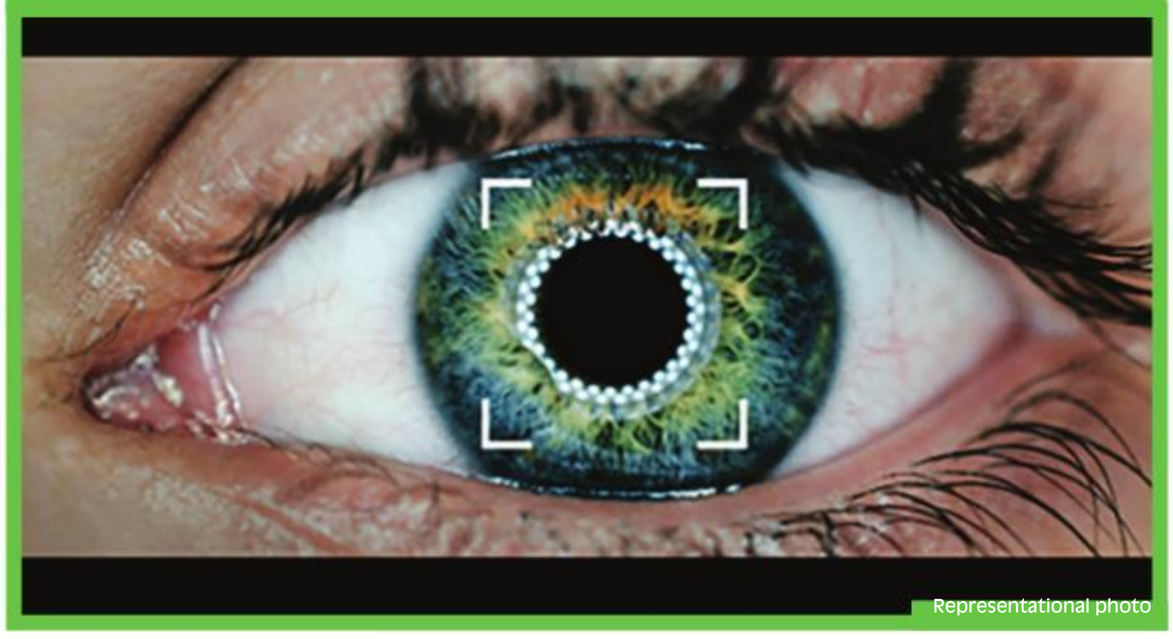
Setting the pace when we speak

Researchers have found that our reading speed adapts to the tools of perception



Representational photo

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It is pointless to speak faster than the listener can understand. That, however, is not true of writing, as the written word is static. But on what depends how fast we read?

This and other questions were looked into by a team of researchers in communication, perception and neuroscience. Benjamin Gagl, Klara Gregorova, Julius Golch, Stefan Hawelka, Jona Sassenhagen, Alessandro Tavano, David Poeppel and Christian J Fiebach, from Goethe University, the Centre for Individual Development and Adaptive Education for Children at Risk, Max Planck Institute for Empirical Aesthetics, Ernst Struengmann Institute for Neuroscience, Max Planck-NYU Centre for Language, Music and Emotion, all in Frankfurt, department of linguistics, University of Vienna, department of psychology, New York University and the Centre for Cognitive Neuroscience, University of Salzburg, describe their studies in a paper in the journal, *Nature Behaviour*.

Speech, and oral communications, of course, came before writing and reading. And there has been much research into the modalities of speech. While one aspect of the study has been the form and structure of words, recent studies have been in the rhythm, or the time-structure of the sounds that constitute words.

"...Specifically, regularities in the envelope of the acoustic signal that correlate with syllabic information and that play a central role in production and perception processes," says a reference cited in the paper. It is possible, another reference says, that the brain adapted an existing mechanism to process and make sense of sound patterns, when animal sound signals grew into speech as a form of complex, human communication.

Spoken languages, the paper says, consist of rhythmic peaks of loudness, which mark the constituents, the phonemes, the distinct units of sound that make up the language. And, across all languages, these peaks appear 4.3 to 5.5 times a second, the paper says. That, the paper says, corresponds to the time, about one fifth of a second, that the brain is found to take to process a unit of information conveyed by sound. The rate at which the brain has adapted to process information is the rate at which signals have come to be produced while speaking — it appears to be a reasonable way in which speech and perception have developed.

Next, comes the development of writing and reading. Writing is a visual means of recording meaning by using the same units (words) that are used in speech. And reading is to recover, from the visual representation, the words that were to be conveyed. Interestingly, the paper says, the time for which the eye, while it scans written matter, pauses, or fixates, to perceive units in the writing, is also the same, approximately one fifth of a second. This is in the case of writing systems that use alphabets, and a little more, a fourth of a second, in the case of languages that use characters, like Chinese.

There are now methods to detect and measure, with fine resolution, the movements of the eye in the course of reading. They have been used extensively to study how the eye takes in units of writing, like words, and see how reading is influenced by factors like word length, frequency or predictability.

In the present study, the authors of the paper examine how eye movements can be related to the time spent on language components. This could help understand whether reading is related to the way spoken language is processed, and if the way the eyes scan writing is different from the way they scan other kinds of visual matter, the paper says.

In the method used, 50 volunteers were asked to read a collection of sentences, and while they read, the movements of their right eye were tracked, every thousandth of a second. What was measured was the length of the pauses between the shifts of gaze, as the reader went through the written matter. The pauses were when the eyes focused on the image and the time for perception, as opposed to the time between pauses. And the result was that the pauses lasted, on an average, 197 milliseconds, or almost a fifth of a second, just like the rhythmic peaks when the text is spoken.

To validate the finding, results of 124 studies, using 14 different languages were analysed. And again, with groups of non-native and native German speakers. The results showed consistently that written text is sampled, when read, at the same rate as in spoken language, and in the rate for reading, the frequency of pauses in scanning is not more than about five pauses a second. Also, that this rate can vary according to the complexity of the written script. (This, however, is in the case of readers with lower levels of reading skills, or non-native readers. That is because highly skilled readers scan sets of words, or phrases, while reading.)

What the work shows is that during reading, our eyes "sample" written text at the same rate in which speech is produced and perceived. This suggests that the time structure the brain follows in retrieving information is the same, both from written matter and speech. A possible explanation, the paper says, is that the brain has evolved to process signals at a rate that has been determined by constraints of the vocal cords, and hence the rhythms found in speech. With the arrival of the written medium, the brain imposes on the eyes a pace of movements that matches the rate at which the brain can process information.

"Eye movements in reading are thus utilised as a temporal interface between a stable physical stimulus — written text — and brain systems that have evolved to process signals whose temporal structure is constrained by the characteristics of our vocal tract," the paper says.

The paper notes, however, that these findings apply in the case of people with low reading skills. The "sight reading" capability of expert readers may define a different relationship between speech processing and reading rates. It may help in understanding low or impaired reading skills, or how non-native readers develop reading ability, the paper says.

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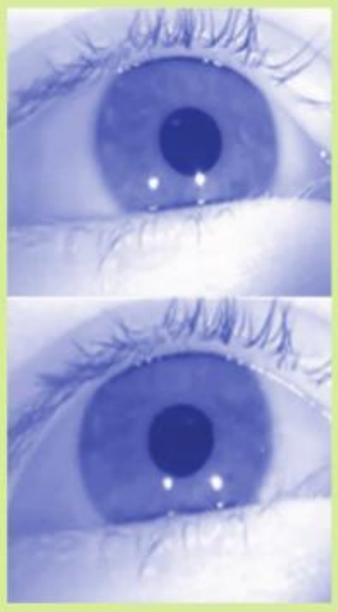
SACCADES

The eye can sharply focus on only a very small field at a time. While viewing an object, the head and body do not move, but the muscles of the eye get it to rapidly scan the parts of the object to build a picture. These rapid movements are called saccades and can last just a fiftieth of a second.

When reading, again, the head does not move, but the eye scans the writing, in steps, with a short wait at each step, when a bit of written matter is read. The pauses, with the step that leads to them, take from a fifth to a quarter of a second.



FOOD OF THE FUTURE

Cellular agriculture is needed to feed the world in the next decades

BIJU DHARMAPALAN & KARTIKAY SHUKLA

What will happen if all cultivable lands are turned into concrete jungles? According to the latest information available from the Agriculture Census, the average size of operational holdings in India has decreased from 2.28 hectares in 1970-71 to 1.84 ha in 1980-81, 1.41 ha in 1995-96 and 1.08 ha in 2015-16. Going by current trends, finding a place to do farming might prove difficult in future.

That said, with an ever-growing population, how does one provide the requisite amount of food? The World Resources Institute estimates that global demand for beef and other ruminant meats could increase by 88 per cent between 2010 and 2050, driven by a growing middle class and world population, which is expected to reach 10 billion by 2050. To meet overall nutrition requirements in future, the Food and Agriculture Organisation predicts that food production must increase by 70 per cent.

Transforming the current food system to provide healthy food diets is a major challenge these days. Therefore, we may be forced to develop alternate technologies to increase food production. People may be encouraged to engage in vertical farming techniques and genetically modified crops. But will that be enough to feed the whole world?

How it works

Food production in future could be limited to labs as humans may have to survive on *in vitro* produced food products. This new form of agriculture, known as cellular agriculture, has already been established in different parts of the globe.

Cellular agriculture aims to provide people with the animal-based products they know and like, but with a lighter impact on the environment as well as numerous human health benefits and significant improvements in animal welfare. Such products are complementary to plant-based ones as the target market is not vegans or vegetarians but those who find it challenging to exclude animal products from their diets.

Cellular agriculture is a key pillar in the fast-paced "new food" sector. Positioned for rapid growth over the next decade, it will play an important role in fulfilling future nutritional requirements while taking pressure off current food production systems and the environment.

The process uses individual cells from plants and animals or single-cell organisms to make agricultural products. They include meats, seafood, dairy and other protein-rich foods and functional ingredients, which are produced either through tissue engineering or precision fermentation without the need to "cultivate" entire animals or plants.

Cellular agriculture currently comprises two different approaches: cell cultivation (cellular) and precision fermentation (acellular). The cell-cultivation method refers to growing meat directly from cells. By cultivating cells to produce meat and seafood, the raising and slaughtering of animals can be avoided. To produce cultured meat and seafood, stem cells are initially sampled from animals through a painless biopsy.

These cells are then fed with nutrients in large vats, also known as cultivators, where they multiply and differentiate. As they grow, they become muscle tissue, which is the main component of meat. A number of start-ups and companies are currently working on developing a variety of cultured foods, including beef, pork, chicken, fish, seafood, milk, and cheese.

The precision-fermentation method refers to the use of microorganisms rather than cell cultures to produce products such as milk and egg-white proteins. These products can be grown directly from microorganisms such as yeast in a similar fermentation process to the one which has been used for many years in the food industry to produce enzymes such as rennet (a key ingredient to produce cheese) or vanillin (the main component of vanilla flavour), as well as other products.

A similar method is used to produce cell-based milk. In this case, mammal milk gland cells are immobilised in a hollow fibre bioreactor. As a result, the cells secrete whole milk which has the same macronutrient profile as cow or human breast milk, depending on the cell source.

On the other hand, hybrid products combine plant-based and cultured ingredients to develop tasty and sustainable products that will also potentially be cost-effective. This new product category shows many promises in terms of texture and taste, while adding an appealing juiciness. For instance, adding cultured fat to a plant-based chicken nugget could provide the genuine taste of chicken as well as improve juiciness and meatiness, while having an authentic texture, thanks to the plant-based proteins. The first proof-of-concept of hybrid products, chicken nuggets comprising 80 per cent vegetable protein and 20 per cent cultured fat, was unveiled in March 2019 by Peace of Meat.

Looking at it this way, plant-based and cultured products are not mutually exclusive categories but actually form a highly promising complementary strategy — together, they have the potential to accelerate market entry by combining two different approaches to arrive at a perfect result, rather than perfecting just one approach completely.

Advantages of the process

Cellular agriculture has the potential to provide the nutrition and other non-food products that our growing population requires, without encroaching on additional lands or further stretching natural resources. Because the production processes occur within a controlled environment and are largely based on established technologies, the benefits are wide-reaching. Cellular agriculture foods

- Have a high feed conversion ratio and deliver similar or identical nutrition profiles
- Meet high standards of consistency, safety and hygiene
- Ensure increased food security, given its independence from seasonal and climatic changes
- Can avoid animal antibiotics, thus minimising antimicrobial resistance
- Can allow for selection of cell lines from animals with the best traits or from hard-to-culture species or those facing extinction
- Can overcome resistance from animal conservation activists as it doesn't involve killing of animals
- Ensure religious sentiments, associated with the killing and consumption of certain groups of animals, can be taken care of
- Ensure reduction in environmental pollution as agricultural waste will be minimal
- Are ideal for space travel and space colonies

Despite the huge benefits that it offers to humanity, cellular agriculture faces pressing challenges in its research, regulatory aspects and consumer acceptance. More publicly funded, open-source research is required to address technical challenges such as growth mediums, cell lines and consumer safety. The regulatory framework for cellular-agriculture products needs further elaboration in order to create a supportive environment for producers and consumers. In addition, consumers need to be informed about and updated on the potential benefits of, and current developments around, cellular agriculture in order to ensure widespread acceptance of these products.

Attaining self-sufficiency in food production and providing food security is not possible through traditional agricultural practices. It's high time we focus on cell-based food products in our public sector research institutions to prevent an imminent food shortage.

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MAKING A DIFFERENCE

An Indian doctor based in the United States has thrown light on how to manage patients with baffling Covid-19 symptoms

SUBHENDU MAITI

More than one and a half years into the pandemic, the scope of mysterious symptoms triggered by Covid-19 is emerging as a big task for the management of novel coronavirus patients.

Patients showing Covid-19 symptoms like respiratory illness with cough, flu and occasional pneumonia sometimes confuse physicians to diagnose the presence of novel coronavirus infections. For some individuals, it could entirely be a diarrhoeal illness while for others, like an adult woman on oral contraceptives, it could be an unpredictable clot formation, leading to stroke or pulmonary embolism.

The appearance of clinical symptoms in Covid-19 in this unpredictable fashion and a rapid downhill course in a short period of time poses a big challenge to physicians managing infected patients. Even vaccinated individuals are not being spared from the disease.

Making a significant difference in this fight against Covid-19, a United States-based Indian doctor has thrown light on how to manage critically ill patients with bizarre symptoms. Dr Mohan Rudrappa (*in photo*), a critical care medicine specialist currently affiliated with the Baylor Scott and White Medical Center in Temple, Texas, U S, observed that viral illnesses can manifest as secondary infections.

"There is such a wide range of health issues involved — from cerebral attacks to cardiovascular complications. There is no consensus on how to define, diagnose and measure these symptoms," Dr Rudrappa said, "Influenza may be accompanied by secondary bacterial pneumonia or aggravation of typhoidal illness of the intestine. Similarly, it is being increasingly observed that coronaviruses can predispose to microbial illnesses unrelated to the lungs."

Dr Rudrappa did his fellowship in critical care medicine from Amritha Institute of Medical Science, Kochi and training from the University of Arkansas for Medical Sciences in the U S. He holds the prestigious fellowships of both the American College of Physicians and American College of Chest Physicians. He is also a recipient of the International Union Against Tuberculosis and Lung Disease Gold Medal from the University of Mumbai in 2006.

Dr Rudrappa particularly stressed that countries with a high disease burden of tuberculosis face a major task in eradicating this illness. Coupled with those are individuals with preference for the use of tobacco, which sets in motion a range of illnesses that are counterproductive with the development Covid-19 pneumonia.

Some individuals have persistence of infection in the body. For example, there may be vegetation on the heart valve. Someone with such an endocarditis will have a diminished level of immunity, predisposing them to severe levels of illness when the virus catches up, Dr Rudrappa felt. Earlier, he led a team of neurocritical physicians to identify aberrations in brain metabolism by sophisticated magnetic resonance imaging techniques.

Dr Rudrappa stressed that such methodologies may be useful in the identification of complex neurologic diseases arising from primary Covid-19 illness or as a complication of Covid-19 vaccination. Prolonged stay in the intensive care unit leads to diffuse muscle weakness and degeneration including the diaphragm, which separates the chest cavity from the abdomen. The diaphragm is a critical muscle for inspiration.

The doctor's pioneering role has led to the introduction of cutting-edge technology like single-photon emission computed tomography scan in diagnosing the changes in vasculature across the lung bed, which is hugely affected with Covid-19 illness and may portend a severely cataclysmic outcome in the omicron variant.

Dr Rudrappa is making all efforts to inform the community about the utility of vaccination, contact precaution and the use of masks as continued preventative strategies to fight Covid-19, while the understanding of its biology still remains at its infancy.

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