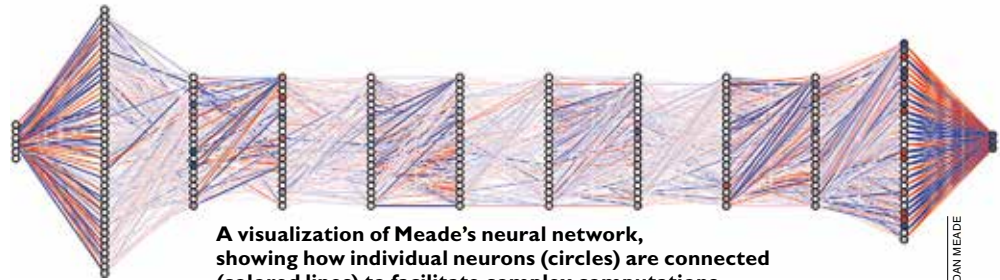


RIGHT NOW

system of millions or billions might change a single output. Neural networks offer the prospect of making those predictions, Meade says, “even if we don’t understand the entire system at first.” That’s because, by processing data much faster and more efficiently than is otherwise possible, neural networks can spot previously invisible patterns and trends that current scientific models have had no way to identify and represent. “That’s truly the deep power of neural networks and artificial intelligence,” he says. “We have a tool now that can suggest new ideas to us. When we don’t know what to do, neural networks can give clues to a way forward.”

And Meade’s next step forward? He has recently turned his attention to a growing number of studies that attempt to identify precursors to earthquakes. Although scien-



A visualization of Meade’s neural network, showing how individual neurons (circles) are connected (colored lines) to facilitate complex computations.

tists can tell with some accuracy where earthquakes are most likely to happen, it remains notoriously impossible to predict when one will strike. The studies conducted during the past decade have been confined to single earthquakes and small collections of isolated data, Meade says, but he wonders if neural networks might help scientists uncover broad and robust correlations that might

help a city like Istanbul forecast and prepare for a quake. “The question now,” he says, “is whether we can assemble data sets that are large enough and coherent enough that we can go after the earthquake-prediction problem in earnest.” ~LYDIALYLE GIBSON

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PROTEIN PAUCITY

Climate Change and Crops

NORTH AMERICANS GET most of their protein from animal-sourced foods, but most of the world relies on a handful of staple crops like wheat, rice, and corn. Cli-

mate change may alter the nutritional value of those crops, creating significant health risks, particularly in places where protein deficiency is already a problem (about 660 million people worldwide are affected).

By 2050, a new study projects, 148 million more people, equivalent to 1.6 percent of the world’s projected population, will be at risk due solely to the impact of carbon dioxide on nutrients. More than a third of them live in India, where the population depends heavily on rice for protein; nations in sub-Saharan Africa and South America would also be seriously affected. The study, says senior author Samuel Myers, a principal research scientist at the Harvard T.H. Chan School of Public Health (HSPH), exemplifies an emerging field—planetary health—which has grown from the observation that

“human activity is disrupting our planet to such a degree that it’s coming to be a primary driver of global health.” He directs the Planetary Health Alliance at HSPH.

The study, co-authored by Danielle Medek, a former fellow at the University Center for the Environment, and professor of environmental epidemiology Joel Schwartz, builds on Myers’s 2014 meta-analysis of 143 different comparisons of staple crops, which found that climate change could significantly alter their nutritional value. That research, published in *Nature*, showed that carbon dioxide levels of about 550 parts per million (the current level hovers around 400 PPM) reduced the iron, zinc, and



Pakistanis eating rice, a staple crop and major source of protein in South Asia.

A MAJEED/AP/GETTY IMAGES

COURTESY OF BRENDAN MEADE

protein content in six staple crops grown over 10 years on three different continents. Protein levels decreased by 6.3 percent in wheat, and 7.8 percent in rice. “That means for exactly the same number of calories from rice, you’ll get less protein,” Myers explains—and more carbs.

The team applied those findings to a database published by Myers and colleagues last year that estimated the per-capita intake of foods among nearly all the world’s population. (Myers considers it “the most comprehensive dietary database in the world.”) This allowed them to estimate how many people could become protein deficient when atmospheric CO₂ reaches 550 PPM. But for every new person who will drop below the minimum protein requirement, Myers stresses, “there are four to 10 times more who are *already* deficient, and whose deficiencies are going to be made worse....In many instances having a mild deficiency is nowhere near as bad as having a moderate or severe deficiency.”

The study’s basic assumption, that people’s diets will remain exactly the same for the next three decades, might seem unrealistic, Myers acknowledges. But, he says, there are two narratives about how economic development and climate change will influence those diets. One predicts that nutrition will improve as developing countries become richer; the other, that food production will be unable to keep pace with rapid global population growth and constraints on natural resources. Because versions of both narratives are likely to prove true in different locations, keeping the data on food consumption constant allowed the team to isolate the effect of CO₂ itself. “You can decide as a reader,” Myers adds, “whether you think this is an underestimate or overestimate.”

The researchers still don’t know what causes the changes in plants’ nutrient profile, he explains, because the original experiments on crop nutrients under different CO₂ levels weren’t designed to uncover the mechanism. The simplest explanation, says Medek, a plant physiologist, is carbohydrate dilution: at higher levels of CO₂, plants absorb carbon from the air and produce starches more efficiently, which might “dilute out” other nutrients. But the 2014 meta-analysis tested for levels of many different nutrients—selenium, boron, and others—in the crops grown throughout the test period and found that their concentrations didn’t



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decrease at similar rates; some of them even *increased*, suggesting that a more complicated process—perhaps in addition to carbohydrate dilution—is going on.

Whatever the underlying mechanisms, the changing composition of crops might pose a risk not just to low-income countries, but to the developed world, too. The researchers cite evidence that increasing the ratio of carbs to protein in North American diets is linked to higher blood pressure and a higher risk of heart disease. Though that

link is still speculative, Myers says, it suggests that more work is needed on the health impact of higher-carb diets in the West—and that changes in staple-crop nutrition could pose a challenge that goes beyond global malnutrition, to affect human health in other ways even as the world gets richer.

~MARINA BOLOTNIKOVA

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GUILT BEGONE

Cashing Out for Happiness

ANYONE WHO’S INDULGED in retail therapy can affirm that money can’t buy happiness—but according to new research from Harvard Business School, money *can* make people happier when they spend it to buy *time*. Assistant professor of business administration Ashley Whillans has found that, in developed countries, people across the socioeconomic spectrum who trade money for time—by choosing to live closer to work, or to hire a housecleaner, for example—*are* happier.

“People have been trying to find ways to use their discretionary income to maximize their quality of life for a long time,” Whillans says, citing extensive research that confirms the positive emotional effects of taking vacations and going out to the movies. “We were really interested in seeing if buying ourselves *out* of negative experiences might be another pathway to happiness that had been relatively unexplored.”

According to the researchers, two key

components of happiness make up people’s subjective sense of well-being: how they describe their life on the whole; and how satisfied they feel in the moment, which the researchers measured by checking in with participants on the day of a given experience. Feelings of “time stress”—more common among the wealthiest individuals—also affect happiness. Higher-earners feel that every hour of their time is more financially valuable, and when something is perceived as valuable (like water in a desert, Whillans says), it is also perceived as more scarce. That scarcity translates into time stress, which can easily contribute to unhappiness.

To assess the impacts of buying one’s way out of negative experiences, the team surveyed residents of the United States, Canada, Denmark, and the Netherlands, ranging from those who earned just \$30,000 per year (but reported that their basic life needs were being met) to middle-class earners and