risen greatly over the years, but in the last decade it plateaued.

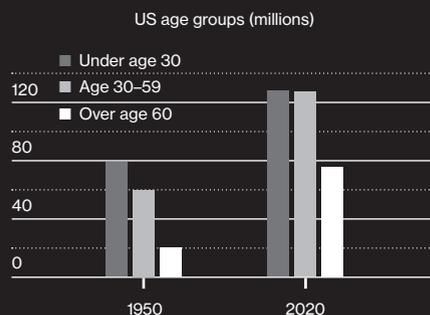
US baby boomers, those born between 1946 and 1964, are skewing the population older.



SOURCE: UN WORLD POPULATION PROSPECTS 2019



SOURCE: UN WORLD POPULATION PROSPECTS 2019



SOURCE: UN WORLD POPULATION PROSPECTS 2109

## Aging societies aren't worse off

**T**he truth is that economists don't know much about how an aging population will affect us.

"There has been a productivity hit," says Nicole Maestas, an economist at Harvard. "It's big, and it's economically meaningful." She and her colleagues have calculated, on the basis of data from 1980 to 2010, that a 10% increase in the population age 60 and older has decreased growth in GDP per capita by 5.5%. It means, if the past is any lesson, that the aging US population could slow economic growth by 1.2 percentage points this decade and 0.6 percentage points in the next. Some of this will be because fewer people are working, but two-thirds of it will be because the workforce is less productive on average.

But Maestas cautions that the projections are based on historical trends and may not be accurate predictions. Her guess is that productivity has fallen as the population ages because the most skilled and experienced people have left in larger numbers, since they're more successful and wealthier and can afford to retire. If she's right, then it's not that workers become less productive as they age, but that the most productive ones stop working.

This means, Maestas says, that a big drop in productivity isn't inevitable. New technologies and business policies might keep talented people working longer. (Less happily, so might shrinking savings and disappearing retirement plans.) Teams made of both young and old people, with diverse experiences, might even be more productive. "Are we all getting less productive,

and we're stuck with that?" she says. "Not necessarily."

"Despite all the stressing about aging," says Daron Acemoglu, an MIT economist, "there is surprisingly very little evidence that aging societies are worse economically." Looking at GDP data from 1990 to 2015, Acemoglu and Boston University's Pascual Restrepo found no correlation between aging demographics and slowed economic growth. In fact, countries like South Korea, Japan, and Germany, all with rapidly aging populations, are actually doing well.

One possible reason? Automation. Countries with aging workforces have been quicker to adopt industrial robots to compensate. The resulting boost to productivity is "softening the doom and gloom around aging," says Acemoglu, who says he went into the research expecting that the impact of aging "wasn't as dark" as many suspected but was surprised by "the total lack of any evidence of negative effects from aging."

Still, Acemoglu also stresses how much remains to be learned. "We're not sufficiently prepared to know what happens when the society ages, and we don't know how to navigate it," he says.

## Living better, but not longer

**T**he increase in life expectancy over the last hundred years has been one of our great technological achievements. At the start of the 20th century, average life expectancy was around 50; by 1960 it was 70, and by 2010 it was up to nearly 80. Most

of the early progress was due to keeping children healthier—in 1900 nearly one in four died before age 10. Later progress came in the treatment of things like cardiovascular disease, allowing most people to live into their 70s.

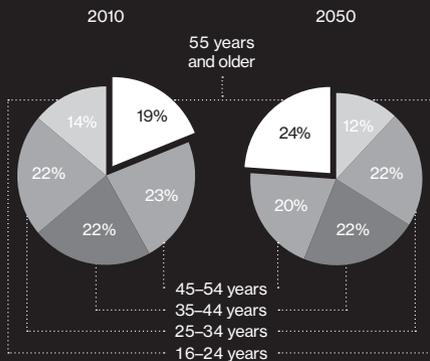
But don't expect this remarkable run to continue. Average life expectancy is leveling off and appears to be hitting a ceiling at just a little over 80. S. Jay Olshansky, at the University of Illinois at Chicago's school of public health, has been predicting this slowdown for years. He says we're near our upper limit for average life spans. "Possibly we can get it up from 80 to 85," he says, noting that already "Japan is closing in on it."

One thing we haven't been able to do is intervene to slow the aging process itself. But a first wave of promising anti-aging drugs (see pages 14–29)—the result of several decades of breakthroughs in understanding the biology of aging—are being tested in humans. They won't let us live forever; they probably won't even let us live longer, Olshansky says. But they could help us stay healthier longer in old age.

For now, the hope for these molecules—which include rapamycin-like compounds that affect immune function, ones that activate proteins called sirtuins, and "senolytic" drugs that clean up damaged and aging cells—is that they can help with age-related ailments. Most ambitious, scientists are planning human tests for metformin, a longtime diabetes drug, to see if it can slow multiple age-related conditions.

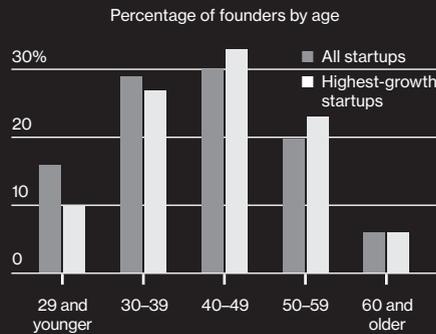
If any of them succeed, it will validate an idea that could change medicine: that it's possible to attack certain illnesses by

By 2050, a quarter of US workers will be 55 or older (percentage of labor force by age).



SOURCE: US BUREAU OF LABOR STATISTICS

The average age of people who founded the highest-growth startups is 45.



SOURCE: AZOULAY, JONES, KIM AND MIRANDA: HBR

And middle-aged founders are much more likely to be successful than younger ones.

A 50-year-old founder is **1.8x** more likely to create a highly successful startup than a 30-year-old founder

SOURCE: AZOULAY, JONES, KIM, MIRANDA; NBER

intervening in natural aging processes—in other words, by treating aging itself in order to slow the contributing causes of disease (page 14). Scientists envision these drugs eventually helping older people as they become frail and disabled, vulnerable to one illness after another—basically, when the body begins to fall apart.

Some of these promising compounds have already dramatically extended the life span of yeast, worms, and rodents, but we're still a long way from performing such longevity tricks in humans. "The most important thing is extending the healthy life span," says Leonard Guarente, an anti-aging pioneer at MIT. "Will that extend maximum life span? The answer is unknown. Anyone that tells you they know is not telling the truth."

Claims that aging itself is a disease that can be cured are good for gaining attention and money for the research—who doesn't want to live forever? It's hard to think Silicon Valley investors like Peter Thiel and Larry Page would pour money into anti-aging research if the payoff were simply to make you less frail in your 80s. But the idea of aging as a pathology creates a misleading promise. Despite several decades' worth of exciting advances, we're still far from a "cure," and don't even really know what a cure might look like.

Beyond being scientifically disingenuous, the aging-as-a-disease crowd is promoting a dangerous message. Not only does treating aging as a disease cast a negative light on getting old, but it distracts us from the most pressing issue: How do we keep ourselves productive and healthy as we grow older?

## Fear of our older selves

It's been 12 years since Facebook CEO Mark Zuckerberg famously asserted that "young people are just smarter," and almost a decade since billionaire venture capitalist Vinod Khosla told an audience, "People under 35 are the people who make change happen," adding, "People over 45 basically die in terms of new ideas."

There are few signs that Silicon Valley is changing its tune. Multiple tech firms have faced lawsuits over age bias. In a court filing for a 60-year-old programmer not hired by Google, the complaint noted that the company's workforce had grown from 9,500 to 28,000 people from 2007 to 2013 with a median age of 29, at a time when the US average was around 42. And Khosla himself recently doubled down on his argument, tweeting, "Experience is a bias."

Academic research indicates that Zuckerberg and Khosla are wrong. In a rigorous study that looked at 2.7 million company founders, economists at MIT, the US Census Bureau, and Northwestern University concluded the best entrepreneurs are middle-aged. The fastest-growing startups were created by founders with an average age of 45. In a 2018 paper they found that a 50-year-old entrepreneur was nearly twice as likely to build a highly successful company as a 30-year-old. And contrary to Khosla's tweet, it turns out that industry experience was a significant positive in predicting success.

Blatant age bias might also explain why Silicon Valley has done such a terrible job

of creating startups in biomedicine, clean energy, or other areas requiring scientific expertise and knowledge. In earlier research, one of the authors of last year's paper, Benjamin Jones, an economist at Northwestern, presented evidence that most great scientific achievements in the physical sciences and medicine come in middle age, not from the precocious young.

It's a message largely lost on Silicon Valley and its youth-fetishizing investors—it seems that billionaires are, after all, set in their ways.

Even if they don't change their ideas about aging, though, it's critical that our larger society does. "If we can't extend health spans and lower health-care costs, if we can't increase productivity and integrate older workers more effectively, and if we can't tackle the disparities that challenge so many aging communities, the costs to society will be mind-blowing," says Paul Irving, chairman of the Milken Institute Center for the Future of Aging.

The harm won't just be economic. The financial and emotional hit to older workers unable to find a job because of bias is devastating to families and communities. And it's a pain caused by our own narrow thinking and limited imaginations. Ageism is a particularly pernicious bias because it is a fear of our own selves. We're all going to get old (if we're lucky) and die.

But while aging might be inevitable, becoming unproductive is not. We might be facing a demographic tsunami, but we don't have to be overwhelmed by it. We can take the high ground. **T**

David Rotman is editor at large of MIT Technology Review.

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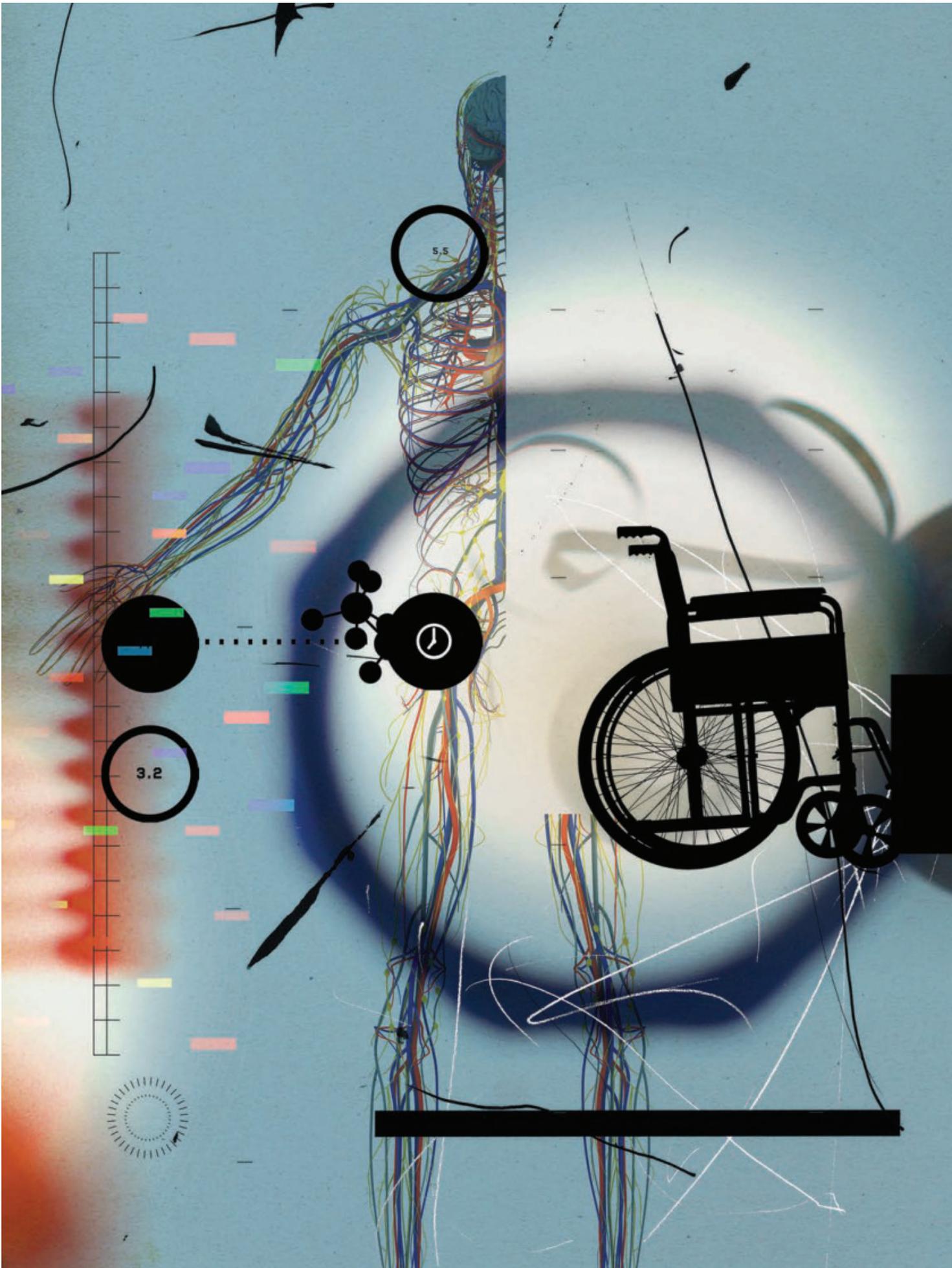
# The biology of aging

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As we get older, we're more susceptible to disease. But what if we treated aging itself as the disease? We're getting close, says one biotech exec, to making drugs that might help us live longer by boosting our immune system. Other researchers think the key is fiddling with how our genes turn on and off, and they have the experimental mice to prove it.

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# 1



WHAT IF AGING WERE A

D

If this controversial idea gains acceptance, it could radically change the way we treat getting old.

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S

Each Cyclops had a single eye because, legend has it, the mythical giants traded the other one with the god Hades in return for the ability to see into the future. But Hades tricked them: the only vision the Cyclopes were shown was the day they would die. They carried this knowledge through their lives as a burden—the unending torture of being forewarned and yet having no ability to do anything about it.

Since ancient times, aging has been viewed as simply inevitable, unstoppable, nature’s way. “Natural causes” have long been blamed for deaths among the old, even if they died of a recognized pathological condition. The medical writer Galen argued back in the second century AD that aging is a natural process.

His view, the acceptance that one can die simply of old age, has dominated ever since. We think of aging as the accumulation of all the other conditions that get more common as we get older—cancer, dementia, physical frailty. All that tells us, though, is that we’re going to sicken and die; it doesn’t give us a way to change it. We don’t have much more control over our destiny than a Cyclops.

But a growing number of scientists are questioning our basic conception of aging. What if you could challenge your death—or even prevent it altogether? What if the panoply of diseases that strike us in old age are symptoms, not causes? What would change if we classified aging itself as the disease?

E

By DAVID ADAM

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David Sinclair, a geneticist at Harvard Medical School, is one of those on the front line of this movement. Medicine, he argues, should view aging not as a natural consequence of growing older, but as a condition in and of itself. Old age, in his view, is simply a pathology—and, like all pathologies, can be successfully treated. If we labeled aging differently, it would give us a far greater ability to tackle it in itself, rather than just treating the diseases that accompany it.

“Many of the most serious diseases today are a function of aging. Thus, identifying the molecular mechanisms and treatments of aging should be an urgent priority,” he says. “Unless we address aging at its root cause, we’re not going to continue our linear, upward progress toward longer and longer life spans.”

It is a subtle shift, but one with big implications. How disease is classified and viewed by public health groups such as the World Health Organization (WHO) helps set priorities for governments and those who control funds. Regulators, including the US Food and Drug Administration (FDA), have strict rules that guide what conditions a drug can be licensed to act on, and so what conditions it can be prescribed and sold for. Today aging isn’t on the list. Sinclair says it should be, because otherwise the massive investment needed to find ways to fend it off won’t appear.

Illustration by Stuart Bradford

S

E

## Milestones in the history of aging research

Key: ■ Life span | ■ Genetics | ■ Treatments

“Work to develop medicines that could potentially prevent and treat most major diseases is going far slower than it should be because we don’t recognize aging as a medical problem,” he says. “If aging were a treatable condition, then the money would flow into research, innovation, and drug development. Right now, what pharmaceutical or biotech company could go after aging as a condition if it doesn’t exist?” It should, he says, be the “biggest market of all.”

That’s precisely what worries some people, who think a gold rush into “anti-aging” drugs will set the wrong priorities for society.

It “turns a scientific discussion into a commercial or a political discussion,” says Eline Slagboom, a molecular epidemiologist who works on aging at Leiden University Medical Center in the Netherlands. Viewing age as just a treatable disease shifts the emphasis away from healthy living, she says. Instead, she argues, policymakers and medical professionals need to do more to prevent chronic diseases of old age by encouraging people to adopt healthier lifestyles while they are still young or middle-aged. Otherwise, the message is “that we can’t do anything with anybody [as they age] until they reach a threshold at the point where they get sick or age rapidly, and then we give them medication.”

Another common objection to the aging-as-a-disease hypothesis is that labeling old people as diseased will add to the stigma they already face. “Ageism is the biggest ism we have today in the world,” says Nir Barzilai, director of the Institute for Aging Research at the Albert Einstein College of Medicine in New York. “The aging community is attacked. People are fired from work because they are old. Old people cannot get jobs. To go to those people with so many problems and now tell them, ‘You’re sick, you have a disease?’ This is a no-win situation for the people we are trying to help.”

Not everyone agrees it has to be a stigma. “I am clearly in favor of calling aging a disease,” says Sven Bulterijs, cofounder of the Healthy Life Extension Society, a nonprofit organization in Brussels that considers aging a “universal human tragedy” with a root cause that can be found and tackled to make people live longer. “We don’t say for cancer patients that it’s insulting to call it a disease.”

Notwithstanding Sinclair’s comment about “linear, upward progress,” just how long humans could live remains bitterly contested. The underlying, fundamental question: Do we have to die at all? If we found a way to both treat and beat aging as a disease, would we live for centuries—millennia, even? Or is there an ultimate limit?

Nature suggests that endless life might not be inconceivable. Most famously, perhaps, the bristlecone pine trees of North America are considered biologically immortal. They can die—chopped down by an ax or zapped by a lightning bolt—but left undisturbed, they typically won’t simply fall over because they get old. Some are reckoned to be 5,000 years young; age, quite literally, does not wither them. Their secret remains a mystery. Other species appear to show signs of biological immortality as well, including some sea creatures.

1935

1940

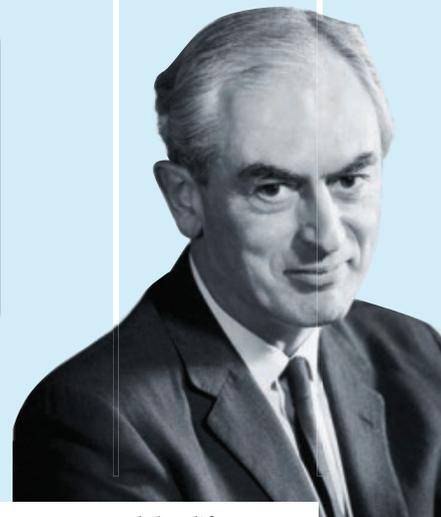
1945

1950



1934

**Clive McCay** discovers the concept of caloric restriction by finding that rats live longer if they consume limited diets.



Such observations have led many to contend that life span can be dramatically extended with the right interventions. But in 2016, a high-profile study published in *Nature* argued that human life has a hard limit of about 115 years. This estimate is based on global demographic data showing that improvements in survival with age tend to decline after 100, and that the record for human longevity hasn’t increased since the 1990s. Other researchers have disputed the way the analysis was done.

Barzilai says efforts to tackle aging are needed regardless. “We can argue about if it’s 115 or 122 or 110 years,” he says. “Now we die before the age of 80, so we have 35 years that we are not realizing now. So let’s start realizing those years before we’re talking about immortality or somewhere in between.”

Whether or not they believe in either the disease hypothesis or maximum life spans, most experts agree that something has to change in the way we deal with aging. “If we don’t do something about the dramatic increase in older people, and find ways to keep them healthy and functional, then we have a major quality-of-life issue and a major economic issue on our hands,” says Brian Kennedy, the director of Singapore’s Centre for Healthy Ageing and a professor of biochemistry and physiology at the National University of Singapore. “We have to go out and find ways to slow aging down.”

The aging population is the “climate change of health care,” Kennedy says. It’s an appropriate metaphor. As with global warming, many of the solutions rest on changing people’s behavior—for example, modifications to diet and lifestyle. But, also as with global warming, much of the world seems instead to be pinning its hopes on a technological fix. Maybe the future will involve not just geoengineering but also gero-engineering.

One thing that may underlie the growing calls to reclassify aging as a disease is a shift in social attitudes. Morten Hillgaard Bülow, a historian of medicine at the University of Copenhagen, says things started to change in the 1980s, when the idea of “successful aging” took hold. Starting with studies organized and funded by the MacArthur Foundation in the United States, aging experts began to argue against Galen’s centuries-old stoic acceptance of decline, and said scientists should find ways to intervene. The US

1955

1960

1965

1970

1975

1980

1985

1952

Zoologist and anatomist **Peter Medawar** proposes the idea of senescence—cellular aging—and argues that aging is linked to reproduction, in a theory he calls “early-life fitness.”



1961

Biologists Leonard Hayflick and Paul Moorhead discover that human cells derived from **embryonic tissue** divide a finite number of times: the “Hayflick limit.”

1977

**Elizabeth Blackburn** at Yale discovers that telomeres, the structures at the ends of chromosomes, have unusual properties and vary in size with age.



1980

James Fries argues that every person is born with a maximum potential life span, and the average is 85 years.

1981

Michael Rose at the University of California, Irvine, breeds a strain of **fruit fly** that can live four times longer than normal.



government, aware of the health implications of an aging population, agreed. At the same time, advances in molecular biology led to new attention from researchers. All that sent money flowing into research on what aging is and what causes it.

In the Netherlands, Slagboom is trying to develop tests to identify who is aging at a normal rate, and who has a body older than its years. She sees anti-aging medicine as a last resort but says understanding someone’s biological age can help determine how to treat age-related conditions. Take, for instance, a 70-year-old man with mildly elevated blood pressure. If he has the circulatory system of an 80-year-old, then the elevated pressure could help blood reach his brain. But if he has the body of a 60-year-old, he probably needs treatment.

Biomarkers that can identify biological age are a popular tool in aging research, says Vadim Gladyshev of Brigham and Women’s Hospital in Boston. He characterizes aging as the accumulation of deleterious changes across the body, ranging from shifts in the populations of bacteria that live in our gut to differences in the degree of chemical scarring on our DNA, known as methylation. These are biological measures that can be tracked, so they can also be used to monitor the effectiveness of anti-aging drugs. “Once we can measure and quantify the progression through aging, then that gives us a tool to assess longevity interventions,” he says.

Two decades on, the results of that research are becoming apparent. Studies in mice, worms, and other model organisms have revealed what’s going on in aging cells and come up with various ways to extend life—sometimes to extraordinary lengths.

Most researchers have more modest goals, with a focus on improving what they call “health span”—how long people remain independent and functional. And they say they’re making progress, with a handful of possible pills in the pipeline.

One promising treatment is metformin. It’s a common diabetes drug that has been around for many years, but animal studies suggest it could also protect against frailty, Alzheimer’s, and cancer. Giving it to healthy people might help delay aging, but without official guidance doctors are reluctant to prescribe it that way.

One group of researchers, including Einstein College’s Barzilai, is trying to change that. Barzilai is leading a human trial called

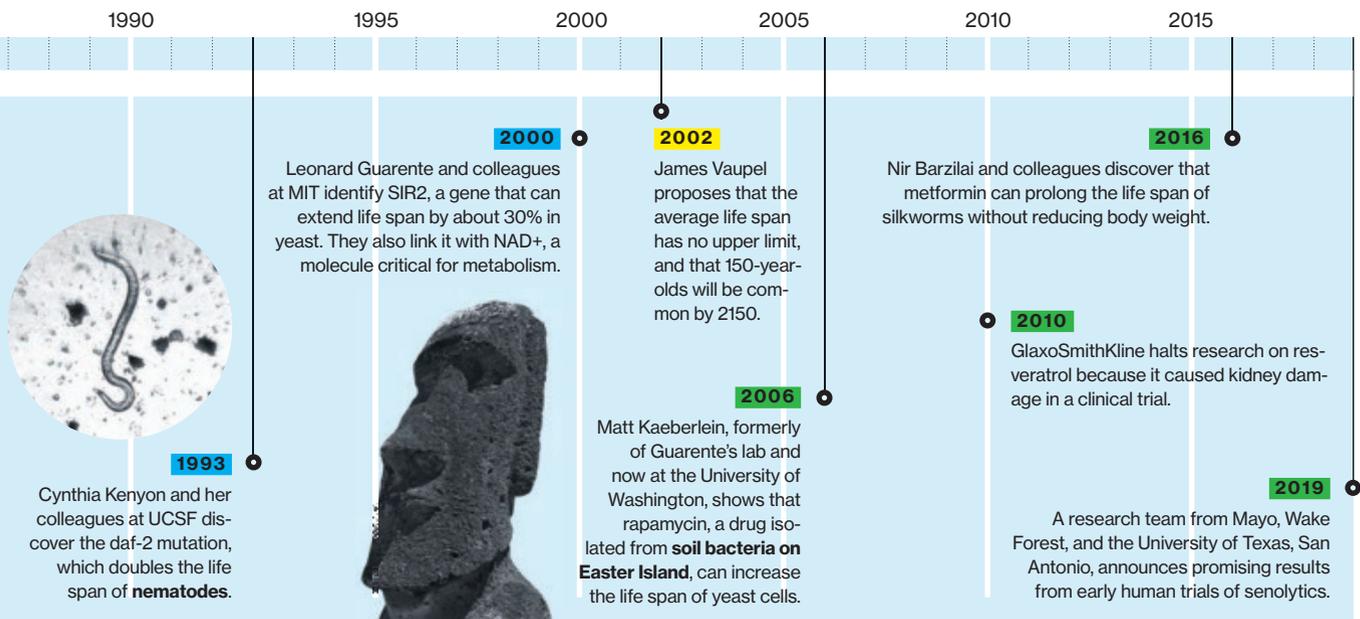
TAME (Targeting Aging with Metformin) that plans to give the drug to people aged 65 to 80 to see if it delays problems such as cancer, dementia, stroke, and heart attacks. Although the trial has struggled to raise funding—partly because metformin is a generic drug, which reduces potential profits for drug companies—Barzilai says he and his colleagues are now ready to recruit patients and start later this year.

Metformin is one of a broader class of drugs called mTOR inhibitors. These interfere with a cell protein involved in division and growth. By turning the protein’s activity down, scientists think they can mimic the known benefits of calorie restriction diets. These diets can make animals live longer; it’s thought that the body may respond to the lack of food by taking protective measures. Preliminary human tests suggest the drugs can boost older people’s immune systems and stop them from catching infectious bugs.

Other researchers are looking at why organs start to pack up as their cells age, a process called senescence. Among the leading candidates for targeting and removing these decrepit cells from otherwise healthy tissues is a class of compounds called senolytics. These encourage the aged cells to selectively self-destruct so the immune system can clean them out. Studies have found that older mice on these drugs age more slowly. In humans, senescent cells are blamed for diseases ranging from atherosclerosis and cataracts to Parkinson’s and osteoarthritis. Small human trials of senolytics are under way, although they aren’t officially aimed at aging itself, but on the recognized illnesses of osteoarthritis and a lung disease called idiopathic pulmonary fibrosis.

Research on these drugs has highlighted a key question about aging: Is there a common mechanism by which different tissues change and decline? If so, could we find drugs to target that mechanism instead of playing what Harvard’s David Sinclair calls “whack-a-mole” medicine, treating individual diseases as they emerge? He believes there is, and that he has found a stunning new way to rewind the aging clock.

In unpublished work described in his coming book *Lifespan*, he says the key to his lab’s work in this area is epigenetics. This fast-moving field focuses on how changes to the way genes are expressed, rather than mutations to the DNA itself, can produce physiological changes such as disease. Some of the body’s own



epigenetic mechanisms work to protect its cells, repairing damage to DNA, for instance; but they become less effective with age. Sinclair claims to have used gene therapy to effectively recharge these mechanisms in mice, and he says he can “make damaged optic-nerve cells young again” to restore sight to elderly blind animals.

We have been here before. Many scientists thought they had found a fountain of youth in animal studies, only to have the results dry up when they turned their attention to people. But Sinclair is convinced he is on to something. He says he'll soon publish the results in a scientific journal for other researchers to examine.

Because aging isn't officially a disease, most research on these drugs exists in a gray area: they don't—or can't—officially tackle aging. For example, Barzilai's metformin project, the closest the world has right now to a clinical trial for a drug that targets aging, aims to prevent diseases associated with aging rather than aging itself, as do the trials on senolytics. “And one of the side effects is you might live longer,” he says.

Barzilai won't go so far as to say aging should be reclassified as a disease, but he does say that if it were, discoveries might happen faster. Studies like TAME have to give people a drug, then wait years and years to see if it prevents some of them from developing an age-related disease. And because that effect is likely to be relatively small, it takes huge numbers of people to prove anything. If aging were instead considered a disease, trials could focus on something quicker and cheaper to prove—such as whether the drug slows the progression from one stage of aging to another.

The Healthy Life Extension Society is part of a group that last year asked the WHO to include aging in the latest revision of its official International Classification of Diseases, ICD-11. The WHO declined, but it did list “aging-related” as an extension code that can be applied to a disease, to indicate that age increases the risk of getting it.

To try to put research into treatments that target aging on a more scientific footing, a different group of scientists is preparing to revisit the issue with the WHO. Coordinated by Stuart Calimport, a former advisor to the SENS Research Foundation in California, which promotes research on aging, the detailed proposal—a copy of which has been seen by MIT Technology Review—suggests

that each tissue, organ, and gland in the body should be scored—say, from 1 to 5—on how susceptible it is to aging. This so-called staging process has already helped develop cancer treatments. In theory, it could allow drugs to be licensed if they are shown to stop or delay the aging of cells in a region of the body.

Reclassifying aging as a disease could have another big benefit. David Gems, a professor of the biology of aging at University College London, says it would provide a way to crack down on quack anti-aging products. “That would essentially protect older people from the swirling swamp of exploitation of the anti-aging business. They're able to make all sorts of claims because it's not legally a disease,” Gems says.

In February, for instance, the FDA was forced to warn consumers that injections of blood from younger people—a procedure that costs thousands of dollars and has become increasingly popular around the world—had no proven clinical benefit. But it couldn't ban the injections outright. By calling them an anti-aging treatment, companies escape the strict oversight applied to drugs that claim to target a specific disease.

Like the Cyclops, Singapore has been given a glimpse of what is to come—and officials there do not like what they see. The island nation is on the front line of the gray surge. By 2030, if current trends continue, there will be just two people working there for every retired person (by comparison, the US will have three people in the workforce for every resident over 65). So the country is trying to change the script, to find a happier and healthier ending.

With the help of volunteer subjects, Kennedy of Singapore's Centre for Healthy Ageing is preparing the first wide-ranging human tests of aging treatments. Kennedy says he's aiming to trial 10 to 15 possible interventions—he won't say which, for now—in small groups of people in their 50s: “I'm thinking maybe three or four drugs and a few supplements, and then compare those to lifestyle modifications.”

The Singapore government has prioritized strategies to deal with the aging population and Kennedy wants to create a “test bed” for such human experiments. “We have made great progress in animals,” he adds, “but we need to begin to do these tests in people.”

David Adam is a freelance writer and editor, and the author of *The Man Who Couldn't Stop*.

# Is an anti-aging drug around the corner?

We will soon learn if a rapamycin-like drug can boost the immune response by targeting how the body ages.

By **STEPHEN S. HALL**

One of today's most promising drugs for targeting aging has a long, circuitous history. In 1999, the US Food and Drug Administration approved rapamycin as an immunosuppressant to prevent the rejection of transplanted organs. Scientists later found it affected all sorts of biological processes; the "mammalian target of rapamycin" (or mTOR) includes immune function and inflammation.

Experiments also showed that rapamycin extended the life span of yeast, worms, and mice. Could it do the same thing in humans?

At present, there's no rigorous way to test rapamycin's potential to slow human aging. Rather, researchers have zeroed in on a significant aspect of aging—the decline in immune function—to see if drugs that mimic rapamycin can enhance immune function in older people.

Joan B. Mannick is cofounder and chief medical officer of a biotech company called resTORbio, spun out of Novartis in 2017, which is conducting clinical trials of RTB101. It's a drug candidate at the forefront of efforts to slow the age-related decline of the immune response. Mannick says we will have our first answer about the potential of this anti-aging intervention within a year.

T R :

Q + A



The drug targets people

**65 and older**

to boost immune response to fight off respiratory tract infections, the

**7th**

leading cause of death in older people.

Results are due by **mid-2020**

**Q: In 2009, experiments showed that molecules blocking the rapamycin pathway extended life span in lab animals. Were you following that work?**

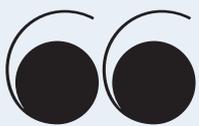
**A:** Yes. Around that time, in 2010, I went to Novartis in what's called their New Indications Discovery Unit. In that unit, we were allowed to choose indications that didn't fall into traditional Big Pharma buckets and so might be missed in drug development. The area that I wanted to work in was aging. I proposed to Novartis that I would look at the effects of Novartis's rapamycin analogue, a cancer drug, on an aging-related condition in humans.

**Q: Why did you choose immune function? And why that particular patient population, in New Zealand and Australia?**

**A:** We had to think about: What is an aging-related endpoint that we can assess in a relatively short period of time in a clinical trial? What we decided to study first was immune function. When old animals are given TORC1 inhibitors [drugs that block the TOR pathway], there's some data that their immune function gets better, and they respond better to an influenza vaccination. In the first study, the first thing we chose to do was just say: Can older people respond better to an influenza vaccination when they're given a TORC1 inhibitor? At the time that we were running this trial, it was cold and flu season in the Southern Hemisphere, in Australia and New Zealand.

**Q: The study showed that the drug improved immune function by 20%. Were you surprised?**

**A:** We were going into uncharted territory. No one had looked yet at whether TORC1 inhibition had any benefits in human aging. So yeah, that was one of those great moments as a researcher when you get data, and the data is positive.



**The field is not a decade away. We don't know yet ... but if this result is positive we'll have a product that is targeting the biology of aging.**

**Q: How do you explain the paradox of rapamycin—which has been used to suppress the immune system after organ transplants—enhancing immune function in this different application?**

**A:** When you use it as an immune-suppressive agent, it's used at high doses. When we're studying its effects on modulating immune function, we use much lower doses or intermittent dosing, and that's where we see it actually enhances immune function.

The other interesting thing is, as we age the mTOR pathway becomes overactive in some tissues. So just turning mTOR down to “younger” levels rather than turning it off—which is what we try to do in transplant patients—may be of benefit in aging-related conditions.

**Q: Can you say anything about interim results of the drug that your company is testing in advanced clinical trials?**

**A:** We don't have anything to say about interim results. They're still on track for readouts in 2020.

The exciting thing about this, which I don't know if the aging field has realized, is this is the farthest-along program of anything in the aging field. We have two phase III trials targeting the biology of aging, to prevent aging-related diseases in humans, that will have a readout in a year. That's huge!

The field is not a decade away. We don't know yet, and we have to wait for the results of the trial. But if this result is positive and if health authorities approve this drug—which are two “ifs”—we'll have a product for people that is targeting the biology of aging to prevent aging-related diseases. Not just in our lifetime, but in, you know, a few years.

I think everybody is sort of like, “Oh, in a decade ...” And no, it's, like, soon! 📺

T H E M O U S E

T H A T D I E D O F

Y O U N G A G E



S O M E        S C I E N T I S T S        T H I N K

E D I T I N G        T H E        E P I G E N O M E ,

W H I C H        T U R N S        O U R        G E N E S

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**T**

he black mouse on the screen sprawls on its belly, back hunched, blinking but otherwise motionless. Its organs are failing. It appears to be days away from death. It has progeria, a disease of accelerated aging, caused by a genetic mutation. It is only three months old.

I am in the laboratory of Juan Carlos Izpisúa Belmonte, a Spaniard who works at the Gene Expression Laboratory at San Diego's Salk Institute for Biological Studies, and who next shows me something hard to believe. It's the same mouse, lively and active, after being treated with an age-reversal mixture. "It completely rejuvenates," Izpisúa Belmonte tells me with a mischievous grin. "If you look inside, obviously, all the organs, all the cells are younger."

Izpisúa Belmonte, a shrewd and soft-spoken scientist, has access to an inconceivable power. These mice, it seems, have sipped from a fountain of youth. Izpisúa Belmonte can rejuvenate aging, dying animals. He can rewind time. But just as quickly as he blows my mind, he puts a damper on the excitement. So potent was the rejuvenating treatment used on the mice that they either died after three or four days from cell malfunction or developed tumors that killed them later. An overdose of youth, you could call it.

The powerful tool that the researchers applied to the mouse is called "reprogramming." It's a way to reset the body's so-called epigenetic marks: chemical switches in a cell that determine which of its genes are turned on and which are off. Erase

these marks and a cell can forget if it was ever a skin or a bone cell, and revert to a much more primitive, embryonic state. The technique is frequently used by laboratories to manufacture stem cells. But Izpisúa Belmonte is in a vanguard of scientists who want to apply reprogramming to whole animals and, if they can control it precisely, to human bodies.

Izpisúa Belmonte believes epigenetic reprogramming may prove to be an "elixir of life" that will extend human life span significantly. Life expectancy has increased more than twofold in the developed world over the past two centuries. Thanks to childhood vaccines, seat belts, and so on, more people than ever reach natural old age. But there is a limit to how long anyone lives, which Izpisúa Belmonte says is because our bodies wear down through inevitable decay and deterioration. "Aging," he writes, "is nothing other than molecular aberrations that occur at the cellular level." It is, he says, a war with entropy that no individual has ever won.

But each generation brings new possibilities, as the epigenome gets reset during reproduction when a new embryo is formed. Cloning takes advantage of reprogramming, too: a calf cloned from an adult bull contains the same DNA as the parent, just refreshed. In both cases, the offspring is born without the accumulated "aberrations" that Izpisúa Belmonte refers to.

What Izpisúa Belmonte is proposing is to go one step better still, and reverse aging-related aberrations without having to create a new individual. Among these are changes to our epigenetic marks—chemical groups called histones and methylation marks, which wrap around a cell's DNA and function as on/off switches for genes. The accumulation of these changes causes the cells to function less efficiently as we get older, and some scientists, Izpisúa Belmonte

included, think they could be part of why we age in the first place. If so, then reversing these epigenetic changes through reprogramming may enable us to turn back aging itself.

Izpisúa Belmonte cautions that epigenetic tweaks won't "make you live forever," but they might delay your expiration date. As he sees it, there is no reason to think we cannot extend human life span by another 30 to 50 years, at least. "I think the kid that will be living to 130 is already with us," Izpisúa Belmonte says. "He has already been born. I'm convinced."

**"I THINK THE KID THAT  
WILL BE LIVING TO 130  
IS ALREADY WITH US.  
HE HAS ALREADY BEEN  
BORN. I'M CONVINCED."**



Izpisúa Belmonte's lab at the Salk Institute.

## YOUTH FACTORS

The treatment Izpisúa Belmonte gave his mice is based on a Nobel-winning discovery by the Japanese stem-cell scientist Shinya Yamanaka. Starting in 2006, Yamanaka demonstrated how adding just four proteins to human adult cells could reprogram them so that they look and act like those in a newly formed embryo. These proteins, called the Yamanaka factors, function by wiping clean the epigenetic marks in a cell, giving it a fresh start.

"He went backwards in time," Izpisúa Belmonte says. All the methylation marks, those epigenetic switches, "are erased," he adds. "Then you're starting life again." Even skin cells from centenarians, scientists have found, can be rewound to a primitive, youthful state. The artificially reprogrammed cells are called induced pluripotent stem cells, or iPSCs. Like the stem cells in embryos, they can then turn into any kind of

body cell—skin, bone, muscle, and so on—if given the right chemical signals.

To many scientists, Yamanaka's discovery was promising mainly as a way to manufacture replacement tissue for use in new types of transplant treatments. In Japan, researchers began an effort to reprogram cells from a Japanese woman in her 80s with a blinding disease, macular degeneration. They were able to take a sample of her cells, return them to an embryonic state with Yamanaka's factors, and then direct them to become retinal cells. In 2014, the woman became the first person to receive a transplant of such lab-made tissue. It didn't make her vision sharper, but she did report it as being "brighter," and it stopped deteriorating.

Before then, though, researchers at the Spanish National Cancer Research Centre had already taken the technology in a new direction when they studied mice whose genomes harbored extra copies of the Yamanaka factors. Turning these on, they demonstrated that cell reprogramming could actually occur inside an adult animal body, not only in a laboratory dish.

The experiment suggested an entirely new form of medicine. You could potentially rejuvenate a person's entire body. But it also underscored the dangers. Clear away too many of the methylation marks and other footprints of the epigenome and "your cells basically lose their identity," says Pradeep Reddy, a staff researcher at Salk who worked on these experiments with Izpisúa Belmonte. "You are erasing their memory." These cellular blank slates can grow into a mature, functioning cell, or into one that never develops the ability to perform its designated task. It can also become a cancer cell.

That's why the mice I saw in Izpisúa Belmonte's lab were prone to sprouting tumors. It proved that

cellular reprogramming had indeed occurred inside their bodies, but the results were usually fatal.

Izpisúa Belmonte believed there might be a way to give mice a less lethal dose of reprogramming. He was inspired by salamanders, which can regrow an arm or tail. Researchers have yet to determine exactly how amphibians do this, but one theory is that it happens through a process of epigenetic resetting similar to what the Yamanaka factors achieve, though more limited in scope. With salamanders, their cells "just go back a little bit" in time, Izpisúa Belmonte says.

Could the same thing be done to an entire animal? Could it be rejuvenated just enough?

In 2016, the team devised a way to partially rewind the cells in mice with progeria. They genetically modified the mice to produce the Yamanaka factors in their bodies, just as the Spanish researchers had done; but this time, the mice would produce those factors only when given an antibiotic, doxycycline.

In Izpisúa Belmonte's lab, some mice were allowed to drink water containing doxycycline continuously. In another experiment, others got it just for two days out of every seven. "When you give them ... doxycycline, expression of the genes starts," explains Reddy. "The moment you remove it, the expression of the genes stops. You can easily turn it on or off."

The mice that drank the most, like the one Izpisúa Belmonte showed me, quickly died. But the mice that drank a limited dose did not develop tumors. Instead, they became more physically robust, their kidneys and spleens worked better, and their hearts pumped harder.

In all, the treated mice also lived 30% longer than their littermates. "That was the benefit," Izpisúa Belmonte says. "We don't kill the mouse. We don't generate tumors, but we have our rejuvenation."

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**FOUNTAIN OF YOUTH**

When Izpisúa Belmonte published his report in the journal *Cell*, describing the rejuvenated mice, it seemed to some as if Ponce de Leon had finally spotted the fountain of youth. “I think Izpisúa Belmonte’s paper woke a lot of people up,” says Michael West, CEO of AgeX, which is pursuing similar aging reversal technology. “All of a sudden all of the leaders in aging research are like, ‘Oh, my gosh, this could work in the human body.’”

To West, the technology offers the prospect that humans, like salamanders, could regrow missing limbs or damaged organs. “Humans have that ability too, when we are first forming,” he says. “So if we can reawaken those pathways ... wow!”

To others, however, the evidence for rejuvenation is plainly in its infancy. Jan Vijg, chair of the genetics department at the Albert Einstein College of Medicine in New York City, says aging consists of “hundreds of different processes” to which simple solutions are unlikely. Theoretically, he believes, science can “create processes that are so powerful they could override all of the other ones.” But he adds, “We don’t know that right now.”

An even broader doubt is whether the epigenetic changes that Izpisúa Belmonte is reversing in his lab are really the cause of aging or just a sign of it—the equivalent of wrinkles in aging skin. If so, Izpisúa Belmonte’s treatment might be like smoothing out wrinkles, a purely cosmetic effect. “We have no way of knowing, and there is really no evidence, that says the DNA methylation [is] causing these cells to age,” says John Greally, another professor at Einstein. The notion that “if I change those DNA methylations, I will be influencing aging,” he says, “has red flags all over it.”

One other fundamental question hangs over Izpisúa Belmonte’s

findings: while he succeeded in rejuvenating mice with progeria, he hasn’t done it in normal aged animals. Progeria is an illness due to a single DNA mutation. Natural aging is much more complex, says Vittorio Sebastiano, an assistant professor at the Stanford Institute for Stem Cell Biology and Regenerative Medicine. Would the rejuvenation technique work in naturally aged animals and in human cells? He says Izpisúa



Belmonte’s research so far leaves that crucial question unanswered.

Izpisúa Belmonte’s team is working to answer it. Experiments to rejuvenate normal mice are under way. But because normal mice live as long as two and a half years, whereas those with progeria live three months, the evidence is taking longer to gather. “And if we have to modify any experimental condition,” Reddy says, “then the whole cycle will have to be repeated.”

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**EDITING AGE**

Wholesale rejuvenation, then, is still far off, if it will ever come at all. But more limited versions of it, targeted to certain diseases of aging, might be available within a few years.

If the Yamanaka factors are like a scattergun that wipes out all the epigenetic




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Notebooks and empty centrifuge tubes from Izpisúa Belmonte’s experiments.

A jar with a staining solution used to study tissues.

Izpisúa Belmonte at work.



marks associated with aging, the techniques now being developed at Salk and in other labs are more like sniper rifles. The goal is to allow researchers to switch off a specific gene that causes a disease, or switch on another gene that can alleviate it.

Hsin-Kai Liao and Fumiyuki Hatanaka spent four years in Izpisúa Belmonte’s lab adapting CRISPR-Cas9,

**“AFTER INJECTION, THESE ... GENES THAT WERE SILENCED DUE TO AGING WOULD BE TURNED ON, THANKS TO OUR WITCHCRAFT, AND START THE REJUVENATION PROCESS OF THE TISSUE. I THINK TURNING BACK THE CLOCK IS AN APPROPRIATE WAY TO EXPLAIN IT.”**

the famed DNA “editing” system, to instead act as a volume control knob. Whereas the original CRISPR lets researchers eliminate an unwanted gene, the adapted tool allows them to leave the genetic code untouched but determine whether a gene is turned on or off.

The lab has tested this tool on mice with muscular dystrophy, which lack a gene that’s crucial in maintaining muscle. Using the epigenome editor, the researchers cranked up the output of another gene that can play a substitute role. The mice they treated did better on grip tests, and their muscles “had become much larger,” Liao remembers.

Another result of this kind came from beyond the Salk campus, at the University of California, Irvine. Researcher Marcelo Wood claims that activating a single gene in old mice improves their memory in a test involving moving objects. “We restored long-term memory function in those animals,” says Wood, who published

the results in *Nature Communications*. After a single epigenetic block is removed, says Wood, “the genes for memory—they all fire. Now that animal perfectly encodes that information straight into long-term memory.”

Similarly, researchers at Duke University have developed an epigenetic editing technique (not yet tested on animals) to turn down the volume on a gene implicated in Parkinson’s disease. Another Duke team brought down the levels of cholesterol in mice by turning off a gene that regulates it. Izpisúa Belmonte’s lab itself, as well as experimenting with muscular dystrophy, has worked on rolling back the symptoms of diabetes, kidney disease, and the loss of bone cartilage, all using similar methods.

The first human tests of these techniques are likely to happen in the next few years. Two companies pursuing the technology are AgeX and Turn Biotechnologies, a startup cofounded by Sebastiano from Stanford. AgeX,

says West, its CEO, is looking to target heart tissues, while Turn, according to Sebastiano, will begin by seeking regulatory clearance to test treatments for osteoarthritis and aging-related muscle loss.

Meanwhile GenuCure, a biotech company founded by Ilir Dubova, a former researcher at Salk, is raising funds to pursue an idea for rejuvenating cartilage. The company has a “cocktail,” Dubova says, that will be injected into the knee capsule of people with osteoarthritis, perhaps once or twice a year. Such a treatment could take the place of expensive knee replacement surgeries.

“After injection, these ... genes that were silenced due to aging would be turned on, thanks to our witchcraft, and start the rejuvenation process of the tissue,” Dubova says. “I think turning back the clock is an appropriate way to explain it.” 

Erika Hayasaki is an Alicia Patterson Fellow in science and environmental reporting.

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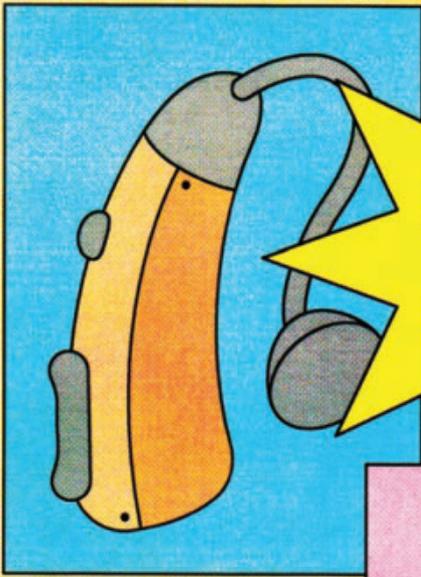
# An older world

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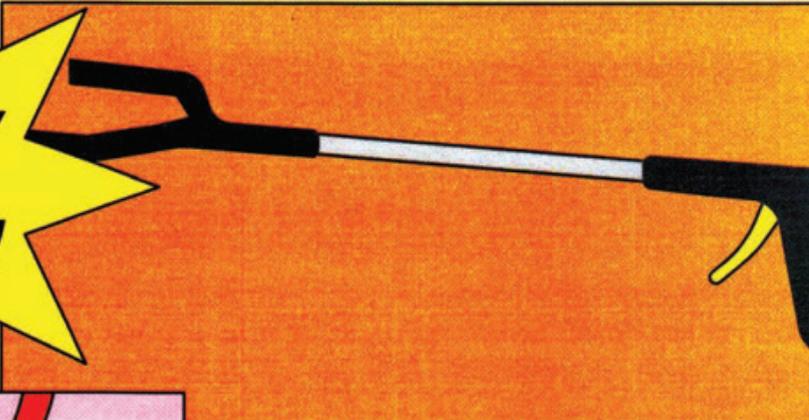
**Our ideas about old age were mostly made up by management consultants and marketers. But what will happen if we shed those stereotypes? And do you really want to keep living for as long as possible? Meanwhile, no matter how much we extend life, we're not doing much to extend a woman's years of fertility. Is that the next anti-aging frontier?**

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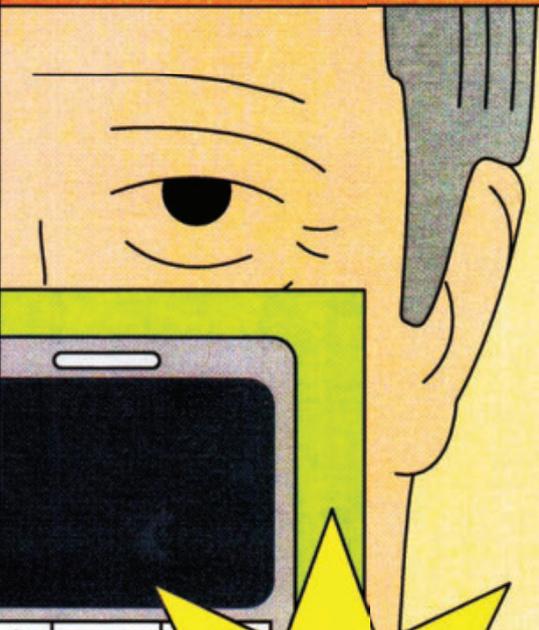
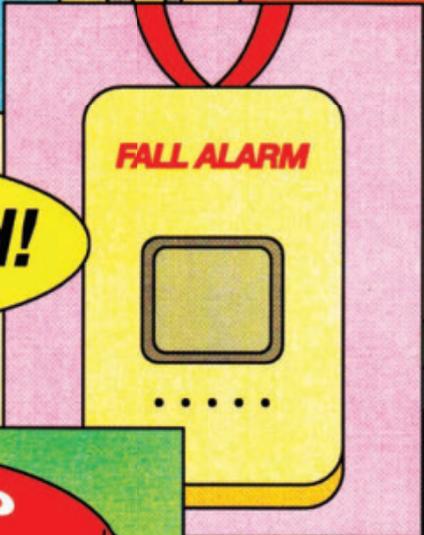
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**Easy to Grip!**

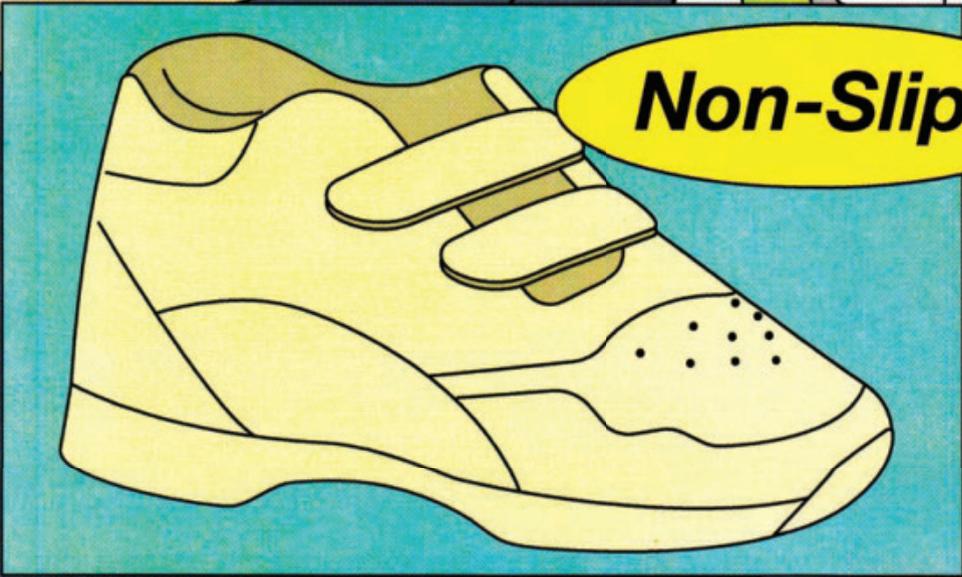


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**Easy to Read!**



**Non-Slip!**

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**Beige!**

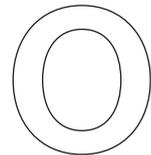
## *How “old age” was invented — and why it needs to be reinvented*



**Products designed for older people reinforce a bogus image of them as passive and feeble. That hurts everyone.**

**By Joseph F. Coughlin**

**Illustrations  
by George Wylesol**



**O**f all the wrenching changes humanity knows it will face in the next few decades—climate change, the rise of AI, the gene-editing revolution—none is nearly as predictable in its effects as global aging. Life expectancy in industrialized economies has gained more than 30 years since 1900, and for the first time in human history there are now more people over 65 than under 5—all thanks to a combination of increasing longevity, diminished fertility, and an aging Baby Boom cohort. We’ve watched these trends develop for generations; demographers can chart them decades in advance.

And yet we’re utterly unprepared for the consequences.

We are unprepared economically, socially, institutionally, and technologically. A wide swath of employers in the US—in

both industry and government—are experiencing what has been called a retirement brain drain, as experienced workers depart crucial roles. At the same time, unemployed older workers struggle to find good jobs despite unemployment rates now at a 50-year nadir. Half of older long-time job holders, meanwhile, are pushed out of their jobs before they planned to retire. Half of Americans are financially unprepared for retirement—25% say they plan to never stop working—and state pension systems are hardly better off. Public transportation systems, to the limited extent they even exist outside of major cities, are unequal to the task of ferrying a large, older, non-driving population to where it needs to go. The US also faces a shortage of professional elder-care providers that only stands to worsen as demand increases, and in the meantime, “informal” elder

care already extracts an annual economic toll of \$522 billion per year in opportunity cost—mainly from women reducing their work hours, or leaving jobs altogether, to take care of aging parents.

And yet these problems might turn out to be surprisingly tractable. It’s strange, for instance, that employers are facing a retirement crisis at the same time that many older workers have to fight outright ageism to prove their value—sort of like a forest fire coexisting with a torrential downpour. For that matter, it’s strange that we, as a society, put obstacles in the way of older job seekers given that hiring them could help prevent programs like Social Security and Medicare from running out of money.

The MIT AgeLab, which I head, has homed in on one such paradox in particular: the profound mismatch between products built for older people and the products they actually want. To give just a few examples, only 20% of people who could benefit from hearing aids seek them out. Just 2% of those over 65 seek out personal emergency response technologies—the sorts of wearable devices that can call 911 with the push of a button—and many (perhaps even most) of those who do have

them refuse to press the call button even after suffering a serious fall. History gives us many examples of such failed products, from age-friendly cars to blended foods to oversize cell phones.

In every example, product designers thought they understood the demands of the older market, but underestimated how older consumers would flee any product giving off a whiff of “oldness.” After all, there can be no doubt that personal emergency response pendants are for “old people,” and as Pew has reported, only 35% of people 75 or older consider themselves “old.”

There’s an expectations gap between what older consumers want from a product and what most of these products deliver, and it’s no frivolous matter. If you need a hearing aid but no one can make one that you think is worth buying, that will have serious ramifications for your quality of life, and may lead to social isolation and physical danger down the road.

But the expectations gap is also—here’s that word again—strange. Why do products built for older people so often seem so uninspiring—big, beige, and boring? It’s not that older people don’t have money. The 50-plus population controls 83% of household wealth in the US and spent more in 2015 than those younger than 50: nearly \$8 trillion of economic activity, if you include downstream effects. Granted, that wealth is unequally distributed, but if better products existed, you’d expect to see them snapped up by the people with more money, and that hasn’t happened (with a handful of very recent exceptions I’ll discuss).

And don’t try to tell me the real issue is that older people aren’t tech savvy. Maybe that stereotype once contained a grain of truth—in 2000, just 14% of 65-plus America used the internet—but it’s no longer the case. Today, 73% of the 65-plus population is online, and half own smartphones.

The expectations gap, then, is the sort of vacuum one would expect nature not to tolerate. If you believe that markets, given enough demand, tend to solve problems

Asking young designers to merely step into the shoes of older consumers (and we at the MIT AgeLab have literally developed a physiological aging simulation suit for that purpose) is a good start, but it may not be enough to give them true insight into the desires of older consumers.

sooner or later, the gap's persistence is uncanny: like a Volkswagen-size boulder hovering six inches off the ground.

Don't worry; there is a natural explanation—and it holds clues for how we can turn many paradoxical problems of global aging into opportunities.



and UK, believed that biological old age occurred when the body ran out of a substance known as “vital energy,” which, like energy in a battery, was consumed over the course of a lifetime of physical activity, never to be replenished. When patients began to display key signs

of old age (white hair, menopause), the only medically sound response was to insist they cut back on all activities. “If death resulted from an exhausted supply of energy, then the goal was to retain it at all cost,” historian Carole Haber wrote in her 1994 book *Old Age and the Search for Security*, “by eating the correct foods, wearing the proper clothes, and performing (or refraining from) certain activities.” Sex and manual labor were both considered to be especially draining.

By the 1860s, modern notions of pathology had begun to replace vital energy in continental Europe, and they eventually found their way to the US and UK. In the meantime, however, social and economic developments were taking place that would preserve as though in amber the conception of old age as a period of passive rest.

In the increasingly mechanized workplace, efficiency was the new watchword, and by the turn of the century, experts were clambering out of the drywall in offices and factories everywhere, offering to wring extra productivity out of workers. The older worker, low on vital energy, was an easy target. As one efficiency expert, Harrington Emerson, argued in 1909, when a company retired its oldest workers, it produced “a desirable wriggle of

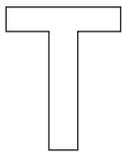
life all the way down the line.” Private pensions—which were first introduced by the American Express company in 1875 and exploded in the decades that followed—were one natural response. They were issued in some cases out of genuine humanitarian concern for unwillingly retired employees, but also because they gave managers the moral cover they needed to fire workers merely for the crime of superannuation.

By the 1910s, it was conventional wisdom that oldness constituted a problem worthy of action on a mass scale. Between 1909 and 1915, the country saw its first federal-level pension bill, state-level universal pension, and public commission on aging, as well as a major survey investigating the economic condition of older adults. In medicine, the term “geriatrics” was coined in 1909; by 1914, the first textbook on that specialty was published. Perhaps the best representation of the tenor of the time was a 1911 film by the important (and notoriously racist) filmmaker D.W. Griffith, which told the story of an aging carpenter falling into penury after losing his job to a younger man. Its title was *What Shall We Do With Our Old?*

By the start of World War I, the first half of our modern narrative of old age was written: older people constituted a population in dire need of assistance. It wasn't until after World War II that the second half arrived in the form of the “golden years,” a stroke of marketing genius by Del Webb, developer of the Arizona retirement mecca Sun City. The golden years positioned retirement not just as something bad your boss did to you, but rather as a period of reward for a lifetime of hard work. As retirement became synonymous with leisure, the full 20th-century conception of oldness took form: if you weren't the kind of older person who was needy—for money, for help with everyday tasks, for medical attention—then you must be the kind who was greedy: for easy living and consumerist luxuries.

With both wants and needs spoken for, this Janus-faced picture gave the

## THE “GOLDEN YEARS” HOAX



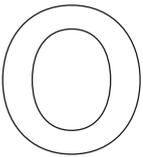
he root cause of all this daylight—between products and consumer expectations, between employer and older worker, between what 75-year-olds think of as “old” and their self-conception—is disarmingly simple. “Old age,” as we know it, is made up.

To be sure, a full Whitman's Sampler of unpleasant biological contingencies can arrive with age, and death ultimately comes for us all. But the difference between those hard truths and the dominant narrative of old age that we've inherited is big enough and persistent enough to account for the expectations gap—and then some.

Two hundred years ago, no one thought of “the aged” or “the old” as a population-size problem to be solved. But that changed thanks to a confluence of since-debunked science and frenzied institution-building. In the first half of the 19th century, doctors, especially in the US

impression of comprehensive-ness, but in fact it pigeonholed older people. To be old meant to be always a taker, never a giver; always an economic consumer, never a producer.

### WHY PRODUCTS CREATE STEREOTYPES



One of the more conspicuous ways the constructed narrative of old age exerts itself today is in products built for older people, which tend to fall to either side of the needy/greedy dialectic: walkers, medications, and pill-reminder apps on one hand, and cruise ships, booze, and golfing green fees on the other.

There's more to life than the stuff you buy, of course. And yet, there is good reason to believe that the key to a better, longer, more sustainable old age may just lie in better products, especially if we define "product" broadly: as everything a society builds for people, from electronic doodads to foods to transportation infrastructure.

Consider the text message. Originally billed as the province of gossiping teenagers, it's been a godsend for deaf people. Transcendent design, as we at the AgeLab call such developments, offers a solution that's larger than the baseline needs of older people, but still includes their needs. The electric garage-door opener is another example: originally designed as a mechanical aid

for those incapable of lifting heavy wooden doors, it offered convenience too attractive to ignore, and found its way into general use.

The nascent field of "hearables"—earbuds capable of such tasks as real-time translation and augmenting certain environmental sounds—may finally destigmatize assistive hearing devices. Sharing-economy services, meanwhile, offer services à la carte that were previously obtainable only as a bundle in assisted-living settings. When you can summon grocery deliveries, help around the house, and rides on demand from your phone, you might even delay a move to a more institutional setting—especially since it might save you a lot of money along the way. Some 87% of people over 65 say they'd prefer to "age in place" in their own homes.

have on public perception would be far outweighed by a single infantilizing product on store shelves. When a company builds something that treats older people as a problem to be solved, everyone gets the message immediately, without even having to think about it.

Products have perpetuated the reductive narrative of old age in a vicious cycle that has lasted decades. It works something like this: The entire product economy surrounding old age reinforces an image in the public's mind of old people as passive consumers. Then, when an older adult applies for a job, she must fight this ambient sense—call it ageism if you like—that she, a consumer by nature, doesn't belong in a production role. As a result, her hard-won experiences rarely



But for the purposes of rewriting narratives, even more important than what products do is what they say. I could write a hundred op-eds extolling the virtues of older people, but any positive effect they

find their way into design decisions for new, cutting-edge products—especially the high-tech ones likely to shape how we'll live tomorrow. And so, without such insight to guide them, the few designers

who design to innovate for older people turn, without realizing it, to the ambient narrative, ultimately churning out the same old reductive products. And so the cycle perpetuates itself.

#### HOW TO FIX OUR THINKING



I'm hardly the first academic to note that the free market can cast what amounts to a distorting field over reality, but in this rare case it may be possible to harness the energy of that market and aim it squarely at our old-age myths. After all, the expectations gap wants to be closed—that hovering boulder wants to crash to the ground—for the simple reason that companies stand to make more money by better serving the truly massive older market.

Such a development won't solve every problem associated with aging, of course. Income inequality and racial inequities both intersect with aging in troubling ways. Wealthier and whiter Americans are more likely to be better financially prepared for retirement, as well as to be healthier and live longer. Fixing how we think about older people isn't going to solve those inequities, but it may at least make the premature firing of older people less common, and help them find better-paying jobs.

It also won't solve the epidemic of suicides, or "deaths of despair," plaguing middle-aged Americans. But on the other hand, redefining "old age" from a black hole of passivity to a period marked by activity, agency, and even renewal surely couldn't hurt the view from middle age. When you're talking about changing the very meaning of the

final third (or more) of adult life, it's impossible to predict all the effects that will spider-web out through earlier stages. Perhaps the promise of a brighter future won't matter much to people in their 20s, 30s, and 40s—but it certainly won't make matters worse. In fact, I wonder if a new, more realistic image of old age might motivate younger and mid-career workers to save more for the future, and lead them to demand better retirement benefits from employers. For the first time, they may find themselves saving not for some hypothetical older person, but rather for a better version of themselves.

Technologists, particularly those who make consumer products, will have a strong influence over how we'll live tomorrow. By treating older adults not as an ancillary market but as a core constituency, the tech sector can do much of the work required

It works something like this:  
The entire product economy surrounding old age reinforces an image in the public's mind of old people as passive consumers. Then, when an older adult applies for a job, she must fight this ambient sense—call it ageism if you like—that she, a consumer by nature, doesn't belong in a production role.

to redefine old age. But tech workplaces also skew infamously young. Asking young designers to merely step into the shoes of older consumers (and we at the MIT AgeLab have literally developed a physiological aging simulation suit for that purpose) is a good start, but it is not enough to give them true insight into the desires of older consumers. Luckily there's a simpler route: hire older workers.

In fact, what's true in tech goes for workplaces writ large. The next time you're hiring and an older worker's résumé crosses your desk, give it a serious look. After all, someday you'll be older too. So strike a blow for your future self.

Global aging may be inevitable, but old age, as we know it, is not. It's something we've made up. Now it's up to us to remake it. ■

Joseph F. Coughlin (@josephcoughlin on Twitter) is the director of the MIT AgeLab and author of *The Longevity Economy*.

# Old age is a waste

Medical ethicist Ezekiel Emanuel argues that life after 75 is not worth living.

By **STEPHEN S. HALL**

In October 2014, Ezekiel Emanuel published an essay in the *Atlantic* called “Why I Hope to Die at 75.” Because Emanuel is a medical doctor and chair of the University of Pennsylvania’s department of medical ethics and health policy, as well as a chief architect of Obamacare, the article stirred enormous controversy.

Emanuel vowed to refuse not only heroic medical interventions once he turned 75, but also antibiotics and vaccinations. His argument: older Americans live too long in a diminished state, raising the question of, as he put it, “whether our consumption is worth our contribution.”

Emanuel was born into a combative clan. One brother, Rahm, recently completed two terms as the controversial mayor of Chicago; another brother, Ari, is a high-profile Hollywood agent. But even given his DNA, Emanuel’s death wish was a provocative argument from a medical ethicist and health-care expert.

Emanuel, now 62, talked with me about the social implications of longevity research and why he isn’t a fan of extending life spans. I was particularly curious to get his reaction to several promising new anti-aging drugs.

T R :

Q + A

If you’re already

**75**

years old, then you can expect to live roughly another 12 years, to the age of

**87**

If you’re already 65 years old, you can expect to live to

**85**

**Q: It’s five years since you published the essay. Any second thoughts as you near the deadline?**

**A:** Not really! [Laughing]

**Q: You announced that you wouldn’t take any measures to prolong your life after 75. Isn’t that an extreme position?**

**A:** First of all, it’s not an extreme position. I’m not going to die at 75. I’m not committing suicide. I’m not asking for euthanasia. I’m going to stop taking medications with the sole justification that the medication or intervention is to prolong my life.

**Q. But it’s called “Why I hope to die ...”**

**A.** As you probably know better than everyone else, it’s editors that choose titles and not authors.

I often get, from the people who want to dismiss me, “You know, my Aunt Nellie, she was clear as a bell at 94, and blah-blah-blah ...” But as I said in the article, there are outliers. There are not that many people who continue to be active and engaged and actually creative past 75. It’s a very small number.

**Q: You suggest that one effect of our obsession with longevity is that it diverts attention from the health and well-being of children.**

**A:** Lots of presidents and lots of politicians say, “Children are our most valuable resource.” But we as a country don’t behave like that. We don’t invest in children the way we invest in adults, especially older adults. One of the statistics I like to point out is if you look at the federal budget, \$7 goes to people over 65 for every dollar for people under 18.

**Q: The buzzword in longevity research is “health span”—living a maximum life with a minimal amount of disability or ill health. Isn’t that a worthwhile goal?**

**A:** If you ask anyone, “All right, design out the life you want,” I think people initially say, “Oh, I want to keep going



as fast as I can, and then just fall off a cliff.” And then they reconsider: “Well, maybe I don’t want to die of a heart attack or a stroke in the middle of the night. I want to say goodbye to my family. So I want some gentle decline, but a very short amount of time. You know, months, not years.”

It makes perfect sense. I’m no different. I would like to maintain my vigor, my intellectual capacity, my productivity, all the way through to the end. But I think we also need to be realistic—that’s not the way most of us are going to live.

**Q: Does that mean you’re skeptical about the health-span idea?**

**A:** In the early 1980s, we had a theory that as we live longer, we’re going to stay in better health. You know, at 70, we’re going to be like our parents were when they were 50. Well, if you look at the data, maybe not. We’re having more disabilities. We have people with more problems. And even more important, for most people, is the biological decline in cognitive function. If you look at really smart people, there aren’t that many writing brand-new books

after 75, and really developing new areas where they are leading thinkers. They tend to be re-tilling familiar areas that they’ve worked on for a long time.

**Q: What’s wrong with simply enjoying an extended life?**

**A:** These people who live a vigorous life to 70, 80, 90 years of age—when I look at what those people “do,” almost all of it is what I classify as play. It’s not meaningful work. They’re riding motorcycles; they’re hiking. Which can all have value—don’t get me wrong. But if it’s the main thing in your life? Ummm, that’s not probably a meaningful life.

**Q: Are the anti-aging drugs in development just a bid for immortality by the back door?**

**A:** Certainly. You listen to these people and their lingo is not “We’re just trying to get rid of problems.” Right? It’s “We want to live longer.” I notice that almost all of these things—not all of them, but many of them—are based out in California, because God forbid the world should continue to exist and I’m not part of it!

The world will exist fine if you happen to die. Great people, maybe even people greater than you, like Newton and Shakespeare and Euler—they died. And guess what? The world’s still there.

**Q: What message do you think it sends when iconic innovators in Silicon Valley—people like Peter Thiel and Larry Ellison—are clearly fascinated by life extension and ...**

**A:** No, no—they’re fascinated by *their* life extension! This idea that they’re fascinated with life extension [in general]? Naw, they’re fascinated by their life extension. They find it hard to even contemplate the idea that they are going to die and the world is going to be fine without them.

**Q: You have described the “American immortal”—people interested in life extension and immortality.**

**A:** There is this view that longevity, living forever—and if not forever, 250 or 1,000 years—is really what we ought to be aiming at. And once you’ve got cultural leaders, or opinion leaders, saying this, peopleglom onto it. And it feeds into a whole situation of “Yes, dying is a bad thing.”

I do fear death. But I think I fear being sort of decrepit and falling apart more.

**Q: Is it really a problem if one of these drugs like metformin shows a modest life-extending effect?**

**A:** I think it would be, especially if what ends up happening is it adds a few years of life. Then the question is: What are the downsides of that? There may be a cognitive downside, maybe a little more mental confusion.

It’s very funny—every time I talk to people, it’s like, “Oh, yeah, definitely quality of life over quantity of life.” But when push comes to shove, it’s really quantity of life. “I might be a little more confused, but I’ll take that extra year!” 📖

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## LOOKING FORWARD,

We asked young people to tell us their hopes for the future of technology. And we asked older people with long careers behind them to tell us what might have been. Here's what they said.

LOOKING  
BACK

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A few years ago I became fascinated with the science of human consciousness. The so-called “hard problem” of consciousness, which asks how an inner subjective experience could arise from the physical activity of the brain, is one of the biggest enigmas in the universe. I was highly intrigued by philosophers who claimed that the standard view of the world put forward by scientists—the notion that everything can be reduced to units of matter or physical material—was incomplete because it couldn’t accommodate the phenomenon of consciousness. I began to read about perspectives on consciousness, as well as the nature of reality, from a wide variety of fields, including neuroscience, philosophy, physics, and spirituality. It became clear to me that we need to discover an entirely new field of science in order to truly explain consciousness. I recently interned at the Qualia Research Institute, which hopes to map out the “state space of consciousness”—i.e., the space of all the various subjective experiences that a sentient organism could possibly have. The state space of consciousness is likely vast beyond comprehension, and most of us spend our lives in one very small cluster of points within it.

As far as I’m aware, few researchers have attempted to figure out the geometry of this space. My hope is that not only can we do it, but once we do, we can develop an objective framework that generates uniquely crisp, bold, and plausible predictions about the quality of different experiences. This would allow us to answer questions like: Is a cluster headache a worse experience than chronic depression? What are the most blissful experiences available to human beings, and how do we sustain them? And so on.

I believe we can, in the long term, eliminate involuntary suffering if we understand consciousness, since we can improve the quality of experience for all sentient organisms once we find out the structure of positive and negative experiences.

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Kenneth Shinozuka is the inventor of Safewander, a wearable sensor that sends a smartphone alert when the wearer gets out of bed.

THE CONSCIOUSNESS HUNTER





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Kairan  
Quazi  
age 10



**A**rtificial intelligence could transform our institutions by targeting the implicit biases that exist in our education, employment, and criminal justice systems. But the way we use AI now isn't working—since predictive algorithms are based on finding patterns in historical data, skewed inputs generate skewed outputs. For example, since our criminal justice system has historically incarcerated minorities disproportionately

for every category of crime, any predictive algorithms that law enforcement uses for criminal identification and recidivism patterns will only perpetuate this problem.

My hope is that we can develop new algorithms to neutralize these biases. I believe that in my lifetime we can realize the potential of AI to revolutionize our socioeconomic institutions. I'm now pursuing degrees in math and computer science with the goal of using AI to help

people who don't respond to traditional teaching methods, so-called neuroatypical and asynchronous learners—people like me. I hope to work on technology that can identify such learners and tailor educational pathways that work better for us.

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Kairan Quazi is an avid vlogger and coder. At age 9 he enrolled in Las Positas College, where he studies mathematics, computer science, and physics. He also serves as an AI research mentee at Intel Labs.



Melati  
Wijsen  
age 18

## THE ENVIRONMENTAL ACTIVIST

**G**rowing up on the island of Bali, it was hard not to see the negative impacts plastic was having on our environment. Even at ages 10 and 12 we understood that plastic was ending up in places that it shouldn't. At the same time, we were learning about people who throughout history made a positive impact—Nelson Mandela, Lady Diana, Martin Luther King, Mahatma Gandhi. We went home one day asking ourselves, what can we do now? We didn't want to wait until we were older.

So we created Bye Bye Plastic Bags, a youth-led NGO with the vision of making Bali plastic bag free. In the past six

years we have spoken to over 50,000 students, distributed over 16,000 alternative bags, and hosted Bali's Biggest Clean Up three years in a row, mobilizing over 45,000 people on the island to collect over 130 tons of plastic waste. Bye Bye Plastic Bags now operates in 40 locations around the world.

Previous generations might not have known what they were doing to the environment. This one does. We hope that what we've done empowers other young people to stand up for what they believe in, that they aren't too young or too small to understand they can play a huge role in building the solutions.

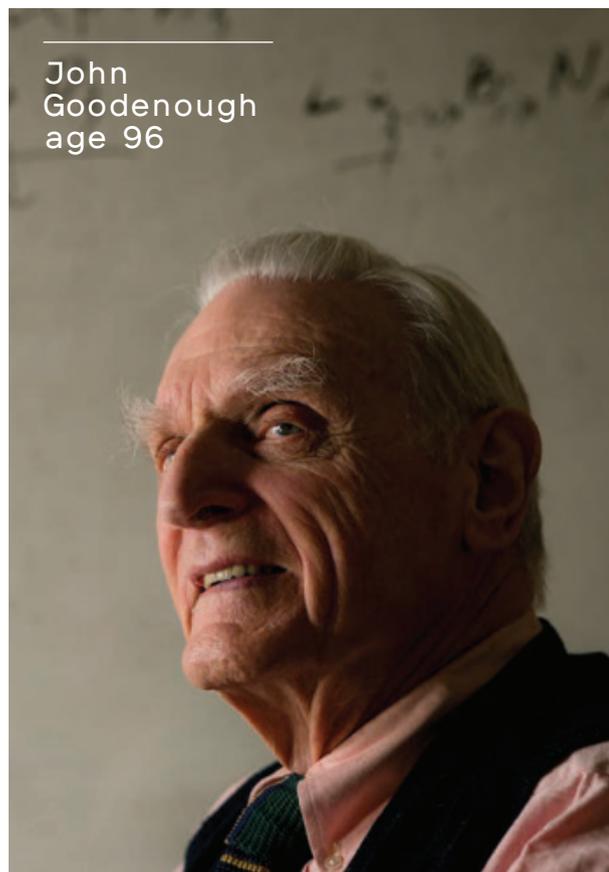
Melati Wijsen cofounded Bye Bye Plastic Bags with her sister Isabel, 16, in her home of Bali, Indonesia.

## THE INVENTOR

**I**n the summer of 1939, I was kayaking in Scandinavia with six German high school boys and a Finnish boy. We launched our kayaks into Finland's Ivalo River to ride its length to Kirkenes in Norway. The Finnish boy was called back home to prepare to fight the imminent invasion by Russia; the German boys, indoctrinated by Hitler's propaganda, received their draft notices calling them to active duty. How wasteful of human talent and resources is war. How wasteful is the exploitation of everyone's habitat by a few in peacetime.

My regret is that we're still making decisions based on profit margins rather than what's best for society and for the long-term preservation of the planet. Technology is morally neutral; its value to society depends on how we use it. But our throw-away economy values profit over long-range responsibility for sustainability. We need collaboration instead of confrontation, preservation instead of exploitation, relationships instead of walls.

John Goodenough developed the lithium-ion battery and is a professor of engineering at the University of Texas at Austin.



John  
Goodenough  
age 96

I was one of the first women engineers at the Jet Propulsion Laboratory, and later in my career managed NASA's automation and robotics program across several centers. It was a major step when I convinced them to invest \$25 million in a Mars rover project—they'd never funded a technology demonstration with that much money before. Our little project overcame both technical and institutional barriers, and the Sojourner Truth micro-rover landed on Mars with the Pathfinder lander on July 4, 1997.

Sojourner demonstrated that a woman could manage a flight project. I was

subsequently promoted to lead the Mars program and got a pay raise in a year when no one at NASA was getting a raise, but when I complained that I didn't want a raise if the people under me weren't getting one, an HR person took me aside and told me that I made so much less than my male peers that JPL would be in trouble with discrimination if I didn't get a raise. Also, I learned that I only got the promotion because the guy that the JPL director wanted to give the job to didn't want it, and he recommended me.

I regret that it was so unusual for a woman to run something like this. But

there has been progress. On Pathfinder there were at most three or four women engineers, but I can now see at least a dozen when I watch launches and landings on the NASA website. There are now women in upper management at JPL, and the head of Johnson Space Center is a woman. So I think I bent a few ceilings—but the big projects are still managed by men.

Donna Shirley, former manager of Mars exploration at the NASA Jet Propulsion Laboratory, is also author of *Managing Martians*. She lives in Tulsa, Oklahoma.

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## What happens when older generations don't need to pass the torch?

By **Rebecca Roache** / Illustration by **Nicolás Ortega**

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# The new midlife crisis

Last year, Greta Thunberg shot to fame as the poster girl for climate-change activism at the age of just 15. By 16 she had a Nobel Peace Prize nomination. Inspired, children around the world have been skipping classes to demand action on climate change.

Young people, though, can do little more than protest. After all, it's not the young who make the big decisions, but the middle-aged.

People between 45 and 65 rule our societies: the median age of an incoming US senator is 51, the average age of a British member of Parliament is 50, and the average age of a CEO in Fortune 500 and S&P 500 companies is 53. There are exceptions, of course—Facebook CEO Mark Zuckerberg is just 35, while Donald Trump is 73. On the whole, however, it is the middle-aged who hold the reins. Younger generations lack the experience and influence needed for the top jobs, while older ones succumb to ill health or simply social pressure to step down. Today we might approach society's elders for advice or consult them for their wisdom, but it's the middle-aged who choose whether to act on that advice, who decide how to implement that wisdom.




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Rebecca Roache is a senior lecturer in philosophy at Royal Holloway, University of London.

If medicine can keep us healthy and sharp for longer, though, tomorrow's 80-year-olds could do the work of today's 50-year-olds. They could be just as fit, and they'd have extra wisdom and experience to boot. It's very possible that by the turn of the next century, society's movers and shakers could be in their 80s, not their 50s.

What happens then? Contemporary views of generational roles will make less sense in a world that relies on the old to run politics, culture, and the economy.

There are risks, of course. If the most important decisions are made by the old, then the interests of the old might edge out those of other age groups. This could exacerbate the sort of intergenerational inequality we already see today. Compared with earlier generations, millennials have less money and more debt. Having each generation hang onto power for longer could make successive generations not only even poorer, but increasingly powerless. We'll need to change the way political decisions are made to ensure that the interests of all ages are fairly represented. And to make that happen, we'll need changes at the grassroots level, such as overcoming the taboos that prevent free, frank, and constructive discussion of death, inheritance, and what the old owe the young and vice versa.

The middle-aged face demotion when their elders show no signs of slowing down—but what about younger people? What will it be like to be in your 20s and 30s in a society where people live until 100 or more and continue to work into their 80s? Today, young people don't earn as much as the middle-aged, and they have lower status and less influence. They do have youth on their side—a great asset in Western societies where the entertainment and fashion industries are dominated by them, and where they are an important consumer group. But the value of youth itself is likely to be eroded in the future. After all, if tackling ageism will be a necessary part of getting the most out of an aging society, then progress will mean attacking a beauty industry peddling “anti-aging” products, a movie industry



## What will it be like to be in your 20s and 30s in a society where people live until 100 or more and continue to work into their 80s?

focused on telling the stories of young people, and a music industry where performers are past their peak by their mid-30s. In a world that no longer celebrates and commodifies youth, young people risk being resented as a drain on the economy, as people who have not yet accumulated sufficient experience to make a useful contribution to society—and if future

generations of the young are poorer, they will be literally less valuable as well.

It might be difficult to conceive of this happening very quickly—but it is difficult to conceive of it not happening, too.

Even so, there is hope. Defeating ageism, like defeating any kind of bigotry, will involve undermining the stereotypes associated with it. Efforts to address

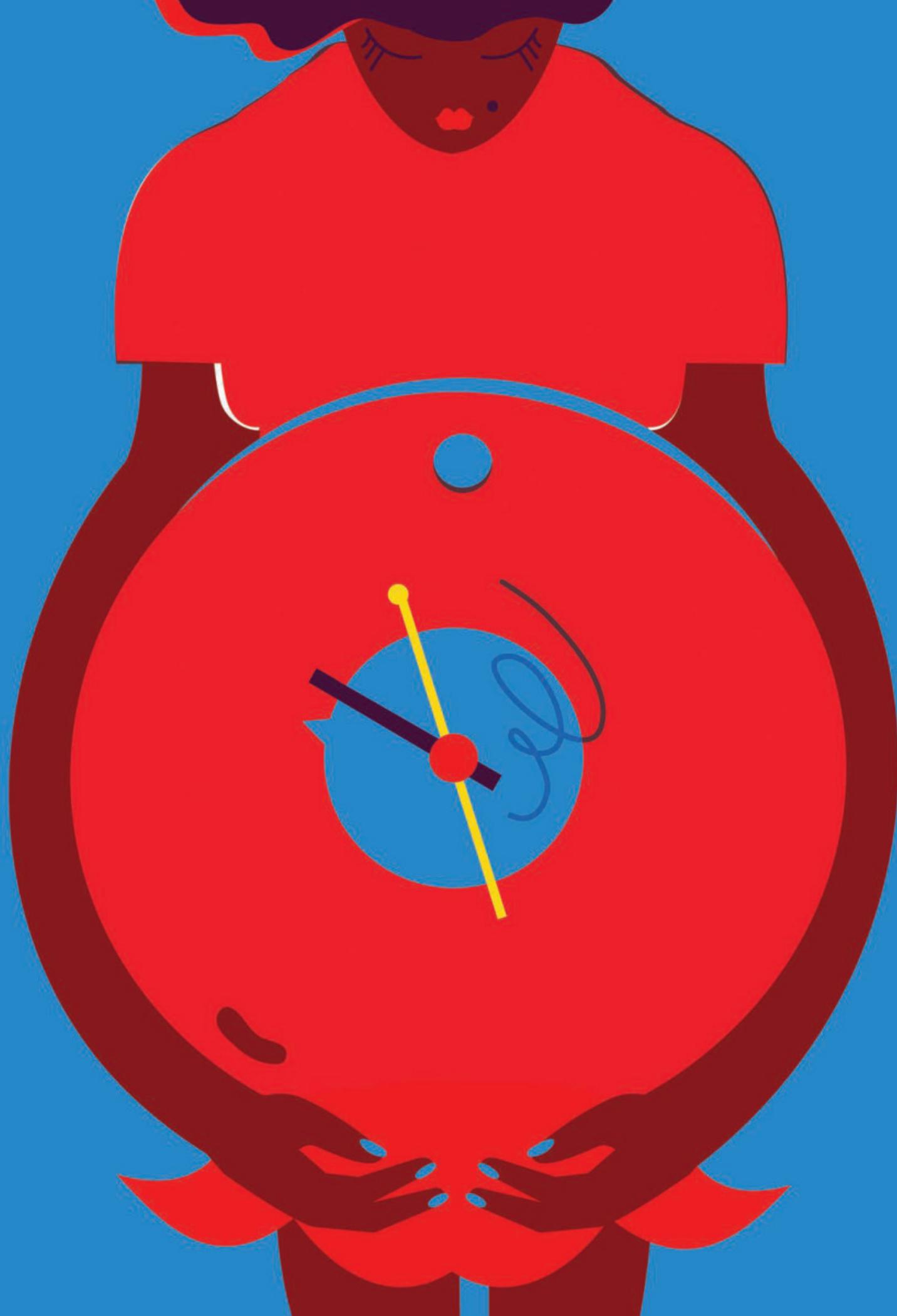
ageism often focus on dismantling ideas that old people are lonely, depressed, demented, and irrelevant. But we needn't (and shouldn't) stop there. We should also tackle stereotypes that paint the young as irresponsible, naïve, and deserving of only the most menial jobs and lowest pay, or that present frivolous millennials as too busy munching on avocados to save for a house. Ending ageism against the old might take the shine off youth, but it will free the young of some unhelpful prejudices too.

Maybe what we can expect from people of different ages will become even more context-dependent.

Olympic swimmers peak at only 21. By contrast, the most successful scientists retain their influence until their death—as the German physicist Max Planck observed, science advances one funeral at a time. How much our mental and physical qualities enable us to excel or hold us back depends on what we're trying to do and how much support we have. But ageism is so pervasive that we simply don't know what tomorrow's 80-year-olds will be like. We haven't yet encountered a society with large numbers of older people able to flourish free from this oppressive prejudice.

An aging world could easily be a dystopia. Increasing life expectancy without improving healthy life span would lead to a sicker population and weigh down an increasingly burdened workforce. Delaying people's retirement from influential, decision-making roles could lead to worsening social inequality, and the risk remains that some people—young and old—could fall through the cracks at times when they are less able to contribute.

How do we change that? If we focus on how individuals of any age can contribute, and recognize that people are able to contribute in different ways at different times, and ensure that there is support—such as finance, health care, training, and education—then we might be able to ensure that an aging society can also be a thriving one. ■



# Honey, I froze the kids

It's becoming popular for twentysomethings who don't want babies until later in life to freeze their eggs. Just don't count on it succeeding.

# W

hen Michele Harrison turned 40, she decided to sell her New York City apartment to buy a bigger one. She could afford it after laser-focusing on her career, working late nights as a single woman, traveling constantly for ad agencies and then in marketing at ESPN.

While in the process of selling, she temporarily moved in with her aunt in the suburbs. She began to notice how nice it was to see green grass and have room to breathe. She quit her job and swapped her hard-charging big-city existence for the wide-open panoramas of Colorado.

One of the first tasks was a routine checkup with a gynecologist. By this time, Harrison was 41. At her appointment, the doctor got right to the point: “Do you want to have a baby?”

“I was like, ‘I have no idea,’” says Harrison. “I was in shock. I don’t think I ever really thought about having kids or about how old I was, because I had been so focused on my career.”

Her doctor referred her to the Colorado Center for Reproductive Medicine (CCRM), which has a reputation for helping “older” women get pregnant. When it comes to fertility, 35 is the tipping point that medicine calls AMA, or “advanced maternal age.” It’s not an arbitrary designation. A woman’s fertility starts to wane around age 32, and the decline picks up speed by 37, according to the American College of Obstetricians and Gynecologists.

“If you want to freeze your eggs,” she was told, “now is the time.” She joined the growing number of women trying to delay biology. More than

7,000 US women froze their eggs in 2016, up from fewer than 500 in 2009.

“I thought, ‘Why don’t I just do this as insurance so I don’t miss the window?’” she says.

## No guarantee

In truth, the window was already nearly closed. Fertility specialists encourage women who want to freeze their eggs to do so in their late 20s and early 30s, when they still have a healthy supply. Midway through gestation, a female fetus has 3 million eggs in each ovary. At birth, that number has dropped to 500,000. By puberty, a girl is down to 150,000 per ovary. At menopause that woman will have very few eggs left, and many will be riddled with genetic errors that occur with aging. The more DNA damage, the more likely an egg or embryo is to result in miscarriage, chromosomal abnormality, or no pregnancy at all.

It’s not clear why girls are born with more eggs than they could possibly ever use. Nor is it clear why the numbers drop so precipitously over the years, although genes seem to play a role. What is certain is that no one has figured out how to definitively extend fertility—yet.

Egg freezing is the closest we’ve come. Hyperstimulate a woman’s ovaries with hormone injections to produce more than the single egg released in a typical menstrual cycle. Retrieve those eggs with a needle in a quick surgical procedure. Then individually flash-freeze them using a method called vitrification, designed to prevent the formation of ice crystals, and immerse them in liquid nitrogen until they’re ready to be thawed. Ta-da—babies on ice!

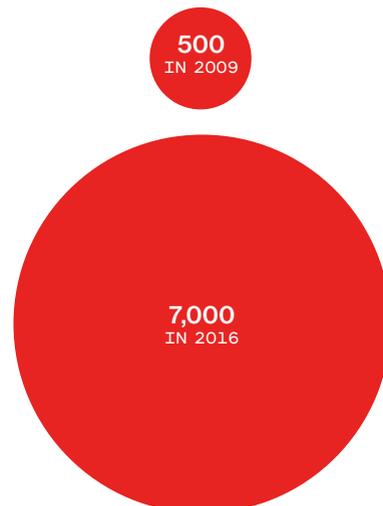
When the American Society for Reproductive Medicine (ASRM) lifted the “experimental” label on egg freezing in 2012, the announcement appeared to herald an era of female empowerment. No longer

would women have to sacrifice career for children; they could have it all, advancing professionally while banking their eggs for when they’d feel sufficiently established to risk derailing their careers to care for kids. If they hadn’t yet found Mr. or Ms. Right, they need not fear; they could simply freeze their eggs while continuing to search for the perfect partner.

Technology companies like Apple, Facebook, and others fanned the frenzy by covering the cost of egg freezing, about \$10,000 per cycle, as an employee benefit.

In the seven years since, egg freezing has gone mainstream. If you were near Manhattan’s Bryant Park on June 20, you might have seen KindBody’s mobile fertility clinic, an RV in chic lemon yellow and white, parked next to an al fresco waiting room (a jute rug prettying up the sidewalk, saucer chairs, comfy poufs) where women could pop by for a fertility assessment after work. This consists of an ovarian ultrasound, a consultation with a fertility specialist, and bloodwork to test for anti-Müllerian hormone, which offers insight into “ovarian reserve”—the stockpile of follicles, or eggs, that remain inside the ovaries.

NUMBER OF WOMEN IN THE US WHO FROZE THEIR EGGS



It's a lot of attention for a technology that is far from a sure bet. Success rates for egg freezing are hard to determine, largely because the practice is so new that many women who've done it haven't yet tried to fertilize their thawed eggs and get pregnant. What data does exist suggests that it's a numbers game—predictably, the more eggs frozen at a younger age, the more likely at least one is to result in a baby.

"It's not like I would discourage egg freezing. Women should be doing it because it's the best option they have, but it is not an insurance policy," says Christos Coutifaris, past president of the ASRM and a professor of obstetrics and gynecology at the University of Pennsylvania. "Insurance policies usually guarantee a payoff. In this case, there is no guarantee."

There was nearly no payoff for Harrison, even though she produced 21 eggs, far more than would have been expected for someone her age—so many that the nurses high-fived her when she emerged from her anesthesia haze. "They were like, 'It's unbelievable,'" says Harrison. "Of course, the doctor said you never know the health of the egg until it fertilizes, but that didn't sink in. All I could think about was the number 21. I thought this was going to be a slam dunk."

Harrison froze her eggs and went about her life. She met a man and fell in love, and when she was 43 and he was 47, they decided to start a family. Harrison tried to get pregnant, but the likelihood of conceiving at 43 is 5%, if that. After a few months of trying, she decided to thaw and fertilize her batch of frozen eggs, confident that her "insurance policy" would pay out. Then the phone calls began.

"Every couple of days, I would get a call from the lab saying, 'You're down to 10 eggs.' Then eight. Then five. Then three," says Harrison.

Her doctor recommended she do genetic testing on those three. Only

one was genetically sound. "I was devastated," she says. "No one prepares you for that emotion. No one prepares you for the highs and lows. No one prepares you that the number can get cut down so drastically."

## Fertility as a right

The prospect of extending fertility is of deep interest to a growing number of

But what does it mean to extend fertility? Do we want to extend it a little—up to age 50, say—or a lot, enabling seventysomethings to give birth? Although women can't easily conceive naturally with their own eggs much past 40, many healthy women in their 50s and even 60s can carry a pregnancy just fine.

However, studies suggest that women over 40 have an increased risk

**"MEN ARE CERTAINLY POSITIONED TO BECOME FATHERS LATER IN LIFE, AND NO ONE HAS PROPOSED BANNING THAT, SO WHY SHOULD WE PROHIBIT WOMEN FROM BECOMING MOMS LATER IN LIFE?"**

women. The birth rate for US women between the ages of 40 and 44 has been on the rise since 1985. The number of births to women 45 and older jumped 3% between 2016 and 2017. And the number of births to women 50 and older has also increased since 1997. This is not because women are staying fertile longer, but because more and more of them are trying to have kids later in life.

That trend has put pressure on researchers to come up with new ways to boost fertility. There's a host of techniques in all stages of development, some benign (acai supplements), some invasive (pricking the ovaries to stimulate blood flow), some that sound like sci-fi (artificial gametes created from stem cells), and others that are downright weird (infusing the vagina with ozone).

of pregnancy complications, including preeclampsia, gestational diabetes, and preterm birth. Most fertility clinics therefore set age cutoffs. "Even if we could take a woman's own egg and make it perfect as technology evolves, there is an age at which you cross the line from acceptable to unacceptable risk," says Alan Penzias, a reproductive endocrinologist at Boston IVF and chair of the ASRM's practice committee, which sets policy for the organization. "Physiologically it can be done, but it shouldn't be done. A woman's body is not designed to be pregnant past her early 50s."

But setting limits on who can get pregnant is tricky. "Men are certainly positioned to become fathers later in life, and no one has proposed banning that, so why should we prohibit women from becoming moms later

in life?" asks Ruth Faden, founder of the Johns Hopkins Berman Institute of Bioethics. She sees the issue as just the latest salvo over reproductive rights in the US, "respecting the rights of women to control their own reproductive stories."

Still, it's undeniable that from a purely physiological perspective, pregnancy is the purview of the relatively young. "I always remind people that medicine has been able to lengthen life span, but somehow women's reproductive life span hasn't changed," says Mandy Katz-Jaffe, scientific director at CCRM, where Harrison was treated. The ovaries are the fastest-aging organ, doing their job only from puberty to menopause. People who live longer, healthier lives have more time to build their families, but women's bodies haven't evolved to easily allow that.

Successfully extending women's fertility would have benefits beyond childbearing itself, though. "I don't wake up in the morning with my goal to help women have babies when they're 70," says Francesca Duncan, who runs the Center for Reproductive Science at Northwestern University. Identifying ways to delay ovarian aging, she notes, would cause the ovaries to produce estrogen for longer, which is good for women's health: among other benefits, it offers protection against heart disease, the leading cause of death for women.

Duncan is also an adjunct professor at the newly established Center for Female Reproductive Longevity and Equality, part of the Buck Institute for Research on Aging. The center launched last year to "address an inequality which has existed throughout human history: men can reproduce throughout their life span; but women's fertility begins to decline in their early 30s."

The center is the first place to bring together scientists working on aging in general and female

reproductive aging in particular, and specifically fertility. It's the brainchild of Nicole Shanahan, a lawyer who became aware of this reproductive inequity at the age of 29, when a fertility checkup revealed she had hardly any active follicles. She tried to bank eggs and embryos for IVF, but each month she had developed a new ovarian cyst that prevented the treatment. "Following the arc

ovulating while listening to Victor Dzau, head of the National Academy of Medicine, talk about changing the narrative on aging. "In my head I was thinking, 'God, I wish I could change the narrative on my reproductive situation!'" she recalls. "And then I thought, 'Wow, maybe I can.'"

"I felt a great sense of injustice," says Shanahan. "At a time in history when we're questioning everything,

**"IN MY HEAD I WAS THINKING, 'GOD, I WISH I COULD CHANGE THE NARRATIVE ON MY REPRODUCTIVE SITUATION!'" SHANAHAN RECALLS. "AND THEN I THOUGHT, 'WOW, MAYBE I CAN.'"**

I was on, I was quickly going to be in menopause in my mid-30s," says Shanahan, who is Google cofounder Sergey Brin's girlfriend. "There was no explanation as to why."

Growing up poor in Oakland, the daughter of an immigrant mother, Shanahan, now 33, was encouraged to dream big: to go to college and law school, get married, and have a career, a house, and a family. "It was eye-opening to me that there are biological factors that would limit that dream," she says.

Through her work as a lawyer, Shanahan found herself in 2017 with Moby, Goldie Hawn, and other Hollywood glitterati at a meeting on "health longevity" in the living room of TV producer Norman Lear. In a corner, Shanahan multitasked, checking her Flo app to see if she was

there needs to be room for consideration of this."

She continued putting out feelers until the Buck Institute expressed interest. The new center is in the process of hiring faculty and spreading the word about its mission. Shanahan originally gave \$6 million to the new center through the Sergey Brin Family Foundation and is increasing her commitment through the Bia Echo Foundation, which she recently started to focus on issues of women's reproductive longevity and equality, criminal justice reform, and protecting the health and habitability of the planet. Bia is the Greek goddess of raw energy; Echo is the name of her daughter, whom she and Brin welcomed in November. After years of failed fertility treatment, they conceived naturally.





Michele Harrison and her daughter, Ellie.

## Tough decisions

After going from 21 eggs to one, Michele Harrison lucked out. On July 13, 2015, she and her husband, John, became parents to Ellie, who is now four and has bright blue eyes, dirty-blond hair, and chubby cheeks. Harrison, 44 when her daughter was born, has moments when she wonders what it would be like for Ellie to be a big sister, but she knows it's out of the realm of possibility. "I still get twinges when I see people in their 40s having another baby," she says.

The quest to extend women's fertility will march on, however. Egg freezing will continue to be used as a pressure relief valve for women who aren't ready to have children. More women will confront this critical and expensive choice as clinics adjust their marketing to target twentysomethings.

As head of the ASRM's practice committee, Alan Penzias thinks this is overkill—in theory. "Don't even think about talking to me about egg freezing," his daughter cautioned him when she turned 24. He responded not as a physician but as someone with a desire to be a grandfather one day: "I have no interest in talking to you about this ... well, maybe a little interest."

Even as it becomes biologically more feasible to prolong fertility, not all women are going to be clamoring to have babies later in life. In June, I cuddled my two-week-old niece, six pounds of vulnerability and potential in a spangled hot-pink onesie. I loved holding her, but I was equally glad to hand her back. I'm closer to 50 than 40. With my oldest child two years away from finishing high school, I've been there and done that. But for women my age who feel the right time to become a mother is now, it's good to know that there are smart people working to level the reproductive playing field. **FI**

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Bonnie Rochman is a freelance journalist in Seattle. Her latest book is [The Gene Machine](#).

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# Living longer

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Health-care costs are soaring, but if you want to blame someone, it's not the old. Bored retirees are finding that mastering the internet might be the ticket to a new career. A near-starvation diet might make you live longer; would you follow it? And there's a church in Florida that promises not eternal life in heaven, but a really long one in this world.

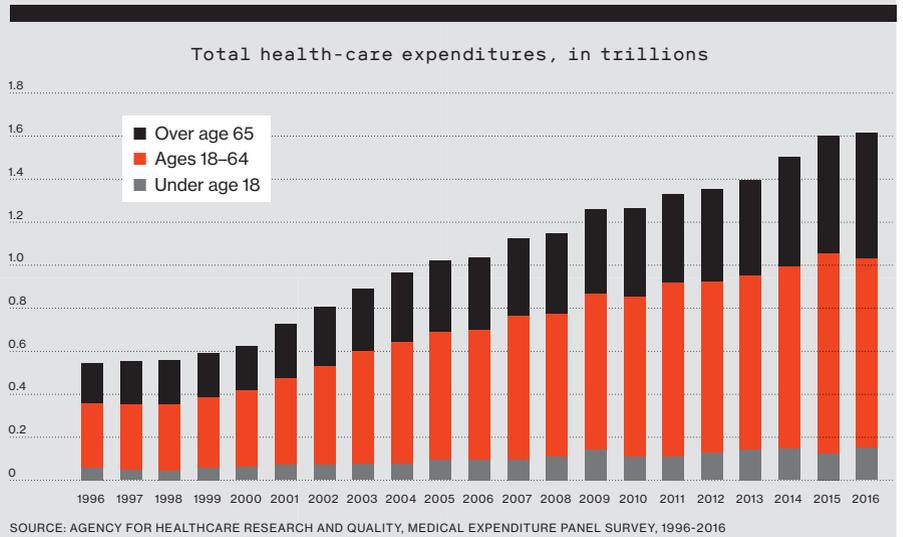
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# US health-care costs are soaring, but don't blame old people

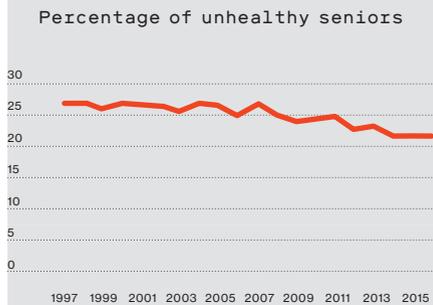
By Tate Ryan-Mosley

*Health-care expenditures have doubled since 2002, but most of that change can be attributed to the 91% increase in costs for those aged 18 to 64. In the last 10 years, the percentage of the US population over 65 has grown from 12% to 16%, but its share of total health-care spending has remained flat, meaning the per-person allocation for those over 65 is actually shrinking.*

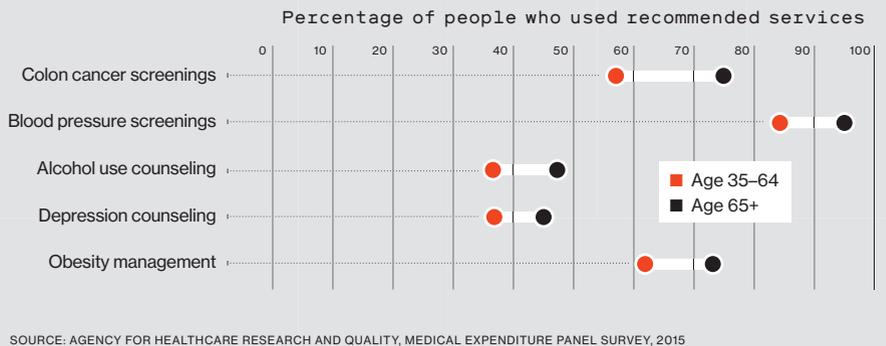


## Share of costs per person for those 65 and over is actually decreasing

**First off, they're healthier than ever.**



**And older people take better care of themselves than middle-aged adults.**



## Meanwhile, share of costs per person for those under 65 is increasing

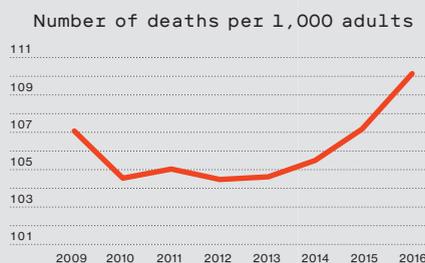
Adults are increasingly dying "deaths of despair," which the CDC defines as those from drugs, alcohol, or suicide.

**147,095 people died "by despair" in 2016.**

That's almost 2.5x the number in 2000.

SOURCE: NATIONAL CENTER FOR HEALTH STATISTICS, MORTALITY IN THE UNITED STATES, 2017

Adult mortality rates are rising as a result, contributing to lower life expectancy (US, ages 15-60).



And the "cost of dying" under 65 is

**24.6%**

higher than end-of-life costs for those over 65.

SOURCE: MEDICARE SPENDING AT THE END OF LIFE, KAISER FAMILY FOUNDATION, 2016



# Late-stage startup

Retired? Bored?

Why not become an entrepreneur?

By LAUREN SMILEY Photographs by Adrienne Grunwald



“All these microaggressions people talk about?” Tom Kamber says. “Just imagine what it’s like when you’re 75.”

People knock you out of the way on the street, he says. They attend to the younger guy standing next to you first. Then the job interviews—he’s getting revved up now—when the recruiters ask your age. “Completely illegal question! It’s like asking, ‘Are you really black?’ ‘You seem gay—are you gay?’” Or if the recruiter is sly, trying to hide just how illegal this is, they’ll ask for your graduation year—“It’s such bullshit.”

Kamber is someone you don’t interview as much as witness. He talks at 1.5 times podcast speed. Blink and you’ve missed three sentences. See his bald head and the Art Deco tattoo snaking down his biceps, or watch him salsa at the intergenerational dance party he put on at a New York club, and he seems the world’s least likely director of a senior center. But listen in. Tom Kamber is getting into ageism—“the last ism,” as he calls it—and Tom Kamber has a lot to say about that.

“When you live in an ageist society, your dreams, which might seem totally normal to you, are a threat to other people,” he warns. He’s speaking not only in rapid-fire sentences, but in paragraphs now. “People are trying to hold you back—because they’re afraid of their own aging. Or because you’re competing with them economically. Because they don’t want to have to introduce somebody else’s ideas into their young-person culture,” Kamber continues, his holy roller sermon coming to its emotional peak. “People are a *pain in the ass!*”

That’s why Kamber created Senior Planet, a tech-themed community center that preps seniors to hack their way through a world conspiring to keep them sidelined. The glass door reads “Aging with Attitude.” With its sleek grays and wood tables, it rivals the WeWork next door in the Chelsea district of Manhattan.

Kamber is pretty exciting, but the place itself is a beehive. By the time he and I sat down to talk, I’d already bought some fingerless gloves from one of its graduates, Madelyn Rich, a fiber artist and entrepreneur who’d paid for her recent Caribbean cruise with her holiday glove sales, mostly online. In a computer lab, a class was learning to use Google Calendar and Google Hangouts. Rachel Roth, a white-haired sophisticate in aviator glasses, wheeled in a cart of her sea-salt-dusted chocolate almonds called Opera Nuts—she hawks them online and through West Elm, Pottery Barn, and Williams Sonoma—and doled out some samples to the staffers in her signature Chinese-takeout-box packaging.

The post-60 set is here for many reasons. By and large, they do not want your wearable panic buttons and fall detectors, thank you very much. They're here for the free classes and camaraderie, to learn to find the photos their daughter is putting on Facebook, to grok the smart lock system their apartment building is installing whether they like it or not (and mostly not). They want to plug back into a world in which "technology has run them over," as Kamber puts it.

Roughly one in five arrive wanting to use technology to work and make money—whether because they've gotten bored with retirement or to turn a pas-

created a platform of sorts to empower those seniors to "uncork their lives."

If anyone is uncorked, it's Calvin Ramsey. After years of toiling in insurance sales, Ramsey was in his early 50s when he decided to give his playwriting dreams one last chance. He wrote a play and then a children's book about the Green Book, the midcentury guide to businesses across the country that would welcome black motorists in an era of segregation. He managed to get the play produced and the book published barely knowing how to send an email. (It involved a lot of cold-calling and post-office runs.)



"I said to myself, 'You're studying when you should be worried about dementia setting in!'"

sion into a side hustle. They want Etsy and Instagram, Google Suite and Microsoft Word. They want to process payments on PayPal, and build a Wix website, and email video clips for acting auditions. They want to open stores aimed at older people like themselves, and launch magazines for curvy women, and drive around Harlem in their own dog-grooming van. They may want to reach their goals even more than younger folks do, because when you get to a certain age, "your horizon is shorter—your dreams become more critical and urgent," Kamber says.

But then there are those blocks. Those people being pains in the ass. "When you're a senior, and you've got an idea, and you want to make it happen," Kamber says, "somebody's got to help out a little bit." So for the past 15 years—in a curriculum now getting recognized by the biggest names in aging, spreading across the US and abroad—Kamber's nonprofit has

As his writing career picked up in his 60s, Ramsey made the big move from Atlanta to the middle of the New York theater scene.

Soon after, he walked into Senior Planet—dressed, as he often is, in a natty suit—to take some beginner courses, figuring it was time to stop avoiding the terms of the modern world. First: getting over his fear of "breaking the machine." Next: email, to send his scripts to directors and actors as his works were staged across the country. "It makes things so much easier!" he says. Then he graduated into the higher-order tasks: Senior Planet's staffers helped him build a website featuring his work, and he started Skyping about his children's book with remote classrooms of elementary schoolers.

One day, as Ramsey sat in nearby Bryant Park, Brandon Stanton, the creator of the hugely popular photo blog Humans of New York, approached him for an interview about how his life had taken off in

his 60s, and shot his portrait. Stanton advised him to quickly launch a Facebook page to capitalize on the 18 million fans the blog would shortly be pointing his way. Ramsey jetted straight to Senior Planet, the staffers helped him set up an author page, and days later, Calvin Ramsey—the man who until recently couldn’t send an email—had 37,000 followers waiting for his next bit of news.

**M**ore older people than ever are working: 63% of Americans age 55 to 64 and 20% of those over 65. Yet it’s unclear whether they are doing so

because they want to or because they *have* to. The age for receiving full Social Security benefits is rising to 67 by 2027. Americans are entering retirement with more debt and less in savings, and the Great American Pension has become a relic of another era. On the brighter side, people are living longer, and a growing body of research makes the point that work—at least some of it, on your own terms—makes

those extra years more enjoyable. For example, researchers at UCLA and Princeton found that seniors who rarely or never “felt useful” were nearly three times as likely to develop a mild disability or even die during the study.

I dropped in on a Senior Planet course called, bluntly, “Work.” The class was learning to use Google Hangouts, and as the lesson wrapped up, a woman with a sharp bob, named Jean McCurry, stopped to talk. She still serves on a couple of boards after a career in higher education, she told me, but pines for the collegiality and structure her old job gave her: “The accountability and responsibility—you really miss it when you retire.” McCurry mentioned a friend older than herself who got a job teaching online courses for a state university, noting, “That’s how she remained relevant in her 90s.”

She was optimistic about getting back in the game, but I couldn’t help feeling a little worried about the daunting discrimination she would face.



The ageism of the era is perhaps best exemplified by Mark Zuckerberg’s infamous assertion back in 2007 that “young people are just smarter,” but it’s not just anecdotal: in a 2017 study by the Federal Reserve Bank of San Francisco, researchers invented résumés for fictitious applicants of various ages, and sent them in response to real-life ads for janitors, salespeople, and security guards. They found that in nearly every job category, the older applicants got fewer callbacks than the middle-aged applicants, who got fewer than the young ones. The drop-off was particularly marked for older women; the researchers speculated—depressingly, but not surprisingly—that women’s physical appearance is more important in service-related careers, and women’s physical aging was judged more harshly than men’s.

With such obstacles to getting a job, and a desire to control their own schedules after years on someone

**Hustle and bustle:** Regulars at Senior Planet include, from left to right, playwright Calvin Ramsey, fabric artist Madelyn Rich, and founder Tom Kamber.





**Senior service:** Michael Taylor and Madelyn Rich used OATS classes to get their new businesses up and running.

else's clock, it's not surprising that some folks take the entrepreneur route.

I found Michael Taylor in the Wix class. Taylor looks like Samuel L. Jackson, with a white-flecked mini-fro. He's a 71-year-old who could pass for 45; he even once got accused of fraudulently using a senior card. When he closed his antiques store in 2009 because of skyrocketing rent and dwindling sales, he didn't want to stop working. His grandfather retired at 84, and "a year later, I saw somebody that wasn't there before—I saw an old man," he recalls. "And I'm like, 'If that's what retirement does for you, I don't want it.' So I plan on working until God calls me home or just until I can't work any longer." Still, he faced that familiar problem: "I found getting a job is not that easy if you're not the 20, 30, or mid-40s candidates."

So in his 60s, Taylor says, "I asked myself, what do I want to do when I grow up?" In 2010, he enrolled

in the New York School of Interior Design, earning a bachelor's and a master's and sometimes marveling at his own gumption: "One day I was sitting there studying for a final exam, and I said to myself, 'You're studying when you should be worried about dementia setting in!'"

He heard about Senior Planet through someone in his yoga class on the Lower East Side. Part of the coursework was learning the new digital tools of his trade: he pulls out a Surface tablet to show me room renderings he created in design software. He also learned to build his business website. He navigates around the work-in-progress, showing me the page showcasing before-and-after photos of his first job—the apartment of a friend who wanted an upgrade for maximum Airbnb monetization. "I like what I'm seeing here," he says, considering the photo layout, making a note to Photoshop out the creases in the sofa.

Taylor has had to make certain adjustments in order to land lucrative clients, including refining his self-presentation. He doesn't lead with his age, and he doesn't mention anything before 1970. A friend advised him not to grunt when he stands up, and at one meeting, Taylor "accidentally" dropped his keys to show how nimbly he plucked them up. "You don't want them to think 'Is he going to make it?'" he says. He laughs at himself, and then puts in his earbuds and takes a call from a client.

**O**n a Monday morning, a class called "Startup!" was diving into a lesson on online marketplaces. A goateed instructor named Roberto was explaining to his dozen students how to increase "arbitrary value" on a platform like Etsy—things like a compelling story that subtly convinces the buyer the product is worth paying more for. Ageism once again popped into the discussion. A woman with a crown of curly hair, who travels to class from Brooklyn, was trying to ramp up her business in hand-sewn lace pillows and curtains. She wondered whether her company's public face should be younger: "I'm thinking about vanity. If my product was high-end, I'd consider whether I'd be doing it, or having a friend of mine or a niece do it."

Roberto asked them to practice pitching their startup to the group. Several ideas were aimed at their own needs—a grocery store focused on saving folks from a long walk, a dog-grooming van that could roll up to your front door, a handyman aimed at Bronx seniors on a fixed income. But it wasn't just by seniors, for seniors. One woman who had promoted jazz shows in Harlem for years wanted

to learn how to price her services; another wanted to open a bar. At the end of each pitch, the students clapped enthusiastically.

Entrepreneurial advice was not what Kamber had originally thought seniors wanted. In the early aughts, he was the New York director for a social-justice-oriented nonprofit when he started tutoring a woman in her late 70s to get online. The idea grew into an organization called Older Adults Technology Services (OATS) in 2004. Kamber, who taught the first class at a public-housing computer lab himself, secured funding from the city to develop the curriculum, and used focus groups to ask seniors what they wanted.

Their responses revealed that the root problem wasn't about how to use technology. They didn't want to simply learn how to email or join Facebook; they wanted a way to beef up their social network after their partner or friends had died. They didn't just want to surf the web; they wanted to contact their member of Congress or apply for benefits. In short, their desires weren't about tech, but about what tech would let them do. "We realized it was actually about aging," Kamber says. "It's about aging, stupid!"

Kamber raised grant money, hired professional instructors, and spread the programming—all free—to 40 computer labs across New York's five boroughs. OATS launched the first Senior Planet space in 2013, a Manhattan hub of community and energy.

Some of the earliest students, like Rich, the knitting entrepreneur, found the center's dynamism a welcome departure from the typical senior center. Still, she told staff what she really needed help with was selling her wares online. When volunteers from Google visited the center one day, one of them asked Rich—she slows her voice as if talking to someone who might have trouble keeping up—"Do. You. Want. To. Open. A. Gmail account?" Rich told him she was already on Gmail; she wanted to see the Google Analytics of her website. "His eyes just lit up!" she recalls.

Senior Planet staffers helped Rich get on Etsy, and she met Rachel Roth, who first strode into the center as she was in the throes of launching Opera Nuts. The two women suggested that Senior Planet let them hold a market in its prime office location to sell their wares, and together they launched the Senior Planet Holiday Bazaar. Rich and Roth now call each other to troubleshoot their website woes as their respective businesses take off.

Kamber's brainchild is expanding. OATS has opened centers in rural upstate New York, Maryland, Texas, and Colorado. There's also a center in Israel, with talk of others in Spain and Japan.

In June, I visited the new center that had opened in a renovated space in downtown Palo Alto, California, called Avenidas. Oculus VR headsets sat ready for classes that would begin in July, and slideshows of members in other cities (like Rachel Roth) flashed on TV sets freshly mounted on the walls. Kamber, who'd flown in from speaking at a conference in Russia, addressed a room packed with startup founders who'd launched apps serving older users, as well as 150 Silicon Valley seniors. Kamber told them a story of one of Senior Planet's New York participants, an actor whose faltering hearing made it difficult to find out about auditions over the phone. Learning to email for the details instead, he extended his career by years.

Back in New York, the seniors continue dropping by even when they're not enrolled in a class: sometimes to take advantage of tech help, or to organize a lobbying trip to Albany, the state capital, for more funding, or to see, say, Calvin Ramsey present his latest show.

One morning in June, Ramsey strode in wearing a linen suit and his black sunglasses and took a seat at the bank of computers. The following night, he'd be talking to people half his age at the National Writers Union about how to market their work. "This whole writing thing has been an out-of-body experience," he said, wide-eyed.

He turned to the task of the day: sending out a teaser for his new play about the first black graduate of Yale. Ramsey opened a Word document and chicken-pecked out letters with two fingers. Diligently, he attached the announcement to an email and added dozens of recipients. Then he thought of more people, and added them; then he thought of even more, and added them, too. He finally pushed "Send," saying "Psheew!" like a spaceship taking off. Within minutes, replies started coming back, filled with congrats. **T**

Lauren Smiley is a journalist in San Francisco covering humans in the tech age.



# I tried

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BY ADAM PIORE



# the starvation

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# diet

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# so you

---

# wouldn't

---

# have to

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**A diet based on  
caloric restriction might  
make you live longer.  
It'll certainly feel like longer.**

PHOTOGRAPHS BY  
BRUCE PETERSON

My bitterness peaked midway through day four of the “Fast-Mimicking Diet,” when a parent arrived at my daughter’s softball game with doughnuts. As little girls and fellow coaches crowded around the box, I stood apart, glumly sipping out of my special water bottle with its “proprietary” blend of nutrients.

For breakfast, I’d consumed a nut bar the size of a small cracker and a couple of vitamins. Lunch was five olives from Seville.

Frankly, I’d begun to resent Valter Longo, the inventor of ProLon, the five-day, \$250 fad diet causing my misery. True, the Italian-born biochemist had seemed perfectly nice when I’d reached him at his office at the

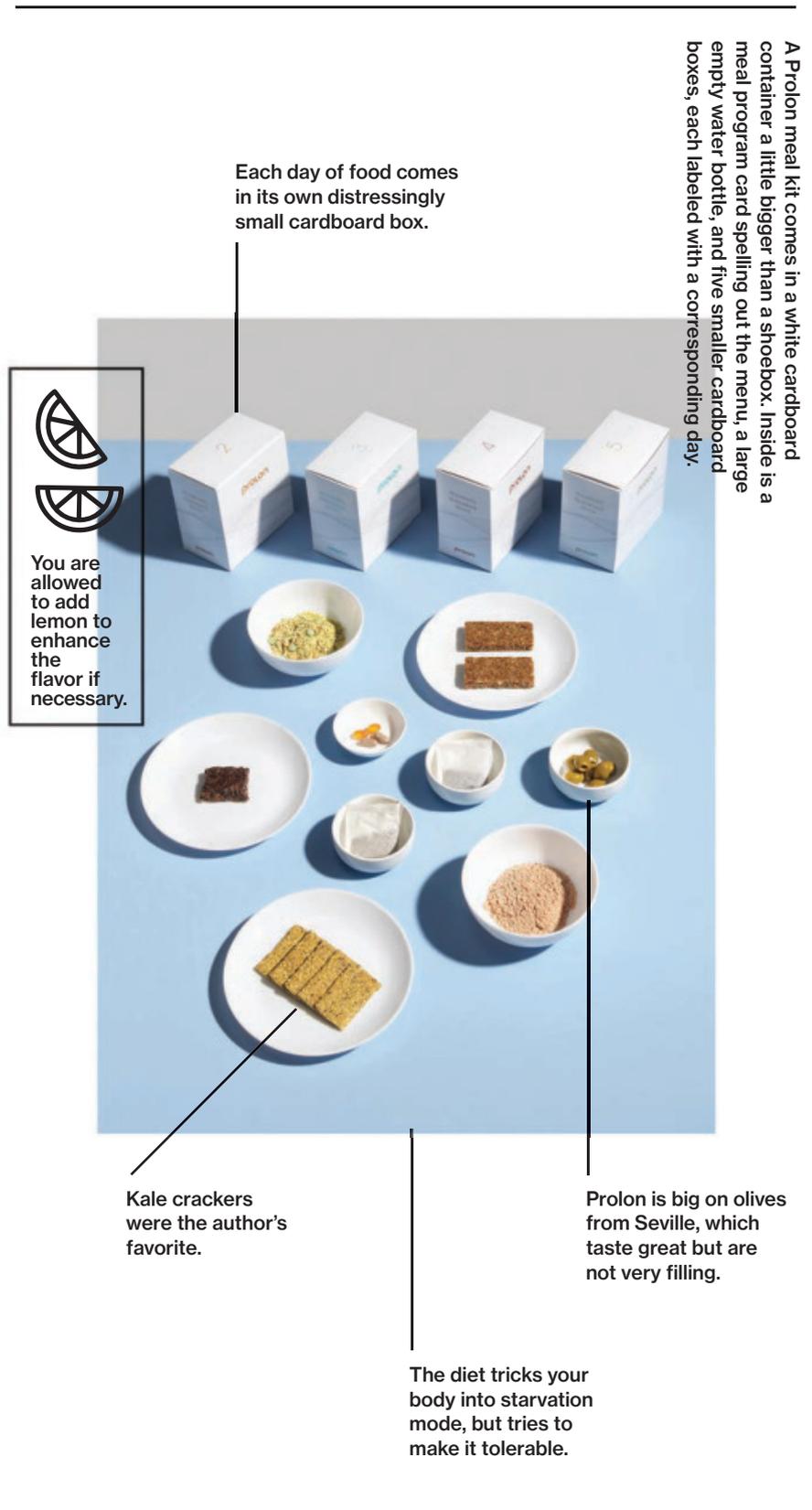
University of Southern California's Longevity Institute a few days before to speak with him about the science behind the diet and what it might do for my general health and longevity. He had patiently explained how the diet would temporarily shift my body into a starvation state that would prompt my cells to consume years of accumulated cellular garbage before unleashing a surge of restorative regeneration. Getting rid of garbage had sounded like just what I needed. But now I blamed him for my predicament. I wanted a doughnut.

My Prolon "meal kit" had arrived in a white cardboard container a little bigger than a shoebox. Inside I'd found a meal program card spelling out the menu, a large empty water bottle emblazoned with the word "Prolon," and five smaller cardboard boxes, each labeled with a corresponding day. I opened the box for day one, billed as a higher-calorie "transition day," and was pleasantly surprised. It didn't look so bad. I'd be sampling many of the diet's highlights: a small packet of kale crackers, powdered tomato soup blend, algae oil supplements, a bag of olives, herbal tea, and not one but two nut-based bars (albeit distressingly small).

When I opened up day two, however, I began to get a better sense of what I was in for. One of the puny nut bars had been replaced by a glycerin-based "energy" drink, which I was instructed to add water to and sip on throughout the day. There was more herbal tea—hibiscus, mint, and lemon (I don't even like herbal tea)—plus a couple more powdered-soup packs and two tiny packets of olives. Where was the rest of it?

"We give you quite a bit of food—just over 800 calories," a trim, youthful nutritionist explained unironically in a YouTube video I pulled up to make sure there was no mistake. The goal of Prolon, he explained, is to trick the body into thinking you are fasting, prompting it to "suppress all of the same pathways as if you were doing a full fast."

"By day three your body has activated all of the benefits and then spends the rest of the days optimizing, regenerating,



A Prolon meal kit comes in a white cardboard container a little bigger than a shoebox. Inside is a meal program card spelling out the menu, a large empty water bottle, and five smaller cardboard boxes, each labeled with a corresponding day.

Each day of food comes in its own distressingly small cardboard box.



You are allowed to add lemon to enhance the flavor if necessary.

Kale crackers were the author's favorite.

Prolon is big on olives from Seville, which taste great but are not very filling.

The diet tricks your body into starvation mode, but tries to make it tolerable.

rejuvenating,” he added cheerfully. “So you can really expect to feel the benefits on day four.”

## The lesson of Biosphere 2

The idea that starving yourself while still taking in crucial nutrients will let you live longer is not new. The practice, called caloric restriction, is the only proven way to extend life that works in a wide variety of creatures, from worms to rodents to primates. And it was already of interest to biologists when Longo was first starting out in the field, almost 30 years ago.

At the time, there were few people more identified with the radical diet than Roy Walford. A larger-than-life figure, Walford had already demonstrated in his UCLA lab that he could double the life span of mice by drastically restricting their caloric intake. He had also published a number of popular books on the topic, among them *The 120 Year Diet* and *Beyond the 120 Year Diet*, and would follow a strict 1,600-calorie diet himself for the last 30 years of his life (the US Department of Health recommends 2,800 calories a day for an active middle-aged man). He weighed in at 130 pounds (59 kilograms) for most of that time, far below the average weight for someone 5'9" (175 centimeters) tall.

When Longo arrived in Walford's lab to begin his PhD work in 1992, Walford was on temporary leave. Several months earlier, he'd gone to the Arizona desert to serve as one of eight “crew members” in a three-acre (1.2-hectare) complex of hermetically sealed domes known as Biosphere 2. The two-year experiment in communal living was billed as a test of the kind of home that might one day be built and used for the colonization of space. Soon after entering the biosphere in 1991, the crew members discovered they could not grow nearly as much food as they had anticipated. It was Walford, the crew physician, who persuaded them to follow a severe caloric restriction diet—a decision that garnered worldwide media attention as they staggered out of the biosphere in 1993, gaunt and sickly.

Walford died in 2004, at 79, of amyotrophic lateral sclerosis, a.k.a. motor neuron disease or Lou Gehrig's disease—a condition, Longo notes, that many suspected was the result of the two years of extreme caloric restriction he endured in the biosphere. It's a theory Longo takes seriously.

“We don't know if that was the cause,” he says. “But I was there when he came out of the biosphere, and he looked sick and so did everybody else. Maybe he paid a price for that. We don't know what the connection is with motor neuron disease. But it's possible his neurons couldn't handle this extreme situation for years and years and years. Maybe it combined with something else.”

The lesson was clear: while caloric restriction might make you live longer, doing it for extended periods was a problem, and probably not practical for most people.

## Biological house cleaning

In any case, at the time Longo was less interested in the association between diet and longevity than in what he considered to be a fascinating by-product of extreme caloric restriction. Longo discovered that when he starved bacteria and yeast, they not only lived far longer than their well-fed counterparts but entered a protective state that seemed to shield them from environmental stress. When exposed to hydrogen peroxide, yeast in starvation mode were between 60 and 100 times more resistant to cellular damage than yeast that had been taken from an environment rich in glucose to feed on.

That was surprising. Wouldn't a cell weakened by starvation become less resistant to damage, rather than more? But in the years that followed, a consensus emerged that explained both Longo's discovery and other researchers' findings that lab animals fed a caloric-restricted diet lived longer.

In a well-fed state, our cells and those of other multicellular organisms invest energy in reproduction and regeneration. But when food is scarce, those functions shut down, and the cell diverts its energy to feeding and protecting itself; it takes far

less energy to protect the cells you already have than to build new ones.

To do so, the body revs up a host of protective pathways. In the case of Longo's yeast and bacteria (and eventually mice), he and others would later show, the organisms make enzymes that neutralize free radicals—molecules with unpaired electrons that can damage other cells. Other proteins and enzymes are produced that ensure proteins don't misfold, and in every cell, the cellular machinery devoted to repairing its own DNA kicks into overdrive.

In more complex organisms like mice or humans, the body still needs calories to keep the heart beating, the brain thinking, and the muscles contracting. To get them, it engages in a process called autophagy (an ancient Greek word that means “self-consumption”), breaking down the body's own cells and recycling their components. But this autophagy is not random.

“It tends to begin by eating proteins that are misfolded or denatured,” explains Eric

**“We give you quite a bit of food—just over 800 calories,” a trim, youthful nutritionist explained unironically in a helpful YouTube video I pulled up to make sure there was no mistake.**

Verdun, the president and CEO of the Buck Institute for Research on Aging. “There is a house-cleaning aspect to it. It consumes itself, but it consumes the proteins that need to be cleaned out first.”

Forced to turn inward for energy sources, the body hunts down, eats, and recycles its own cellular garbage, in the process removing debris that can prevent cells from operating efficiently.

## Starving cancer cells

Longo was fascinated by this process, and he would spend the next two decades helping to identify the genes and biological pathways at work. As he did so, he began to recognize something unexpected. Many of the genes involved were also prominent in the cancer literature.

In the cancer field, they were known as “proto-oncogenes”—the very same genes that, when mutated, had the power to transform a normal cell into a cancerous one, by essentially wedging the cell’s regeneration machinery permanently into the “on” position and causing it to divide and proliferate uncontrollably.

That gave Longo an idea. He had already shown that starvation could cause all an organism’s normal cells to enter a protective state. But cancer cells aren’t normal cells. One of the hallmarks of cancer is that the cells do not respond to biochemical signals suppressing their growth. What would happen, Longo wondered, if he put mice into starvation mode before exposing them to chemotherapy? If the normal cells went into a protective state but the cancerous ones did not, drugs could kill the cancer with less risk of damaging normal tissue.

Longo administered high doses of the chemotherapy drug doxorubicin to yeast. He found that under starvation conditions, normal yeast cells became a thousand times more resistant to stress, while cancer cells were exposed to the full brunt of the poisons. When Longo repeated the test on mice, starving one group for 60 hours prior to the chemo, the results were dramatic. Every single one of the normal mice died. Every single one of the starved mice lived.

But when Longo began reaching out to clinicians who worked with cancer patients, he encountered unexpected resistance. “We thought, ‘Of course. Everybody is going to do it. It’s going to be easy,’” Longo recalls. “It took us five years to recruit 18 patients. It was water-only fasting. Completely free. Don’t eat. Just drink. Nobody wanted to do it. Everybody thought it was a disaster.”

Facing defeat, Longo and his team groped for alternatives and quickly hit on a better idea: perhaps they could design a diet that aimed to trick the body into thinking it was fasting, without actually starving. Longo knew that if he made a low-carbohydrate diet lacking glucose and certain key amino acids—in other words, most proteins and all carbs were out—the body would still enter its protective state.

Longo created a company, L-Nutra. By 2014, his lab had produced its first prototype. And in 2015, he published a study demonstrating that middle-aged mice on the fast-mimicking diet had far fewer tumors and were protected against cognitive decline. By then researchers in Leiden in the Netherlands had finally signed up enough volunteers to show that water-only fasting helped protect human patients from the ravages of chemotherapy. They agreed to begin testing a version of Longo’s diet on 125 cancer patients undergoing a similar chemo regime.

Longo says more than 40 trials are currently under way, at a wide variety of institutions. Not all of them are for cancer; there are also studies for Crohn’s disease, Alzheimer’s, and Parkinson’s.

## The danger of success

Longo never forgot his roots in Walford’s lab. He knew that calorie restriction had “incredible effects,” but he also knew a strict diet had problems. Immunity was lowered, because the body could not produce white blood cells as quickly. Besides, “very few people can stick to calorie restriction,” he says. “Maybe one in ten thousand in the United States. It was not feasible for the great majority of the people.”

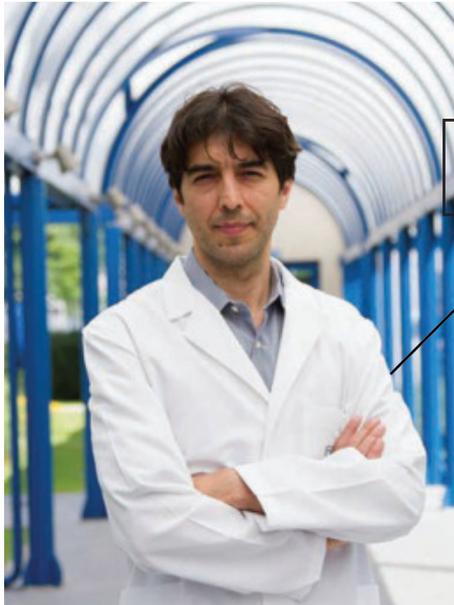
Longo was convinced, however, that periodic calorie restriction had some of the same health benefits as being on the diet full time—benefits worth the effort, if one could endure hunger pangs for a few days.

He decided he had to commercialize the diet—not just for the benefit of cancer patients, but because he also wanted it taken seriously as a tool for promoting healthy aging. “To me, it was very clear that it had to be somehow made into a drug-like product,” he says. “I realized early on that if there wasn’t a product, it would be very difficult for doctors and every health-care professional to take it seriously, and also to implement it. Doctors are used to something that has been tested clinically. They can’t say, ‘Here is a diet somebody at USC used.’”

So in September 2016, ProLon, the diet I tried, was born. Research on the “fast-mimicking diet” is still limited. So far, the most prominent publication on it is a 2017 study in the journal *Science Translational Medicine*, in which 71 healthy adults in the United States were given the ProLon diet for five consecutive days once a month for three months. The results established that the diet not only was safe but reduced things like body fat, blood pressure, insulin-like growth factor, low-density-lipoprotein cholesterol, and triglycerides, all of which are associated with aging and age-related diseases. It’s also far easier to stick to than a straight water starvation fast.

The sparseness of research data in humans has done little to dampen enthusiasm. Today ProLon is successful beyond anything an academic could reasonably hope for. The product—which, according to a company website, promises to “[put your body] into a protective and stress resistant mode; remove damaged cells and tissues; and promote self-repair through cellular regeneration and rejuvenation”—is all the rage in Silicon Valley. It’s sold in 15 countries and has been tried by more than 150,000 people.

Instead of doing backflips, however, Longo has grown increasingly concerned in recent years about what this commercial success might do to his scientific



VALTER LONGO,  
PROLON  
INVENTOR

reputation. In 2017, after a series of articles about the product—one of which described Longo as “sounding like a snake-oil salesman” although it was fairly positive about the research—he announced he would no longer accept consulting fees and would donate his shares in the company to charity.

“All the decisions are made by the CEO,” he says. “I act as a professor ... I am a scientist, and my heart is in the science and making sure it works. And the company’s heart is in a different place. Once you start having investors and you start having shareholders, it’s different.” He adds, “If I’m doing anything, I’m trying to get the company to do the right things, and sometimes I’m telling them, ‘Look, can you lower the price?’ I’m fighting for the people I see coming to the university to do the trials. I’m the watchdog of the company.”

Longo is not the only anti-aging scientist who has found himself the subject of unflattering media coverage, or attacks from rivals criticizing products he’s involved with as untested. The others deal with it in

different ways. Nir Barzilai, who directs the Institute for Aging Research at the Albert Einstein College of Medicine, founded a publicly traded company called CohBar that focused on peptides involved in aging and age-related diseases. He stopped doing any research in the area to eliminate the appearance of conflict when he talks about it in the media. He has a financial stake, in other words, but his scientific career is now focused on other questions.

“You get into lots of conflict,” Barzilai says. “I’m in interviews. I’m on television. I didn’t want anybody to say, ‘You’re promoting your research and your company.’”

Others take a more relaxed attitude. Leonard Guarente, an MIT professor and prominent anti-aging researcher, cofounded a company called Elysium to sell supplements designed to work on a family of proteins called sirtuins that have a role in aging, as he discovered in the early 2000s. His stated goal is to use the profits to follow up with scientific studies that document the effects on humans.

He’s not afraid to own it, despite the media backlash. “I don’t know if it bothers me as much as it bothers some others,” he says.

In a field badly tarnished by hype and false claims, the scientists face a real dilemma. Their products, unlike many others on the market, have legitimate science behind them. It’s early days, but their anti-aging approaches could work. “Our goal in this research is to stop the age-related diseases,” says Barzilai. “If we’re not going to do that, who’s going to do it, exactly? It cannot happen without us.”

## Minus 8 pounds and happy

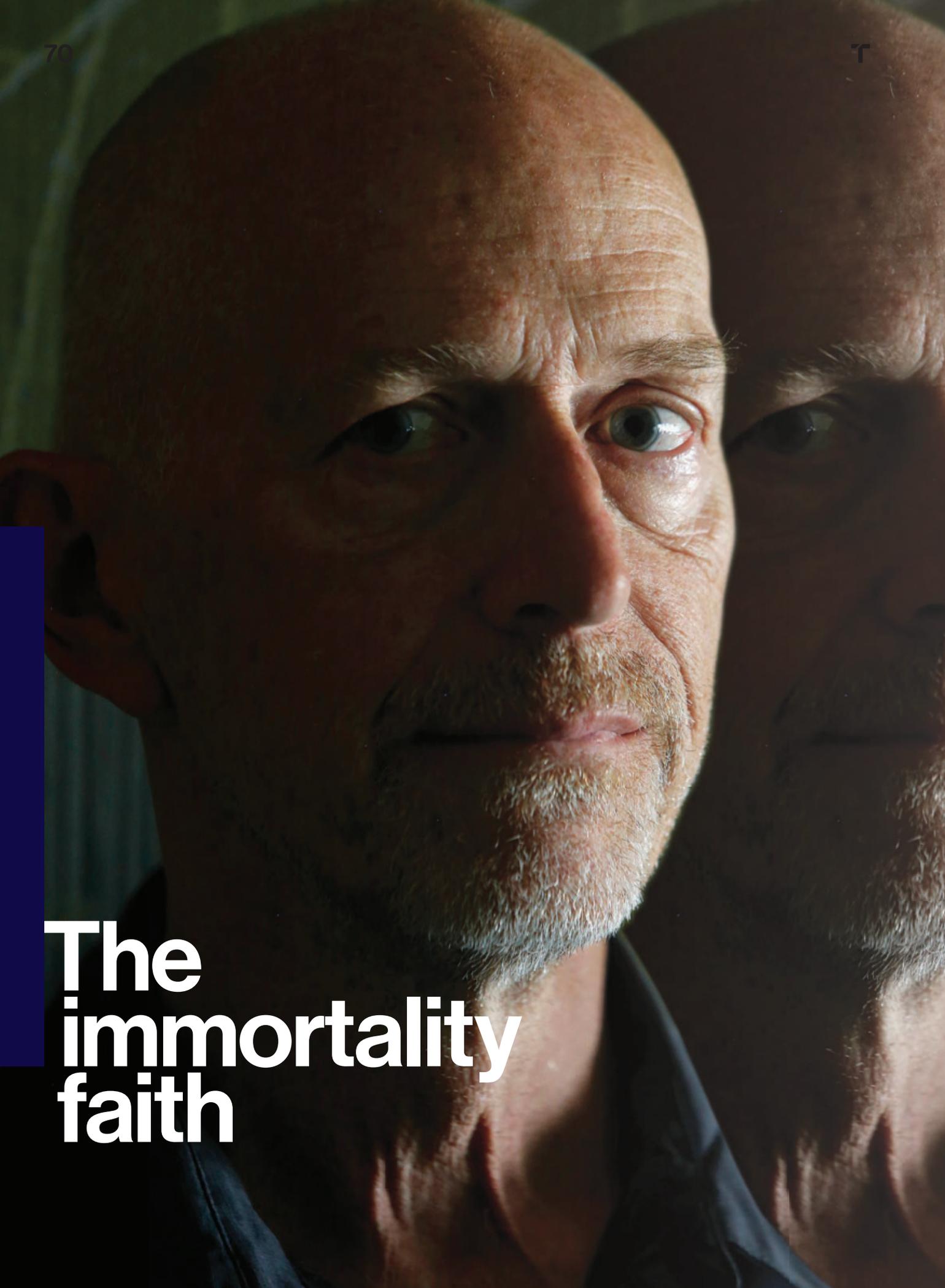
After five long days on Prolon, I awoke one morning to a day that promised as much soup, juice, and light meals of legumes and pasta as I could handle. Day six is a “transition” day, and dieters are encouraged not to binge. I can’t say I followed the suggested instructions. My first stop was Whole Foods, where I consumed an entire packet of Frisbee-size puffed-rice discs.

I felt great. My wife told me I seemed to be unusually energetic. I had lost eight pounds (nearly four kilograms) over five days, too. Overall, it hadn’t been too bad. I’d been reading about and reporting on different biological pathways involved in healthy aging on and off for several years, and the scientific claims made about Prolon were consistent with much of what I had read.

It wasn’t easy. I’d been hungry, grouchy, and bitter. But I never could have completed a real water-only fast for five days. And in the days that followed, it seemed to me I really did feel far better than I had before. Even if I was imagining the effects, which I don’t think I was, I stayed away from sugars and junk food for weeks afterward. That alone is reason enough to do it again—which I plan to after the suggested three-month interval has passed.

By then, the softball season will be long over. **■**

Adam Piore is a freelance journalist based in New York. He is the author of *The Body Builders: Inside the Science of the Engineered Human*, about how bioengineering is changing modern medicine.



# The immortality faith

For a core of  
longevity true  
believers, the time  
to intervene is

NOW.

# “How old are you?”

James Clement wanted to know.

I turn 50 this year. There’s a new creaking in my bones; my skin doesn’t snap back the way it used to. It’s developed a dull thickness—you can’t tickle me at all. My gums are packing it in and retreating toward my jaw. These changes have been gradual or inexplicably sudden, like the day when I could no longer see the typed words that are my profession. Presbyopia, the ophthalmologist told me. Totally normal. You’re middle-aged.

To Clement, though, my age was great news. “Yep, you are going to live forever,” he said. “I think anybody under 50 who does not have a genetic liability will make it to longevity escape velocity.”

Clement, 63, is a spry man with a shaved head and clear eyes, who spends his days gulping vitamins and trying to figure out how to make people live longer, including himself, his parents, and even me. From a home and several outbuildings in Gainesville, Florida, Clement runs BetterHumans, which he calls the world’s “first transhumanist research organization.” With funds from wealthy elderly men he knows, he is independently exploring drugs known to extend the healthy life span of rodents. Using a calculator, he extrapolates what a suitable human dose might be, and then finds people who will take them.

If he thinks the results look safe and have a hint of promise, he will recommend the treatments to his parents, who are in their 90s, and to his financial supporters. “I don’t think it’s happening fast enough,” he

says. “I use my parents as my motivation. If I were doing it for humanity—well, that is not as urgent.”

Clement’s open-plan kitchen is a laboratory too. On the counter, I saw pill bottles, and jugs half-full of white powders from Chinese suppliers, whose low prices are part of what allows his nonprofit to do human research “on a shoestring.”

“Are those all the vitamins you take?” I asked, pointing.

“No, these are,” he said, opening a cabinet with four shelves stocked with neatly organized containers: kelp, gamma E, policosanol, super K, acetyl-L-carnitine, DHA, pomegranate extract, and so on. A different cabinet held the nighttime capsules. He has learned to gulp them by the fistful.

Trying to forestall age isn’t without risk. The day I met him, Clement was recovering from a serious fall after he blacked out. Two years ago, he got a pacemaker installed. He believes a serious problem with his heart was brought on by an over-the-counter nutraceutical, the root extract berberine. It can cause the heart to beat slower, a condition called bradycardia. “I think that’s a legitimate story to tell people,” he says. “You don’t always know.”

## Escape velocity

Transhumanism is a patchwork of beliefs about how technology will enhance the human condition, maybe radically so. There are Extropians and brain uploaders, artists keen to paint in virtual worlds, and do-it-yourself biohackers ready to have electronic chips implanted in their bodies. One common thread, though, is the hope for super-longevity.

Who wouldn’t want to reach 110, if not 500? Unlike mere armchair futurists, the life extensionists are prepared to experiment on themselves, and others, using vitamins and prescription cancer drugs, as well as compounds available only by finagling them from chemical suppliers.

“It’s not supposed to be for people,” said Richard Daly, a retired plastics manufacturer I met in Florida, of the peptide he swears reduced his biological age by four years. He winked. If a scientific paper points to a promising molecule, someone in “the community” has found a way to take it.

Lately the idea of living longer, maybe a lot longer, seems more realistic. As biologists uncover the fundamental facts of life, even ivory-tower academics now claim they know what the molecular “hallmarks” of aging are. In their lab animals, at least—roundworms and white mice—they can regularly increase life spans by 20% or 30% and sometimes more.

Given these clues, Clement is expanding his medicine cabinet of pills. So far he has financed and supervised four small studies, in volunteers, of treatments found to extend the healthy lives of rodents—the immune drug rapamycin, the supplement NAD+, a combination of compounds that kill off aged cells, and injections of plasma concentrated from umbilical cords. His aim is “to do as many small trials



ALFONSO DURAN



Tranhumanist James Clement (opening page) is researching how to stay alive forever.

Congregants at the Church of Perpetual Life in Hollywood, Florida.

as possible” to generate and publish basic information on safety and possible benefits. With that, he says, people interested in life extension “can decide to take the risk.”

The payoff? Hanging in there until scientists ultimately cure death. Ray Kurzweil, a Google research director and the author of books on a coming technological “singularity,” tells people to wear seatbelts, avoid extreme sports, and exercise—in

other words, stick around until science reaches “escape velocity” and life is prolonged by innovations that add years faster than they pass.

## Double dose

Clement, a lawyer by training, sees his job as bringing that day closer and making sure it’s affordable to everyone, “not just billionaires.”

year published his own pilot study exploring his treatment in 26 volunteers with pulmonary disease.

I thought the two studies—one from America’s number-one-ranked hospital, another from an unknown researcher in Florida—were remarkably similar. But there was one difference: Clement has taken the drug combination six times himself and gotten his parents to do so as well. In 2018, Kirkland cautioned longevity seekers in the pages of the *Journal of the American Medical Association*: “Patients should be advised not to self-medicate with senolytic agents or other drugs that target fundamental aging processes in the expectation that conditions alleviated in mice will be alleviated in people.”

But Mayo has stoked the phenomenon with press releases talking up potentially “transformative” anti-aging results from its labs. Kirkland’s combination of drugs, dasatinib and quercetin, is known by the shorthand “D&Q” in the anti-aging community. After Kirkland showed that another drug, called fisetin, makes mice fed it live about 20% longer, self-experimenters didn’t delay in trying it. “The Mayo clinic protocol called for 180mg, but I decided to [hit] those zombie cells harder,” read a post I found on the Age Reversal Network, a bulletin board that’s a hotbed of longevity tips. The poster had decided to give himself nearly a double dose, 300 milligrams.

Just in case the longevity drugs don’t work, transhumanists like Clement have a backup plan. He wears a steel wristband directing anyone who finds his dead body to call the brain-freezing company Alcor, in Arizona, to preserve his brain for reanimation in the distant future.



One potential aging treatment he is giving some 30 volunteers is a drug combination identified in 2015 at the Mayo Clinic by researcher James Kirkland as a way to selectively kill malfunctioning “senescent” cells in mice. Kirkland this

**Brain freezing.  
That’s the backup plan.**



## Transhumanist church

On a corner in Hollywood, Florida, amid low palms and dirt side streets, there is a cream-colored building called the Church of Perpetual Life. One Friday in June, I watched the vitamin and supplement entrepreneur William Faloon step out of a white Mercedes convertible with his wife. They posed for photos. She wore a minidress and white pumps; Faloon wore a suit, tie, and matching pocket square.

The motto of the church, created by Faloon and a business partner, Saul Kent, in 2013, is “Aging and death can be optional.” It bills itself as a transhumanist religion (one of its patron “saints” is the science fiction writer Arthur C. Clarke). In practice it’s a gathering spot for hard-core life extensionists and the latest in a series of oddball projects Faloon has financed, including plans for a cryonics “timeship” in Texas with room for 10,000 frozen bodies.

for 10,000 frozen bodies.

“It’s hilarious,” says Steve Perry, a longevity enthusiast in New York. “He’s making a mockery of religion and maybe getting a tax break, too. If you are going to live another hundred years, you have to have a sense of humor.” (Faloon, who bought the building, pews and all, from a Baptist denomination, says it “is as legitimate a church as any other.” He adds, “We have an attorney who we pay a lot of money to.”)

The investor Peter Thiel has remarked that most people cope with death through a combination of “acceptance and denial.” Add humor to the list. But Faloon is as serious as they come. “I was worried about it as soon as my mother told me I was going to die. As soon as I heard that, I said no way—I am



**“I was worried about it as soon as my mother told me I was going to die.”**

William Faloon, cofounder of the Church of Perpetual Life, also makes money from diet supplements, books, and a magazine.

not going to let that happen,” says Faloon. Now, at 64, he says he feels like “a duck in a shooting gallery,” given the risks of age-related disease.

Faloon makes his money from the Life Extension Buyers Club, which operates a storefront and clinic in Fort Lauderdale and a phone bank in Las Vegas. It sells large amounts of dietary supplements and publishes a magazine with detailed articles on how to stay alive. In 2017, the US Food and Drug Administration sent

reached the pews. There was friendly chitchat around a free buffet and talks by a fruitarian (a person who eats only fruit) and the manager of a vegan health retreat. Faloon took the podium in front of a large black flag emblazoned with a rising phoenix to present his “age-reversal strategy,” a staircase of interventions essentially identical to the four being tested by Clement. Added to these at the highest step was CRISPR, the gene-engineering technology. The prospect is that DNA modifications might one day prevent aging altogether.

Clement told me he hasn’t been to the church, since the other speakers are not “as scientifically rigorous as I would prefer.” But Faloon is one of his biggest supporters; he recently gave him \$200,000 for a study of heart disease, listens to his advice, and shares it at his church. “James is probably the most efficient clinical researcher out there,” says Faloon. “He will do a study for \$50,000 that a drug company will spend \$10 million on. It’s easy to write him a check.”

In his talks, Faloon flashes recent news headlines and scientific articles about anti-aging medicine. “Age reversal, radically extended life—it’s happening, they are recognizing it!” he told an audience in Las Vegas last year. Never mind that some of these publications warn against anyone actually taking the drugs. To Faloon that’s more foot-dragging. “They are telling you to wait!” he said. “We jumped on this. As a result, we already know [it’s] not toxic, and incredibly beneficial.” It was a reference to Clement’s research.

During the service, Faloon told congregants how to get D&Q, the senolytic drug mixture, which needs a doctor’s prescription, giving them the name of a compounding pharmacy that could supply it. I called the pharmacist, Alan Zimmer, who told me it costs \$225 a dose. “Demand for this has not been very strong,

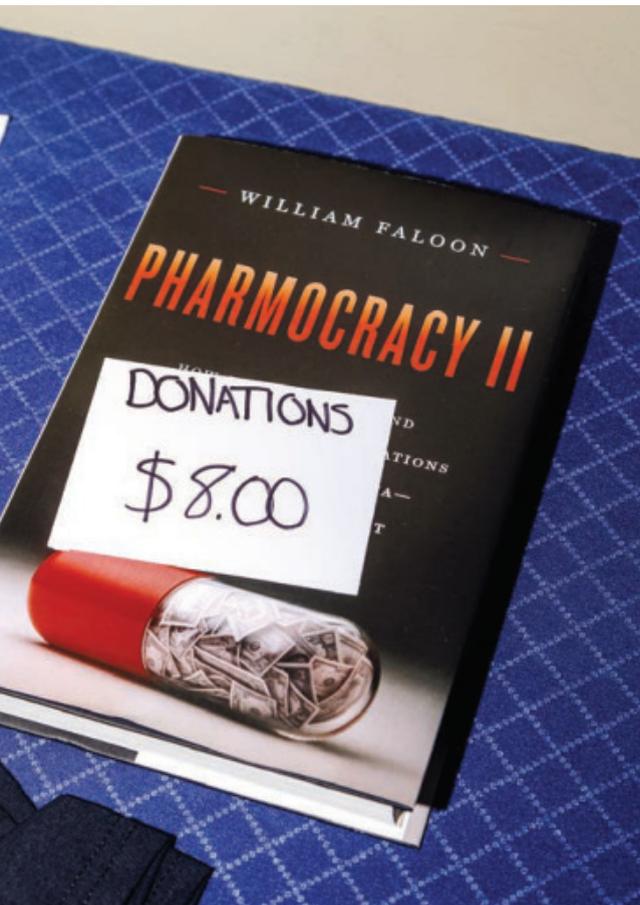
It’s something new, not very popular, although I know a lot of the anti-aging people are excited about it,” says Zimmer. “What the ramifications are, time will tell. Most of the research is from lab animals.”

This is a tricky problem, says Zimmer, who has seen longevity fads come and go. “The dilemma of anti-aging research is that to do real research in humans would require life spans, and if we had to wait for that, then the entire population on Earth would have passed on,” he says. “People here could never take advantage, because they would all be dead. So they look to research on animals, and apply it hypothetically.”

Later this year, at a conference of longevity enthusiasts called RAADfest, to be held in Las Vegas, Faloon plans to take the strategy one step further with what he has been calling the “Perpetual Clinical Trial.” It’s so named because it has no end date and “there is no upper limit as to how long we will attempt to enable study participants to live.” He is inviting 50 people to join for a small fee and get “aggressive” treatment using therapies from the age reversal ladder. Latecomers will have to pay much more to participate.

Of course, no one can say if the treatments will really extend your life. That remains a matter of faith. “As a member,” says a pitch for Faloon’s Life Extension Buyers Club, “you belong to an elite group of forward-thinking individuals who have a clear vision of the marvels that will exist in that wonderful world of the future.” **T**

Antonio Regalado is MIT Technology Review’s biomedicine editor.



Life Extension a warning by next-day air, noting over 400 products on sale with “various” unproven health and life extension claims.

The day I visited the church, cars overflowed the parking lot into the side streets. Some visibly ill people

D O

Y

By Andy Wright

# EXO- SKELETON

As the market for products aimed at older users explodes, some entrepreneurs are turning to a radical idea: actually get the customers involved.

# 80 - EAR - OLDS

DREAM OF

# S ?

## MOBILITY

Seismic's body suit uses built-in sensors and robotics to give wearers extra support when sitting or lifting.

Photograph by  
CODY PICKENS

# ON

a drizzly Tuesday afternoon in San Francisco, people are filtering into a small conference room appointed with a whiteboard and subdued black-and-white photography. As the seats fill up around the long white table, a woman dressed mostly in red, with sparkly silver nail polish, invites everyone to her upcoming ukulele performance. A man in a blue plaid shirt passes around a container of heavily iced hot cross buns. A woman in a green turtleneck chitchats about the presidential power struggles in Venezuela. They're here to talk about technology—a scene that should be entirely unremarkable in a city filled with small white conference rooms where people are doing exactly the same.

“Okay, everyone ready?” asks Richard Caro, the meeting's leader, an Australian with neatly cropped silver hair, alert dark eyes, and the demeanor of a kind professor. “Let's start with you, Lynn. You've got one here”—he glances down at his notes—“that says ‘hearing aids.’”

Lynn Davis, a 71-year-old retired project coordinator, says her sister-in-law recently talked about a pair of \$300 hearing aids she'd bought online and loved. Excited, Davis had Googled the product, only to find a lengthy blog post that “ripped it apart.”

“Ha!” chortles the woman sitting next to her. “A piece of junk!”

The comment sparks a spirited back-and-forth about hearing aids. Caro, at 63, is one of the youngest people in the room: the average age of the 11 women and five men gathered here is somewhere in the mid-70s. A retired computer programmer says she has considered buying hearing aids that can be programmed at home. A man with an iPhone sticking out from the pocket of his flannel jacket talks about the signal-to-noise ratio. A redhead wearing a hand brace describes her stereophonic pair, which affords her surround-sound hearing.

“Wow, you've got the Cadillac!” one woman cracks.

“For the money,” the redhead responds, “I have the Ferrari.”

They are the Longevity Explorers, part of Caro's experiment to improve the way technology is developed for older adults. They've been meeting here since 2014. Throughout most of the meeting Caro sits quietly at the head of the table, hands clasped together, and just listens. He wishes more people—especially entrepreneurs—would do the same.

**E**lizabeth Zelinski has a story she likes to tell. It's about the company that made a wearable pad to prevent people from hurting their hip if they fell. “They couldn't sell the thing,” says Zelinski, a professor at the University

of Southern California's Leonard Davis School of Gerontology. “Because, guess what? You know why? Nobody wants to have a big butt.”

If they had just done some user testing, she says, “they would have saved themselves from a lot of heartache.”

It's a familiar tune to engineer Ken Smith, director of the mobility division of the Stanford Center on Longevity. He says one of the biggest mistakes designers make is to assume that around the age of 60 people lose interest in aesthetics and design. This can have dire consequences for products meant to help people with their health. No one wants to stick a golf-ball-size hearing aid the color of chewed gum in their ear, any more than they want to wear a T-shirt that reads “SENIOR CITIZEN.”

Similarly, there's a common perception that people of a certain age simply can't or don't want to learn about new technologies. There is only a kind-of, sort-of, not-really kernel of scientific truth to this. Zelinski, a specialist in neuroscience and cognition, says aging causes changes to the medial temporal lobe—the part of the brain associated with new learning. And your white matter, or myelin, which helps speed the transmission of information from one brain cell to another, is going to get funky, she says. “People just need longer... they need more exposure to something to learn how to use it. It's not that they completely lose the ability to learn.”

Experts say older adults who still work, or who spend time with younger family members who use technology, are more apt to pick it up. Also, says Zelinski, “a lot of the technology that older people are interested in has to be something that they find easy to use, that's affordable and compelling.”

That sounds like what anyone would want. And yet the list of lousy products for older people is long. Smith describes clunky walkers, ugly canes, and institutional-looking grab bars—although he adds that he's recently seen some cleverly disguised to look like towel racks or other household objects.

Smith's division has helped bring to market a number of products for the older consumer, like a line of Stanford-designed shoes for people with knee arthritis. One of the options even looks like a slick running shoe, rather than a Frankensteinian orthotic.

Engaging older people in designing for older people “is a good thing,” says Smith. “Because younger people do tend to have this picture of designing things that are functional for older people, but not really understanding what makes them happy.” Presented with products that are “brown, beige, and boring,” many older people will forgo convenience for dignity.

Social isolation is real for many older people. Virtual-reality company Rendeever makes headsets that let users revisit old haunts or join in activities with their peers.

I S O L A T I O N

on Barbara Beskind, then 89, as a designer in 2013 to help it create products for older people. Hazel McCallion, former mayor of Mississauga, Ontario, was 98 when Revera, one of Canada's largest providers of assisted living, hired her as its chief elder officer in 2015.

But progress is incremental, perhaps because aging still gives people the heebie-jeebies.

“Unfortunately, the first thing you hear when you say ‘Well, so much of the population is aging, they’re living older’—people will say, ‘Oh my God! What are we going to do about this problem?!’” says Smith. “And you know, if you back off a step, you realize this is, like, one of the great accomplishments in human history.”



That’s why last year, as part of an annual global design challenge he runs at Stanford, Smith brought in the Longevity Explorers so that the designers could actually meet some older people. Smith said the workshop helped—his young finalists came away thinking of older consumers as less of a stereotype, and more as individuals with heterogeneous tastes and needs.

A handful of major companies are trying to set an example by doing something similar. Design heavyweight IDEO brought

says, “all the existing products were ugly and stigmatizing. It just seemed there was a fertile opportunity that was being missed.”

After he’d conducted about 100 interviews with people in their 70s, 80s, and 90s, one thing stood out: many of the people he met missed feeling useful. “There’s this huge demographic of people who have sort of been put aside and told to go off and play bridge and bingo and not contribute to society,” he says. Zumba and lectures were fun, but not fulfilling.

An idea took shape: Why not get people together to talk about aging and use those discussions to pinpoint problems technologists should tackle? It would be a resource for product developers, as well as giving the target audience some influence over the companies gunning for their dollars.

“We weren’t sure we could make it interesting to them so they’d want to come back,” he says. “We weren’t sure anything useful would come out of it. We weren’t sure of anything.”

It turned out to be an experiment that paid off. Today there are eight Longevity Explorer “circles,” as Caro calls them: five in

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**PRESENTED WITH PRODUCTS THAT ARE “BROWN, BEIGE, AND BORING,” MANY OLDER PEOPLE WILL FORGO CONVENIENCE FOR DIGNITY.**

**C**aro has an adventurous streak—he once heli-skiied the Himalayas—but he is not brash. He gathers his thoughts before he speaks, and when he does, he uses his hands judiciously for emphasis. He’s mastered Silicon Valley Neat Casual: Button-ups under top layers that suggest athletic activity, dark jeans, an Apple watch.

He arrived in California from Melbourne, with a stop to study lasers at Oxford University as part of a doctorate in experimental physics. After a job at a pioneering laser eye surgery firm in Boston, he spent the 1990s at startups and medical-device companies in Silicon Valley and ended up going solo as a management consultant and angel investor. Then, five years ago, he decided to take on the problem that had been nagging him for years. For older people, he

Northern California and one each in Rhode Island, Pennsylvania, and Ohio. There are about 500 members, most of whom are in their 70s, 80s, and 90s, although there are members in their 60s as well. He often gets emails from people who want to either join a group or start one, and he is gradually greenlighting circles throughout the US, run by volunteers. The circles are enabled by Caro's company, Tech Enhanced Life, a public benefit corporation.

Circle meetings go like this: Members start by writing down topics they want to cover (like hearing aids) on sticky notes and passing them to Caro, who cycles through those suggestions before introducing a discussion topic. He uses the same topic at multiple circles, and it's usually from a theme that has cropped up at more than one meeting. (The day I was there, the topic was "What do we do about the fact that the world seems to be shrinking around me? I'm not ready to just sit in my armchair and wait for the end.")

Practical demonstrations are encouraged. At one point during my visit, a woman whipped out a tool she liked for opening packages (plastic clamshells are even more maddening when you have arthritis). Explorers recommend and review gadgets and digital tools—everything from ride-share apps to jar openers—and those conversations get turned into guides on [techenhancedlife.com](http://techenhancedlife.com).

One of the site's most popular pages is a roundup of toenail clippers—it turns out the difficulty bridging the distance between your hands and toes is a common side effect of gaining years. Content for older adults and their caretakers is free; a small fraction of the information deemed of more interest to companies or researchers lives behind a \$45-a-month paywall.

Today the company is funded mainly by Caro, two other cofounders, and a handful of investors, but eventually Caro wants it to pay for itself. In 2017, after feedback from Explorers that they would like to weigh in on product development, not just the finished goods, he introduced "sponsored explorations"—a paid service for companies designing products for older adults. Each Explorer gets a fee, usually in the range of \$100 to \$500, for taking part in focus groups, information-gathering sessions, and other projects. They've done them with early-stage companies, venture-backed startups, and "humongous companies that everyone in the world has heard of," Caro says. He's evasive, though, about who those clients are and how many sponsored explorations have been conducted, saying only that the number is "more than 10 but less than 100." The products have involved everything from robotics to fintech—and frequently, he says, the companies come away realizing that their assumptions were "completely wrong."



Charles Mourani met Caro at a conference in Palo Alto when he was two months into building Mason Finance, a service targeted at older adults interested in selling their life insurance policies for cash—the kind of thing many turn to when they're hit with large, unanticipated expenses, like medical bills.

Mourani's team still hadn't tested its product with users beyond their own parents and grandparents: "It's not like you can just simply show up to a retirement home," he says. So he hired the Longevity Explorers. Over the course of 2018 they ran three different projects, and the results, he says, were "eye-opening."

Among the things that surprised Mourani was the Longevity Explorers' proclivity for reading the terms of service. Younger users breeze through this step on most websites by simply checking a box, ignoring the text, and clicking "next." But older users

want to read the small print. A 30-second application quickly becomes 10 minutes when someone reads every single condition.

Lots of designers have had similar “aha!” moments after talking to their older users. Take Nick Baum, who created StoryWorth, a subscription app and website that allows family members to prompt each other to tell stories about themselves. Launched in 2013, the site has collected well over one million stories, Baum says, the vast majority of them from people over 60. During the early years, Baum handled a lot of the customer support himself and often fielded phone calls from older users. Once, an unanticipated problem popped up.

Gillette's Treo razor is designed for those who have to shave others. It has a different angle, a special razor guard, and a tube of shaving gel built straight into the handle.

#### PERSONAL CARE

“We quickly ran into this case

where couples were sharing an email address,” he says. “At first I thought, ‘Well, that’s crazy. Who would share an email address?’ Then I realized that 50 years ago people didn’t have cell phones, and they had a shared phone number, right? And so of course you get email—why not have shared email?” Rather than force people to change their behavior, he adjusted to allow more than one account under the same email address, so that people sharing a

single email could get individual communications from the company in the same in-box.

Designing for older users doesn’t only benefit older users, says Caricia Catalani, a design director at IDEO. The company recently worked with Los Angeles County to revamp its voting machines, with an eye toward older people who were robust voters in their youth but had stopped showing up at the polls. It turned out that designing for them led to “good design decisions for everyone,” says Catalani.

Those with weak or no vision liked having audio prompts, for instance. But so did people with low literacy and young people who had never voted before, because the audio program acted as a host and guide. They also found that larger, more legible text was “desirable from everyone’s point of view,” not just for older voters with poor vision. The new machines are currently being manufactured and will be rolled out soon.

**FREQUENTLY, CARO SAYS, THE COMPANIES COME AWAY REALIZING THAT THEIR ASSUMPTIONS ABOUT OLDER ADULTS WERE “COMPLETELY WRONG.”**

I asked Catalani if she sees companies showing more interest in incorporating the viewpoints of older adults in their design process.

“I wish that was true,” she says. While some are starting to see older people as a demographic defined by more than age, many just see “the financial opportunity,” she adds. It’s a revenue stream they may never tap if businesses continue to see their elder customers as a monolithic pocketbook instead of as individuals.

Lynn Davis—who had debunked the \$300 hearing aids at the Longevity Explorers meeting I attended—first joined the group about four years ago. She’s an Apple devotee who recently learned how to use Google Docs and describes her tech aptitude as “low to middle.” But those who have worked with the Longevity Explorers know that is not exactly true of the group as a whole.

“When I’m in a room with 85-years-olds on average who all have an iPhone in their pocket, the question remains as to how representative that actually is,” says Mourani.

Caro acknowledges this. Most members are white and middle class, and many are former professionals. He describes the consulting groups as just one tool—suited to understanding early adopters, for instance, rather than all consumers. “When we have more circles in other places, we’ll be able to do even more sorts of projects,” he says.

When Davis meets me to talk about the group, she’s wearing chic purple-framed eyeglasses and guitar-pick earrings. She says she dreams of exoskeletons that will improve mobility, and cars that come on their own when you call, but for her, Longevity Explorers isn’t just about better products—it’s about better relationships. Receiving advice from, and commiserating with, her peers is a major draw.

“It’s just nice to know there’s a room full of people who also get stuck,” she says. Often, tech talk segues naturally into what she calls the “hard work” of discussing things like hospitalization and loneliness.

It’s no secret that older adults like Davis can be a boon for companies—but people I spoke to for this story told me that although businesses are eager to sell them things, they’re slow to include them in the design process.

Caro is betting this will change. He is in talks to start about 10 more circles nationwide—the beginning of what he calls a “movement”: groups all over the world where older consumers are telling developers what they want, and not the other way around. But ultimately, like the Explorer meetings, it’s not really about physical things.

“It’s about being in control of your own destiny,” he says. ▣



## Fiction

By Charlie Jane Anders

Illustrations by Chrissie Abbott

# I'll have you know

**T**ell me about your dreams," Dr. Webbo says, without looking directly at El. Instead, she keeps her gaze focused on the middle distance, because El's vitals and medical records are scrolling across her corneas.

"Boring. Weird," El says. "A lot of shoe salesmen trying to get me to wear birdcages on my feet. I wake up feeling amazing, though." Dr. Webbo's private office looks just like a secluded meadow full of wildflowers.

"Hmm. It says here that you're only on the most basic sleep package. Your dreams are keeping you young, but they're not teaching you anything." Dr. Webbo refocuses her view, and now she's staring right at El. "You're a hundred years old now—happy birthday, by the way!—so it's more important than ever to keep learning."

"What if I don't want my dreams to teach me?" El says. "I still learn the

old-fashioned way: by making a series of increasingly disastrous choices."

Dr. Webbo doesn't even laugh at El's joke, which, let's be honest, was only half a joke. El did try to re-skill as an interior-decor coder at age 83, right when all of the decor-scripting languages were becoming obsolete. And then there's the matter of El's roommate, whom we'll get to soon enough.

"This is a quality-of-life issue." Dr. Webbo furrows her high forehead, causing her locs to shift around. "You could live for another 25 or 30 years, and you want to make the most of the time you have."

"Yeah. But I read online that these dream lessons are just a lot of mind control, to reprogram your behavior. That's why they want to give them to old people, so we won't make any trouble."

"Don't believe everything they say on the bubbs," Dr. Webbo mutters. Then she shrugs. "Is there anything else you wanted to talk about?"

"Yeah." El takes a deep breath. "I want to do it. I want to start hormones and

nano-therapy. I wanna transition from male to female. As a hundredth-birthday present to myself."

"Are you sure? It's a big step at your age."

"Yeah. This is probably the first good decision I've made in 40 years."

Dr. Webbo asks El some more questions, but meanwhile the doctor's already using her left index finger to click "yes" on a bunch of boxes. El produces a hologram of her therapist, Dr. Russell, winking and giving a big thumbs-up, and Dr. Webbo only glances at it. Seems like gender transition has gotten easier and less gatekeepery since the last time El looked into it.

El always pictured the first gender-confirmation treatment being a kind of glittery mist blown into her face from a cupped palm, like fairy dust. And yeah, that's one of the options, but there's also a kind of body paint (starts blue, turns pink, very on-the-nose) and a lozenge you can put under your tongue.

But El wants to make a wish and snort fairy-dust, so that's what she goes with. Head rush!

"You should start noticing the effects pretty much immediately," Dr. Webbo says. "Your body will look and feel different, and you might have some mood swings." She gazes at the enhanced scan view. "Meanwhile, I'll mark on your file that you declined the dream enhancements, but they're still going to send you some literature."

El's head is still swimming from the sparkly flakes, and her whole brain is doing a happy dance. Today is the first day of my life as a woman, El says to herself. I finally found myself, and it only took a lifetime.

Then she registers the thing about "literature," and starts to argue—but stops. After all, she's starting her second century on this planet, and she just finally took the plunge and flipped her gender. Today of all days, she ought to be gracious. "I'll check out the literature. I promise I'll think about it. I'll even talk to my roommate about it."

Dr. Webbo shakes her head. "I would avoid discussing this with Goaty, if I were you."

El still doesn't feel any different when she by-scrolls away from the Hyper-Endocrinology Center—but the world looks quite transformed. Her gender marker changed in every datasink while she was finishing up her birthday checkup with Dr. Webbo, so everywhere she looks, the shops are advertising these wraps that morph from sundress to corset-dress at sunset. Cartoon characters and knights in armor call her "Ms." or "Ladyperson" as they pass on the scroll, and even the trees appear fluffier. Of course, every window and streetlight offers El various hundredth-birthday deals, which she's dreaded (one reason she gave herself something else to celebrate today).

The newsbubbs are full of occurrences that would be terrifying on their own, but which collectively form a gaudy tapestry. The artificial reef we built off the Gulf Coast has been singing again, mostly Stevie Wonder and Aretha Franklin. The Martian robot commune is threatening to shoot down any humans who approach. Five million people are threatening to go on an emotional-labor strike. The Patent Office is once again recognizing Inaction Patents (for new and innovative methods of refraining from doing something) and has already received thousands of applications.

By the time El gets home, her back aches and her knees are doing her a mischief, and all her euphoria at finally making the big change is wearing off. All she wants to do is sit down, maybe watch some stories. But of course, her roommate greets her at the front door, bouncing and demanding to hear every single detail.

Goaty is seven feet tall and teal-colored, except for a purple beard, and today they're wearing a long crimson necktie and some Bermuda shorts on their woolly goat body. Plus very serious square-framed glasses.

"Not much to tell," El tells Goaty. "Just a routine checkup. Oh, and I changed my gender at last. Feels good so far."

"You don't look a day over 90." Goaty claps their hoofs.

Goaty's ingratiating tone makes El suspicious, so she squints at them. "You've lost another 2% of your value."

"That's the trouble with a floating exchange rate," Goaty says in a fake-cheerful tone. "Sometimes it just don't float the way you want."

When El decided to put all of her retirement savings into a new cryptocurrency, she never expected to end up actually sharing her apartment with the evolved form of Goatcash. For the first few years, Goatcash was fine, accruing value faster than a flesh-and-blood goat could chew through a trash pile. But something happened—the sort of thing that seems to happen all too often lately—and now Goatcash is a sentient being, who lives with her.

And sometimes Goaty randomly devours all of El's junk food, usually while taking terrifying dips in valuation.

"Today of all days, I don't want to have to worry about you," El says to Goaty. And then she can't help mentioning the exact thing that Dr. Webbo told her not to: "My doctor thinks I should get my dreams enhanced."

"Whoa. I've never dreamed, unless you count my birth, when I experienced delusions of liquidity." Goaty strokes their glorious lavender plume of beard with their left hoof. "But don't you want to make the most of your dreams? I've been watching you sleep, and I have to say you're pretty uninspiring."

"You've been ... watching me sleep." El can feel her microbiome go feral.

"What?" Goaty turns shrugging into a dance. "You watch me sleep all the time."

"That's only because you sleep all the time." El snorts. "You should get a job. Whatever kind of jobs they give to failed cryptocurrencies."

"I'm a success on my own terms!"

It's just barely nighttime, but El feels exhausted. Big day.

She crawls into bed and feels the gel slowly ooze over her, getting in her pores. While she sleeps, the gel will rejuvenate her cells, like always, and stimulate her neural pathways. She only looks up a few times to see if Goaty is watching.

Sometime in the middle of the night, the "literature" that Dr. Webbo promised arrives. Instead of the usual dream nonsense, El's ninth-grade volleyball coach, Mr. Rayford, is standing next to her first real boss, Jayjay Manter, and they're both talking to El about the benefits of enhanced dreaming.

"Just think. You could learn a language, or even become a juggler." Mr. Rayford juggles three volleyballs.

"I dunno," El says to these authority figures, whom her conscious mind barely remembers. "I worry there's a thin line between sleep-learning and indoctrination."

"All learning is indoctrination," says Jayjay, with the smirk that El remembers



from all those awful staff meetings. “Information is never truly content neutral, right? The point is, you don’t want to be left behind.”

El keeps arguing with them until she wakes up, feeling crampy. Goaty is making a big show of not looking at her.

“Here’s what I don’t get, though.” Goaty is doing some painfully incompetent goat-yoga. “You’re happy to alter your body, and to some extent your mind, by flooding yourself with female hormones and nanotech. But you don’t want to enhance your dreams? You could learn to code in Whut, or understand the new disunified ultrasymmetry physics.”

“Could I finally understand why I put all of my money into a cryptocurrency that keeps trying to eat my drapes?”

“Hey!” Goaty stops in the middle of violent planking. “I never promised to keep gaining value. Or to be a perfect roommate. All I promised is I would solve the Byzantine Generals Problem. Have you been attacked by a Byzantine general even once since you invested in me? No, you have not. Success!”

El keeps noticing weird sensations, like she can actually feel her fat redistributing to her chest and hips, and her skin softening. She almost cried at an ad for shower-grout caulk. She can still remember being in her mid-50s and desperately wanting to transition from male to female. It was right after her divorce from Bessie, which had felt like the end of her life, even though the marriage had only lasted seven years.

Back then, one thought stopped El in her tracks: What if I’m just too old? The idea of starting over at age 54, or 55, just seemed insurmountable, and El pictured everybody looking at her and going, *Who do you think you’re kidding?* But after she decided not to take the plunge, she kept meeting people her own age and even older, who’d transitioned “late,” and who

seemed serenely happy in their own skins.

For decades, El kept finding reasons to hold off, like *Why not wait until after the Robertsons’ picnic?* Or *Maybe once I’ve made myself indispensable at this new job.* And then there was always another occasion where El probably ought to make an appearance as a distinguished older gentleman rather than ... whoever she was going to be after transitioning. And that was part of the problem, really: El had a hard time visualizing the person she was going to be, and how people were going to react to her, and she was really good at convincing herself that it was fine either way.

Until one morning, El woke up and realized that a) she was 99 years old, and b) she no longer gave a shit. And it was not too late at all, because it was never too late, and whatever El did, she would still be the same person, in most of the ways

that matter. And the harder you try to get “taken seriously,” the less serious you’re actually being.

El goes out and scrolls to the tea-dome, where some friends around her age are getting wrecked on Lapsang souchong and shortbread. Everybody congratulates El on the birthday and transitioning and just generally still being a work in progress.

Turns out Yen and Harriet and a few others have been doing the “enhanced dreaming” thing. “I woke up having memorized all of Samuel Coleridge,” says Harriet with a laugh. “You don’t want to get left behind.”

“I can do my own taxes now, thanks to the enhanced dreaming,” adds Aaron. “You don’t want to get left behind.”

“What’s the point of dying

without ever once getting to be real?”

“Why do you all keep repeating that phrase?” El says.

“Which phrase?” Yen asks.

El repeats it: “You don’t want to get left behind.”

“I never said that,” Harriet protests.

That evening, El has a hot date, so she reaches all the way into the back of her closet for the dress she bought 20 years ago and never wore, and she feels a moment of panic as she slips it on. Like this dress could burst into flames as soon as she clasps the clasp. Her skin is so sensitive, all of a sudden. “What’s the point of dying without ever once getting to be real?” El says out loud. She wiggles her thumb and a mirror appears, revealing a round-faced woman with her white hair in a bob, who could be one of the old ladies on that comedy show El used to watch. She looks cute, but unremarkable. Which ... is perfect.

This is the person El was trying so hard to visualize, back in her 50s.

She hasn’t really been aware of her own body for a decade or two, other than as a flawed vessel that could break down at any moment. What if her body could be a source of joy once more?

El’s date, a 117-year-old nonbinary person named Ray, insists on getting a pitcher of margaritas, because what’s one more artificial liver replacement? The two of them eat nothing but chips and guacamole and red-hot salsa. Ray is extremely cute, with pink streaks in their hair and a velvet jacket. But they mention that they’re also doing the “enhanced dreaming” thing—and they also randomly keep saying, “You don’t want to get left behind.”

El ends the date early, even though she was having a pretty good time.

The weird sales pitch is back in El’s dreams. This time, it’s Dr. Lathorp, the marriage counselor who kind of took Bessie’s side during their divorce. “I’m glad you’re working through your gender issues at last,” Dr.

Lathorp says, with maximum condescension. “But listen, you need to sign up for the enhanced dreams. You don’t want to be the only one who doesn’t understand.”

“You mean, I don’t want to get left behind. That’s what everyone keeps repeating to me. Like they’ve been brainwashed.”

“‘Brainwashing’ has a lot of negative connotations. But nobody wants a dirty brain.” Dr. Lathorp sounds exactly the same as when she called El a supporting character in her own marriage.

“Yeah, I think I’m gonna pass,” El says.

“I’m trying to help you.” Dr. Lathorp is scribbling with a pen that has no ink. “You don’t want Dr. Webbo to report that your faculties are impaired, or you could get put on Supported Living. You might not be allowed to leave your house without supervision, for instance.”

“If you were gonna threaten me, you shouldn’t have chosen the form of someone who was so bad at their job.” A chill is going all the way through El’s bones, and she suddenly doesn’t feel super confident of breathing.

When El looks again, Dr. Lathorp has turned into the state legislator that El interned for in college, Mitch Something-or-other. Mitch is holding out a piece of paper and saying, “C’mon, sign this, will ya? I have places to be.”

El ignores Mitch in favor of studying her surroundings. They’re in Mitch’s old office: glass case of softball trophies, shelf of unread books, beautiful desk supporting a crappy computer. El starts pulling books off the shelf and throwing them on the floor.

She’s just remembered two things: dream geography is bullshit. And El studied interior-decor coding for five years.

There, at the back of the bookshelf, El finds a ragged hole in the fake wood. She pushes her hand through, and then her whole body, until she’s in a dank secret passageway. Behind her, Mitch keeps explaining the many benefits of dream enhancement, in a stentorian tone. El keeps going down the passageway as it

gets deeper and narrower, until she finds a bunch of roots dangling from the dirt over her head.

El can’t help giggling at the literalism, as she pulls on the roots and gets herself root access. As she suspected, there’s been some corruption here: a malicious codeset that embeds instructions like DON’T VOTE, NEVER CHALLENGE AUTHORITY, STAY HOME, YOU DON’T WANT TO GET LEFT BEHIND. She wishes she had a way to make screenshots of all this, and then her dream helpfully provides an old-school digital camera, like from her youth.

“I’m leaving,” El tells Mitch, who’s followed her down into the tunnel. “People are going to find out about your scam. If you know what’s best for you, you’ll clear the hell out of my dreams.”

“But—” Mitch Something-or-other sputters. “You’re making a terrible mistake.”

“Terrible mistakes are kind of my thing,” El says. “But you know what? I’m a success on my own terms.” She doesn’t even realize for a moment that she just quoted Goaty.

She pushes her way back into Mitch’s office, and keeps shoving through doors, until she finally pushes out of the gel’s dreamscape.

Back in the real world, El sits up, with the last of the gel evaporating off her skin. Goaty is lotus-positioning at the foot of her bed, staring at her.

“Whatever you just did, you should do it way more often,” Goaty says. “You’ve never slept this entertainingly before.”

El just rolls her eyes, and searches her image folder for the screenshots she took of the secret code at the heart of the enhanced-dreaming program. “You know what?” she says to Goaty. “I think I’m turning into the kind of old lady who makes trouble.”

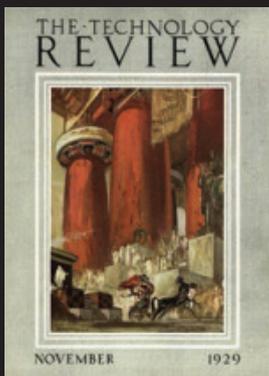
Goaty is too busy trying to eat her only dignified pair of pants to answer. ■

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# A topic with great longevity

This publication has been writing about human longevity for at least 90 years. In some ways what's amazing is how little has changed.



November 1929



May 1954



February 2005

**From “Forestalling Death”:** Is it possible to extend life? If it is possible, is it worth while? In this advanced and enlightened era in which reckless and dogmatic assertions are rampant, is it presumptuous to claim that you and I and the rest of us have hopeful prospects of living longer and possibly physically better lives than did our forebears? These are questions to intrigue philosophers and pundits and those superior individuals known as biologists, but the answers to these queries are also of some faint interest to the remainder of us, even the engineers, many of whom are reputed to be able to derive value and enjoyment out of salubrious existence and healthful longevity.

**From “Is There a Limit to Human Life?”:** Throughout most of its history the population of the United States has been characterized by its youthfulness, but this is no longer the case. If the present rate of increase of older persons continues, as it should (barring atomic warfare or some other unforeseen disaster), the close of the present century will see more than 20,000,000 older individuals in the American population ... Centenarians are, of course, always asked as to what they attribute their great ages, but invariably their answers are a bit weird, often absurd, and completely lacking in uniformity. In the olden days the few favored persons who attained to great old age undoubtedly did so through the operation of the law of the survival of the fit, but in our modern sanitary civilization the achievement of unusual old age is probably largely a matter of heredity—and luck.

**From “Do You Want to Live Forever?”:** De Grey began reading the relevant literature in late 1995 and after only a few months had learned so much that he was able to explain previously unidentified influences affecting mutations in mitochondria, the intracellular structures that release energy from certain chemical processes necessary to cell function ... By July 2000, further assiduous application had brought him to what some have called his “eureka moment,” the insight he speaks of as his realization that “aging could be described as a reasonably small set of accumulating and eventually pathogenic molecular and cellular changes in our bodies, each of which is potentially amenable to repair.”