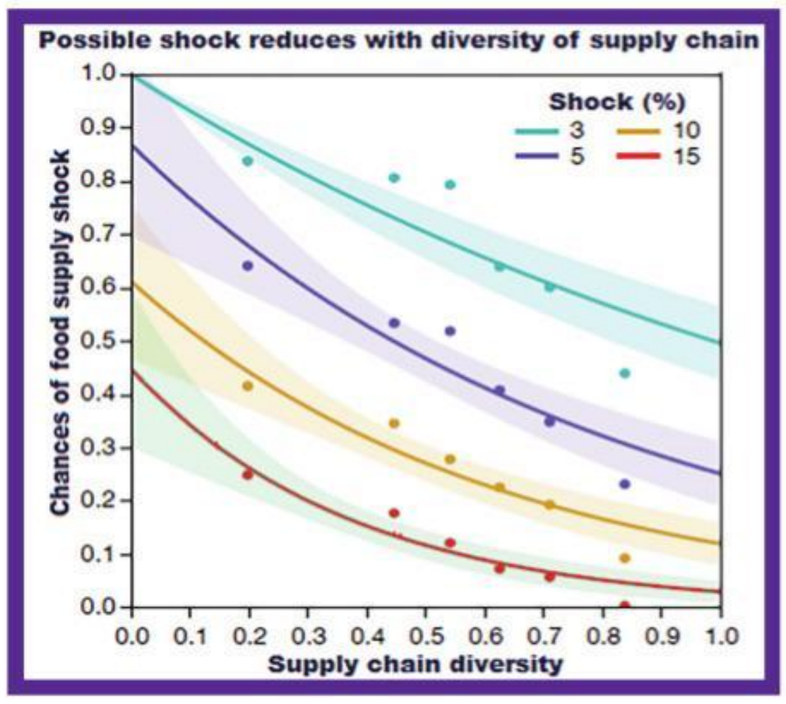
Resilience in food supply

A variety of sources is found to bring stability

S ANANTHANARAYANAN



The adage about putting all eggs in one basket is apt when it comes to food, as diversity in the food supply chain is found to be effective in preventing stock-outs of the larder.

Michael Gomez, Alfonso Mejia, Benjamin L Ruddell and Richard R Rushforth, from the department of civil and environmental engineering, Pennsylvania State University, and the School of Informatics, Computing, and Cyber Systems, Northern Arizona University, describe in the journal *Nature* their study of what characterises the places, out of more than 300 cities and centres in the United States, which were best able to avoid disruptions to food supply over a four-year period. They find that the places with the most diverse sources of supply were the ones that had the most resilient food supply line from 2012-2015, the years when most of the U S faced moderate to severe droughts.

Like eggs in one basket, or the French saying about the mouse that has only one hole to hide in, many crucial networks of supply or service rely on diversity for stability. A well-known example is the Internet, which handles immense and highly variable traffic, but we rarely hear of a breakdown, or even a serious loss of speed. The reason is that a message is not sent out as a load to be carried down a fixed pathway, but broken into fragments and each finds its own way, using widely diverse pathways, equalising the traffic over the best routes and being ready with alternatives if some routes become ineffective.

The other well-known example is the stability of ecosystems. The most luxurious forests, and the ones that can take periods of drought, series of poor summers or severe winters, attack by fungi or locusts in their stride, are those that have high diversity of species growing together. The importance of insect and animal diversity has been accepted and much of the conservation efforts worldwide is for conserving diversity.

The constancy of the pressure of a volume of gas is also seen as a result of the range of the speeds of its molecules. Given the temperature, there is a distribution of speeds. But, with a large number of molecules, the distribution is unchanging, for practical purposes, and so is the pressure of the gas. The diversity in physical systems has been studied with mathematics, and there is a measure, called the entropy, or the level of uncertainty, which reflects diversity in the system.

The scientist Claude Shannon, who is known for his work on the accidental "noise" that affects information sent through telegraph wires, also worked on the diversity in a string of text — measuring how the letter that would turn up next is more uncertain when many different letters are there in the text. The ideas have been extended to ecological systems and a measure to quantify diversity is called the Shannon Index. And in their work on food supply chains in the U S, the authors of the paper in *Nature* work out this index for the food networks in operation.

The context is the rising dependency of large human settlements on the supply chain of food — cereals, vegetables, milk and meat products. The paper notes that extreme weather events, which are expected to be frequent as a result of climate change, have been the reason for "food supply shocks", where stores in large cities suddenly find their shelves empty. Geopolitical and policy changes, and events like a pandemic can also affect sources and supply channels.

There is a growing risk of "global breadbasket failure," the paper says. As sources of food supply to a place are now widespread, even international, rather than "local", the result of a crisis can have far-flung consequences. It increases the range of events that could affect supply, the paper says, although having more sources of supply also provides resilience.

The study covered the stability of food supply and the food supply system, that is, the sources of crops, live animals or animal feed and meat, at 284 cities and 45 other centres in the U S. And the consumption centres were classified according to the frequency of "food shocks", or instances when food supply fell by over a given percentage (three to 15 per cent) for a year, compared to the average over four years. "Thousands of inflows to hundreds of cities" allowed the team to calculate the probability of "shock intensity" growing beyond a limit, over a period of four years. And along with that, was the assessment of the diversity of the supply sources of the cities.

The manner of assessing diversity of sources was to list out each city's trading partners or neighbours, food traders-suppliers of different categories of food. They were classified under physical distance, climate correlation, urban classification, economic specialisation and cities that formed clusters. And based on those criteria, a measure of diversity of supply sources, related to the Shannon Index, was calculated.

DIVERSITY IS STABILITY

The chances of food supply shock, in the different cities, were then compared with the level of diversity of the sources of food supply. As displayed in the figure, the probability of food supply shock falls rapidly with rising diversity in the supply chain. "Analogous to biodiversity buffering ecosystems against external shocks, our results show that cities with a greater diversity of food suppliers have a lower probability of suffering a food supply shock for any reason," says the paper. The method of study brings together theories of ecology and networks to propose a practical food supplies risk management framework, based on actual data, the paper says.

More than half the population of the world lives in cities and that proportion is increasing. The factors that affect supply of food materials, in the face of pressures from climate change, hence merit careful monitoring. One is now seeing moves in various quarters to modify and "bring efficiency" into established systems of procurement and distribution of farm produce. As the diversity in supply chains proves a powerful deterrent to supply failure, whether these changes would affect the level of diversity needs to be ensured. The thing about "highly connected" networks, such as the Internet or ecological systems or social networks, is that they are not designed and built, but grow "organically" and are highly optimised, in keeping with stability. They contain redundancies and safeguards, for security, but the characteristic feature is not obvious economy, it is stability.

And so it is with supply chains, which are social networks of agriculture commerce. They are built over centuries, in step with the growth of cities, trade routes, production regions and markets. After several changes and course corrections, existing systems include efficient and economical alternatives to failure of connections, or rise and fall of production or demand, or even crop failure. And several factors, which include the geographical, commercial, logistical and personal have been provided for as the systems evolved.

Under rapidly changing conditions, deficiencies can readily be found. Those, however, cannot be grounds to make sweeping changes — it is the deficiencies, to some extent, that may be addressed. But it would be imprudent to give up a system that is based on an organic network of mutually dependent agents, in favour of one that has not been proven in the same context.

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RECONNECTING THE CIRCUITS

Here's the neuroscience behind why your brain may need time to adjust to 'un-social distancing'

KAREEM CLARK

With Covid-19 vaccines working and restrictions lifting across the United States and other countries, it's finally time for those now vaccinated, who've been hunkered down at home, to ditch the sweatpants and re-emerge from their *Netflix* caves. But your brain may not be so eager to dive back into your former social life.

Social distancing measures proved essential for slowing Covid-19's spread worldwide — preventing upward of an estimated 500 million cases. But, while necessary, 15 months away from each other has taken a toll on people's mental health. In a national survey last fall, 36 per cent of adults in the U S, including 61 per cent of young adults, reported feeling "serious loneliness" during the pandemic. Statistics like these suggest people would be itching to hit the social scene.

But if the idea of making small talk at a crowded happy hour sounds terrifying to you, you're not alone. Nearly half of Americans reported feeling uneasy about returning to in-person interaction regardless of vaccination status.

So how can people be so lonely yet so nervous about refilling their social calendars? Well, the brain is remarkably adaptable. And while we can't know exactly what our brains have gone through over the last year, neuroscientists like me have some insight into how social isolation and re-socialisation affect the brain.

SOCIAL HOMEOSTASIS — THE NEED TO SOCIALISE

Humans have an evolutionarily hardwired need to socialise — though it may not feel like it when deciding between a dinner invite and re-watching *Schitt's Creek*. From insects to primates, maintaining social networks is critical for survival in the animal kingdom. Social groups provide mating prospects, cooperative hunting and protection from predators.

But social homeostasis — the right balance of social connections — must be met. Small social networks can't deliver those benefits, while large ones increase competition for resources and mates. Because of this, human brains developed specialised circuitry to gauge our relationships and make the correct adjustments — much like a social thermostat.

Social homeostasis involves many brain regions, and at the centre is the mesocorticolimbic circuit or "reward system." That same circuit motivates you to eat chocolate when you crave something sweet or swipe on Tinder when you crave... well, you get it.

And like those motivations, a recent study found that reducing social interaction causes social cravings — producing brain activity patterns similar to food deprivation.

So if people hunger for social connection like they hunger for food, what happens to the brain when you starve socially?

YOUR BRAIN ON SOCIAL ISOLATION

Scientists can't shove people into isolation and look inside their brains. Instead, researchers rely on lab animals to learn more about social brain wiring. Luckily, because social bonds are essential in the animal kingdom, these same brain circuits are found across species.

One prominent effect of social isolation is — you guessed it — increased anxiety and stress. Many studies find that removing animals from their cage buddies increases anxiety-like behaviours and cortisol, the primary stress hormone. Human studies also support this, as people with small social circles have higher cortisol levels and other anxiety-related symptoms, similar to socially deprived lab animals.

Evolutionarily this effect makes sense — animals that lose group protection must become hyper-vigilant to fend for themselves. And it doesn't just occur in the wild. One study found that self-described "lonely" people are more vigilant of social threats like rejection or exclusion.

Another important region for social homeostasis is the hippocampus — the brain's learning and memory centre. Successful social circles require you to learn social behaviours — such as selflessness and cooperation — and recognise friends from foes. But your brain stores tremendous amounts of information and must remove unimportant connections. So, like most of your high school Spanish — if you don't use it, you lose it.

Several animal studies show that even temporary adulthood isolation impairs both social memory — like recognising a familiar face — and working memory — like recalling a recipe while cooking.

And isolated humans may be just as forgetful. Antarctic expeditioners had shrunken hippocampi after just 14 months of social isolation. Similarly, adults with small social circles are more likely to develop memory loss and cognitive decline later in life.

So, human beings might not be roaming the wild anymore, but social homeostasis is still critical to survival. Luckily, as adaptable as the brain is to isolation, the same may be true with re-socialisation.

YOUR BRAIN ON SOCIAL RECONNECTION

Though only a few studies have explored the reversibility of the anxiety and stress associated with isolation, they suggest that re-socialisation repairs these effects.

One study, for example, found that formerly isolated marmosets first had higher stress and cortisol levels when re-socialised but then quickly recovered. Adorably, the once-isolated animals even spent more time grooming their new buddies.

Social memory and cognitive function also seem to be highly adaptable. Mouse and rat studies report that while animals cannot recognise a familiar friend immediately after short-term isolation, they quickly regain their memory after re-socialising.

And there may be hope for people emerging from socially distanced lockdown as well. A recent Scottish study conducted during the Covid-19 pandemic found that residents had some cognitive decline during the harshest lockdown weeks but quickly recovered once restrictions eased.

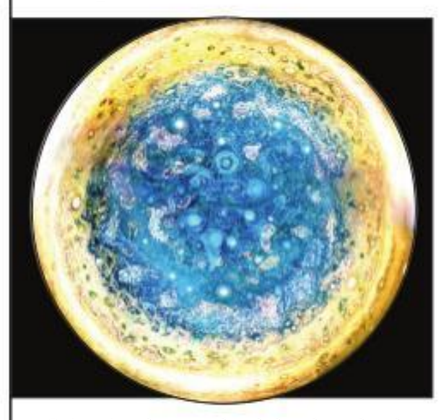
Unfortunately, studies like these are still sparse. And while animal research is informative, it likely represents extreme scenarios since people weren't in total isolation over the last year. Unlike mice stuck in cages, many humans had virtual game nights and *Zoom* birthday parties (lucky us).

So power through the nervous elevator chats and pesky brain fog, because "un-social distancing" should reset your social homeostasis very soon.

The writer is a post-doctoral associate in neuroscience, Virginia Tech, United States. This article first appeared on www.theconversation.com

PLUS POINTS

Jupiter's aurora



Scientists have solved the decades-long mystery over how Jupiter produces regular-as-clockwork auroras of X-ray light.

The X-rays are part of the gigantic planet's bursts of visible and invisible light triggered by charged ion particles interacting with its atmosphere. A similar phenomenon occurs on Earth, which creates the aurora borealis — also known as the Northern Lights — that is seen during the colder months in the northernmost countries. But Jupiter's auroras are much more powerful than Earth's in that they release hundreds of gigawatts of energy. This energy from Jupiter's north and south poles is so intense that it would be enough to provide power briefly for every human.

A research team, co-led by University College London and the Chinese Academy of Sciences in Beijing, has finally figured out how these auroras are created after 40 years. The scientists found that the X-rays were triggered by regular vibrations in Jupiter's magnetic field lines that surround the planet in vertical loops that connect from its north pole to its south pole. The vibrations create waves of plasma — ionised gas — that send heavy ion particles "surfing" along the magnetic field lines until they smash into the planet's atmosphere, and release colossal amounts of energy in the form of X-rays.

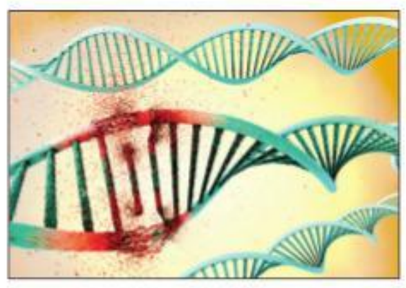
The X-ray bursts were produced every 27 minutes in the scientists' observations. The charged ion particles, that collide with Jupiter's atmosphere, originate from volcanic gas pouring into space from giant volcanoes on Io, one of Jupiter's 79 moons.

This gas becomes ionised — its atoms are stripped of electrons due to collisions in Jupiter's immediate environment — and forms a doughnut ring of plasma around Jupiter known as the Io Plasma Torus.

The new study has been published in the journal *Science Advances*.

—The independent

Cancer DNA



Researchers at the Indian Institute of Technology-Madras have developed an Artificial Intelligence-based mathematical model to identify cancer-causing alterations in cells. The algorithm uses a relatively unexplored technique of leveraging Deoxyribonucleic acid, or DNA composition to pinpoint genetic alterations responsible for cancer progression.

The research was led by B Ravindran, head, Robert Bosch Centre for Data Science and Artificial Intelligence, and Mindtree Faculty Fellow, IIT-Madras, and Karthik Raman, faculty member, RBCDSAI, and also the coordinator, Centre for Integrative Biology and Systems Medicine, IIT-Madras. Shayantan Banerjee, a Master's student at IIT-Madras, performed the experiments and analysed the data. The results have been recently published in the peer-reviewed international journal *Cancers*.

The researchers hope that the driver mutations predicted through their mathematical model will ultimately help discover potentially novel drug targets and will advance the notion of prescribing the "right drug to the right person at the right time."

In this study, the main goal was to discover patterns in the DNA sequences — made up of four letters, or bases, A, T, G and C surrounding a particular site of alteration. The underlying hypothesis was that the patterns would be unique to individual types of mutations — drivers and passengers — and therefore could be modelled mathematically to distinguish between the two classes. Using sophisticated AI techniques, the researchers developed a novel prediction algorithm, NBDriver and tested its performance on several open-source cancer mutation datasets.

Highlighting the performance of the algorithm, Ravindran said, "Our model could distinguish between well-studied drivers and passenger mutations from cancer genes with an accuracy of 89 per cent. Furthermore, combining the predictions from NBDriver and three others commonly used driver prediction algorithms resulted in an accuracy of 95 per cent, significantly outperforming existing models."