Biology Bazinga

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What is the future of human evolution?

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Evolution is the development of living organisms over time, driven by natural selection. However, with modern medicine and technological advances, is Darwin's idea of 'survival of the fittest' still relevant for humans today? Are we still evolving at all?

The belief that evolution no longer effects humans has become more widespread due to our increasing dependence on technology. For example, people with poor eyesight who would have struggled 5000 years ago are now aided by the simple invention of glasses, which allow them to survive and reproduce, meaning the disadvantageous allele that caused their vision problems is passed on. This has led many to believe that biological adaptation has been replaced with purely cultural adaptation, meaning only behavioural changes are used to overcome problems instead of physical ones.

However, cultural and biological adaptation are not mutually exclusive, and recent DNA analysis has revealed that physical evolution is still occurring within the human population. In Northern Europe, an area with a history of dairy farming and therefore high milk consumption, the ability to produce lactase (an enzyme that allows the digestion of milk) into adulthood is much more common compared to other areas with less regular exposure to milk. This is caused by natural selection of the gene that controls lactase production and therefore provides concrete evidence of recent human evolution.

Evolution is still able to occur because there will always be selection pressures that we cannot easily or quickly adapt to by using technology. We can attempt to predict some pressures that are likely to impact us in the near future, potentially causing physical evolution (alongside cultural).

For example, the spread of pathogens has become much easier as a result of increased travel and international connections, and as seen by COVID-19, pandemics could become increasingly common. This would create huge selection pressure as without immediate development of a vaccine/cure those that are more equipped to fight off the disease are much more likely to survive and reproduce.

The rapidly increasing population and lack of resources to provide for this has also led some scientists to theorise that humans would be more likely to survive if they evolved to be smaller, meaning they would require less energy.

Climate change will also inevitably cause problems for us in the future, and there could be some impacts we cannot combat with technology. Increasing global temperatures could reach levels too hot for current humans and, most people will probably still not have access to air conditioning, especially in low income countries. Could future humans develop characteristics typically seen in desert dwelling animals? Will we have larger ears like the fennec fox to increase the surface area that can radiate heat to help cool the body down?

'Traditional' evolution like this is hard to forecast and attempts to often result in open ended questions because we cannot know exactly what selection pressures or mutations will occur. However, with the development of genetic modification a new type of evolution could emerge, controlled completely by us.

Scientists are already able to edit the genes of human embryos, now, the biggest barrier to the creation of 'designer babies' in the future is no longer the science itself, but ethical objections to it.
However, editing DNA to prevent genetic diseases like sickle cell anaemia is likely to be approved in the future as it is low risk; edited genes are not heritable, therefore any potentially negative impacts are limited. This type of 'genetic therapy' is already used to treat LCA, a rare hereditary condition that results in blindness. Normalising the use of this kind of genetic modification could serve as a pathway into allowing editing of the genomes of human embryos. From here, it would not be profitable for the corporations that funded the research to stop and limit this technology to medical treatments. Therefore, it is likely that the ability to choose or enhance certain characteristics in children will be made available. Eventually, artificial selection could replace Darwin's theory entirely.

Genetic interference on this scale could lead to a whole generation of enhanced humans with longer lifespans, increased intelligence, peak fitness and disease resistance.

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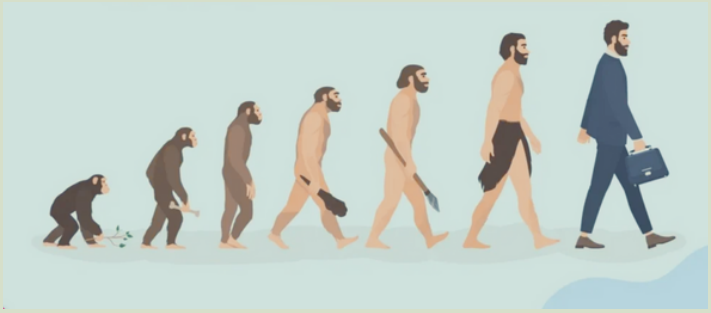
These differences would cause these individuals to naturally gravitate towards each other, eventually separating from unmodified humans and potentially creating an entirely new species. They would easily outcompete the unmodified humans if environmental conditions created increased selection pressure or if any conflict occurred, dividing or replacing the human race as we know it entirely.

Another way this could occur would be through symbiosis with machines. Although this may sound very hypothetical and bring to mind science-fiction, implants like pacemakers are already widely used and brain-computer interfaces are being developed for people with paralysis, to allow them to communicate more efficiently and use the internet. In 2021 a clinical trial for this technology, run by the company Synchron and involving a brain implant, successfully allowed volunteers to type using brain signals. This technology will continue to advance, and it is feasible to assume that, similarly to genetic modification, the economic benefits of approving implants for non-medical use will eventually outweigh any moral objections or concerns. Therefore, looking forward, there is a strong possibility that humans could evolve through combining ourselves with machines to enhance our physical and mental capabilities.

However, technology could also have negative impacts on our development. Evolution is not necessarily progressive, or directional and our new tech dependant lifestyles could result in adaptations that would be considered disadvantageous today. One of the most common theories is that the way our bones and muscles develop will change because of the vast amount of time we spend hunched over mobile phones. Already, changes to the skeleton are being observed, most commonly in 18-30 year olds. 'Text neck' is a phenomenon that is caused by poor posture, meaning the weight of the head is not distributed correctly. It results in a 'spiny growth' on the back of the neck which develops within a person's lifetime to help support the head. Although this is not caused by genetics, it provides an insight into how our bodies may adapt in the future, with emphasis on supporting the neck and perhaps weaker leg bones and muscles because of reduced movement.

Overall, the impacts of rapidly advancing technology on the natural progression of our evolution have been extreme and create a wildly uncertain view of the future. However, the idea that these advancements have put a stop to all genetic changes in our species is outdated, it is much more likely that technology will be the driving force behind the next chapter in our evolution. We cannot predict the exact course selection will follow, but we can be certain that it will occur. If humans exist in 10,000 years, they will appear vastly different from today; the causes of evolution may change but the process itself is inevitable.



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Artificial intelligence application in health care industries

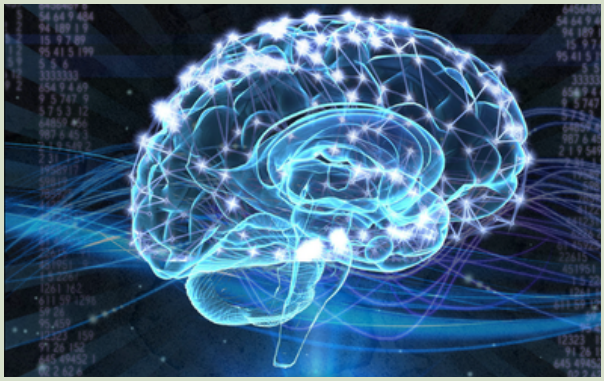
Evamary T

Having been in gradual development since the turn of the century, artificial intelligence has already produced impressive technologies that have significantly altered the healthcare landscape. Life science companies and research institutions are teaming up with pioneering technology giants such as Google, IBM and Apple, and emerging AI start-ups like Open Dialog, to create more effective ways to deal with diseases and care for patients. The current applications of AI in healthcare are broad, from disease diagnosis and drug discovery to personalised treatment plans, patient monitoring, and human-like chatbots. Furthermore, the technology is being applied by many life sciences companies to optimise processes in a way that continues to accelerate the pace of change.

Several types of AI are already being employed by payers and providers of care, and life sciences companies. The key categories of applications involve diagnosis and treatment recommendations, patient engagement and adherence, and administrative activities.

There are already a number of research studies suggesting that AI can perform as well as or better than humans at key healthcare tasks, such as diagnosing disease. Today, algorithms are already outperforming radiologists at spotting malignant tumours, and guiding researchers in how to construct cohorts for costly clinical trials.

Machine learning – neural networks and deep learning
In healthcare, the most common application of traditional machine learning is precision medicine – predicting what treatment protocols are likely to succeed on a patient based on various patient attributes and the treatment context. A more complex form of machine learning is the neural network – a technology that has been available and has been used for categorisation applications like determining whether a patient will acquire a particular disease since the 1960s and has been well established in healthcare research for several decades. Most complex forms of machine learning involve deep learning, or neural network models with many levels of features or variables that predict outcomes. There may be thousands of hidden features in such models, which are uncovered by the faster processing of today's graphics processing units and cloud architectures. A common application of deep learning in healthcare is recognition of potentially cancerous lesions in radiology images. Deep learning is increasingly being applied to radiomics, or the detection of clinically relevant features in imaging data beyond what can be perceived by the human eye.



Natural language processing
The dominant applications of NLP involve the creation, understanding and classification of clinical documentation and published research. NLP systems can analyse unstructured clinical notes on patients, prepare reports (example, on radiology examinations), transcribe patient interactions and conduct conversational AI.

Physical robots
They perform pre-defined tasks like lifting, repositioning, welding or assembling objects in places like factories and warehouses, and delivering supplies in hospitals. More recently, robots have become more collaborative with humans and are more easily trained by moving them through a desired task. They are also becoming more intelligent, as other AI capabilities are being embedded in their 'brains' (really their operating systems).
• Surgical robots, initially approved in the USA in 2000, provide 'superpowers' to surgeons, improving their ability to see, create precise and minimally invasive incisions, stitch wounds and so forth. Common surgical procedures using robotic surgery include gynaecologic surgery, prostate surgery and head and neck surgery.

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Given the rapid advances in AI for imaging analysis, it seems likely that most radiology and pathology images will be examined at some point by a machine. Speech and text recognition are already employed for tasks like patient communication and capture of clinical notes, and their usage will increase.

The greatest challenge to AI in these healthcare domains is not whether the technologies will be capable enough to be useful, but rather ensuring their adoption in daily clinical practice.

For widespread adoption to take place, AI systems must be approved by regulators, integrated with EHR systems, standardised to a sufficient degree that similar products work in a similar fashion, taught to clinicians, paid for by public or private payer organisations and updated over time in the field. These challenges will ultimately be overcome, but they will take much longer to do so than it will take for the technologies themselves to mature.

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Is supplementing vitamins actually beneficial to us?

Sophie C

A survey in 2022 showed that 16.1 million people in the UK are 'heavy users' of vitamins and other supplements, but do we need them and are we aware of their effects?

Why do we need vitamins?

Vitamins are necessary for performing a variety of functions in the body, although our bodies can't produce them in sufficient amounts which is why we need to get them from other sources. They can act as coenzymes which essentially assist important reactions within the body, such as Vitamin K which is important in helping blood to clot. However, our bodies only need small quantities of vitamins which can usually be obtained from a regular balanced diet, and it is thought that taking too many vitamins can result in more harm than good.

Who might benefit from taking vitamin supplements?

There are certain groups of people who may be deficient in certain vitamins and so may benefit from taking supplements. For example, those who are vegan or have other dietary restrictions may need to supplement vitamins like calcium that they are not receiving enough of in their diets, or for pregnant women it is recommended to supplement folic acid. However, some deficiencies can be caused by a syndrome called malabsorption, in which the small intestine is unable to absorb certain nutrients and fluids. Among other causes, this can be due to the fact that your body cannot produce the enzymes needed to digest certain foods. For this condition, people may benefit from enzyme supplements instead of vitamins.

When do vitamins become harmful?

Taking considerably too much of a vitamin can have some serious effects, such as hair loss, fatigue or lack of focus. Also, certain vitamins can inhibit each other's absorption, causing deficiencies that didn't exist before.

For example, taking too much calcium can inhibit magnesium from being absorbed. Not to mention, they can have effects when taken in conjunction with medicine, affecting its absorption, excretion or changing its potency – this could be dangerous as you may not be receiving the correct prescribed dose. It is also worth noting that vitamins are not always well regulated as there is no requirement for them to be licensed or registered with the UK government.

What is the overall verdict?

The average multivitamin has a wide margin of safety so is unlikely to have any adverse effects, however, research shows that supplementing multivitamins does not have any noticeable positive effect either. For example, one study in an American medical journal involving 450,000 people found that multivitamins did not reduce risk for heart disease or cancer. Moreover, it is thought that less than 10% of vitamins in a tablet or capsule are actually absorbed by the body. Ultimately, supplementing certain vitamins in moderation is unlikely to be harmful, however it is worth being mindful and researching vitamins before taking them to ensure that it is actually necessary. Anyone who has a varied, balanced diet should be able to receive sufficient nutrients without the need for supplements and so may want to think twice and save some money.

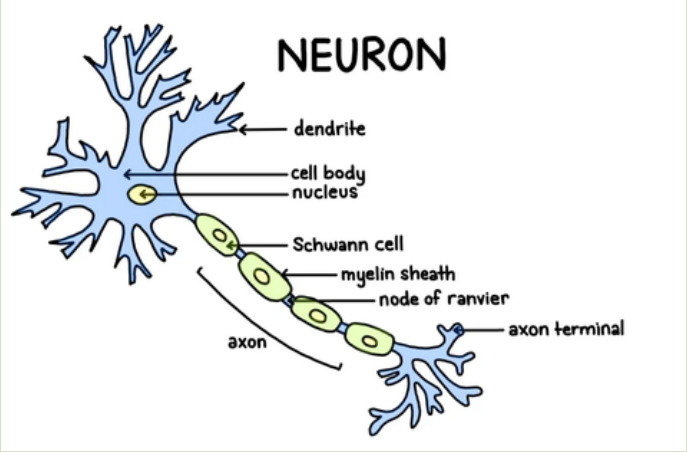
Brain-computer interfaces

Katy B

We've all seen the sci-fi movies depicting humans controlling computers with their thoughts but what was once a mere fantasy, is now becoming a reality. As technology progresses at rapid rates, we're witnessing the transformation of once impossible ideas becoming tangible realities. Amid these innovations, lies brain-computer interfaces (BCIs), serving as the bridge that connects the human brain with the boundless capabilities of technology.

So, what exactly are brain-computer interfaces? Essentially, a BCI is a computer-based system that captures brain signals, analyses them, and translates them into commands that direct an output device to carry out a desired action. However, to understand how a BCI works, it's necessary to understand the basics of the brain itself.

The human brain is perhaps the most complex organ in the human body. This spongy mass of fat and protein is responsible for controlling everything you will ever do. From allowing us to learn and feel, to every blink and breath we take. All of this comes down to tiny chemical and electrical signals that are racing between different neurons in both our brain and body. With around 130 billion neurons in an adult human body, 100 billion of those neurons are condensed in our brain alone. Each neuron consists of a cell body from which extensions, known as dendrites and axons, branch out to form connections with other neurons. Dendrites carry incoming electrical signals towards the cell body, and axons carry electrical signals away from the cell body to other neurons. These electrical signals can be then detected by various methods.



Here is where BCIs enters the picture. In non-invasive approaches, electrical signals are picked up by an electroencephalogram (EEG), a component of a BCI, where electrodes are placed on the scalp and detect the electrical activity in the brain, resulting in EEG data. This data is then translated into control signals for an external device to carry out an output.

Whilst the media hype about BCIs can sometimes exaggerate their capabilities, it's clear that their real-world applications are becoming increasingly prominent, especially in tackling paralysis. Take Pat Bennett, for instance. Diagnosed with amyotrophic lateral sclerosis (ALS) in 2012, Bennet faces the challenges of progressive neurodegeneration which consequently causes her lips, tongue, larynx, and jaw muscles to lose their ability to articulate phonemes clearly. Although Bennet's brain can still generate phonemes, her muscles fail to execute these commands.

However, in 2022, scientists with the Brain Gate research collaborative reached a major milestone by helping Bennet speak words on a screen merely by her thinking of them, thanks to a BCI. Standford neurosurgeon Henderson implanted two pairs of small electrodes into separate speech-related regions of her cerebral cortex. An AI algorithm then interpreted the electronic signals from Bennett's brain, learning to differentiate the specific brain activity linked to different phonemes. This algorithm could then create a language model based on these phonemes to convert the streams of phonemes into the sequence of words they represent, to then be displayed on a computer screen. After many trials, Bennett achieved a remarkable achievement, generating 62 words per minute on a computer screen simply by thinking.

Brain-computer interfaces

Katy B

BCI research also plays a significant role in helping assisted movement. Jan Scheueurmann, a paralyzed woman, demonstrated control over a robotic arm using only her mind. Like Pat Bennet, Jan underwent a procedure involving the implantation of two sensors in the motor cortex of her brain. Each sensor, equipped with around 100 tiny needles, picks up electrical signals from about 200 of her brain cells. These signals are then decoded into commands for the robotic arm, enabling it to perform different movements such as bending at the elbow, wrist, and grasping objects. Jan was able to successfully control the robotic arm as early as the second day of training, and over the course of 14 weeks, her ability continued to increase steadily.

Yet BCIs aren't just stopping there- they also offer hope for restoring vision through visual neural prostheses. Visual neural prostheses aim to replicate the electric signals delivered to the visual cortex. This is done by capturing visual data from a camera, translating it into electrical signals, and stimulating the visual cortex, accordingly, thus allowing the individual the ability to see again. Although, visual neural prostheses are still in the early days of development.

Alternatively, advances in BCIs have the potential to create opportunities for advancements in military settings. Throughout the last decade, Defence Advanced Research Projects Agency (DARPA) has been involved in innovating a program known as the 'Silent talk', that aims to develop communication on the battlefield, without the need for speech or body gestures. The project has three major goals. The first is to map a person's EEG pattern (electrical activity) to individual words. The second goal is to determine whether these patterns are common to all people.

If so, then the third goal arises to develop a way to transmit those patterns to another person, thus removing the need to speak.

Moreover, DARPA has recently proposed 'The Cognitive Technology Threat Warning System' which uses a BCI designed to quickly detect subconscious sensory data, and then alert soldiers to a possible threat, passive or direct.

The advancement of BCI for military applications may seem exhilarating but is this the path we want to follow? Whilst medical applications are designed to help patients, military applications are designed to help nations win wars, a clear moral blind spot.

BCIs are no doubt life-changing tools, but the real question is whether we will choose to use them responsibly or exploit their power.

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Poison Dart Frogs and Their Role in Research

Lilia S

Introduction to the Poison Dart Frog (dendrobatidae)
Poison dart frogs are considered one of the most poisonous and toxic species on Earth and have many adaptations which are vital to their survival. They are native to tropical Central and South America and are diurnal which means they are active during the day, unlike many other frog species.

One adaptation of poison dart frogs is that they are aposematic, meaning their brightly coloured skin assists them in deterring predators. The reason why the dart frog's predators are warned off is because they have undergone learned avoidance, which is where animals learn to avoid prey with indicators of toxicity, such as vibrant colours. Another predator deterrent used by the frogs is their poison. Poison dart frogs are dangerous to the touch and highly toxic, meaning if predators ingest these frogs they can suffer from swelling, nausea, and muscular paralysis. An example of how toxic these frogs are is the Golden Poison Dart Frogs' ability to kill 20,000 mice due to the volume of poison contained within the frog. However, poison dart frogs don't get their toxicity from themselves, they get it from the insects that they consume, meaning that the frogs' typical toxin delivery is through ingestion. Therefore, poison dart frogs living in captivity aren't actually poisonous as they don't consume insects containing toxins.

Poison dart frogs are very important to their ecosystem as they play a crucial role in controlling insect populations, due to their diets, and because they prevent plants being overconsumed. Poison dart frogs also help researchers with the monitoring of environmental health as their presence or absence acts as a signal for change in biodiversity and habitat quality. Despite this being the frog's primary role, the poison dart frog also has a role in medical research.

'The Poison Dart Frogs' role in research
Poison dart frogs are very intriguing animals, and an interesting aspect of their existence is their role in medical research. The species Epipedrobates tricolor is a poison dart frog which has played a huge role in research and has resulted in the synthesis of a nonaddictive painkiller called 'epibatidine'. The drug was discovered in the skin of the frog and has been modified and synthesised in attempt to produce a beneficial new drug. Epibatidine has an extremely high analgesic potency and due to this, scientists initially considered the potential for epibatidine to replace morphine as a painkiller. Another reason for this consideration was the drugs inability to cause habituation, which means epibatidine cannot become accustomed to.

Epibatidine relieves pain by interacting with nicotinic and muscarinic acetylcholine receptors which are involved in the transmission of pain signals.

However, epibatidine is not a drug which is viable for human use due to the severe side effects, such as bradycardia, observed in research which resulted in epibatidine clinical trials being discontinued. Epibatidine is an alkaloid and its effect on cardiorespiratory function and ganglionic synaptic transmission was examined in rats. These rats were urethane-anesthetized, paralyzed and artificially ventilated. This research conducted on epibatidine found that not only does the drug have structural similarities to nicotine, but that it also elicits cardiorespiratory effects similar to that of nicotine. Although epibatidine modified from poison dart frogs did have the potential to be a useful drug, its toxicity and dangerous side effects identified in these rat clinical trials eliminated this possibility.

Despite poison dart frogs not providing a successful drug alternative to morphine, they still played a huge role in medical research into painkillers which adds to their list of fascinating facts. Unfortunately, these frogs are classified as an endangered species and have moved even further down the IUCN's conservation chart. The reason for their population decline is due to deforestation harming valuable habitats and human population increase exacerbating this issue. Hopefully we will see a rise in the population of these poison dart frogs as although they have high toxicity and can therefore be harmful to other organisms as well as humans, they are captivating creatures which have proven to be important in the maintenance of ecosystem quality as well as in scientific research.

Should euthanasia be legalised?

Daisy K

The topic of legalising euthanasia in the UK has been continuously debated over many years and the law still states that euthanasia is illegal, and any person found assisting this act – such as doctors and physicians – could face up to fourteen years in prison under the crime of manslaughter. However, this medical procedure could arguably be a benefit to the lives of hundreds of patients and their families which is why it is a continuous and fluctuating debate in medicine, law, and sociology. The process of euthanasia is carried out by a physician administrating a fatal dose of a specific drug (most commonly Pentobarbital) which causes the human body to shut down. The patient will painlessly fall unconscious and at about 60 minutes after the dose administration, they will die. There is no doubt as to why this process is illegal in most countries including the UK as many will argue that it can be classed as assisted suicide, contracted killing or even murder as a secondary party is willingly taking the life of the patient. Despite this, euthanasia, where legal, is carried out with the express permission of a patient or that of a third party if their medical condition is so debilitating that they cannot make the decision themselves (e.g. if the patient is in a coma) and is normally a voluntary procedure.

As of the start of 2024, in Europe, euthanasia is legal in Belgium, the Netherlands, Luxembourg, Germany, and Spain with other countries considering legalising the procedure in the future. Additionally, Switzerland allows the process of assisted suicide – helping someone to end their life – despite having prohibited euthanasia (which has a heavier focus on relieving someone's suffering by ending their life medically). One of the key supportive arguments to the legalisation of euthanasia in these countries is the idea that when someone's suffering is so great and there is pretty much zero possibility that they will get better, then their pain should be taken away in the form of ending their life so they do not have to experience a deteriorated lifestyle where they cannot function without increased medical support.

There are many pro-euthanasia arguments surrounding UK debates and these have been discussed seriously in the past. Some of the arguments are based on human rights, including the fact that people have a right to die as long as it does not bring harm to others or affect the state in any way.
There are also a lot of practical arguments such as the idea that euthanasia can be regulated and the fact that allowing people to die could free vital medical resources that were not actively contributing to a person's cure or healing – for example those suffering from terminal illness will eventually die after a lot of pain and suffering, while using hospital resources that could possibly be more useful to preserving life elsewhere.

However, these arguments do have downsides which need to be considered, such as the fact that while euthanasia could be regulated in theory, there is a substantial risk of people implementing the procedure for selfish reasons or pressurizing more vulnerable patients which could lead to medical professionals being less sure of the extent that the patient is agreeing voluntarily. While humans may have the right to die (as stated under their right to life) doctors do not have the 'duty to kill' and forcing them to do so a part of a job could have large negative psychological effects. These are some of the main reasons euthanasia isn't yet legal in the UK, with most arguments against it being based on the morality, regulation, and psychology of the procedure. Overall, there are equally weighted arguments, for and against euthanasia which is a clear marker of why some countries allow it while others don't and the debate no doubt changes based on the specific situations of various patients, their conditions, beliefs, and lifestyle. It would be impossible to say that the procedure should be legalised in the UK when we don't yet have a fool-proof way of regulating it.

How does depression affect the brain?

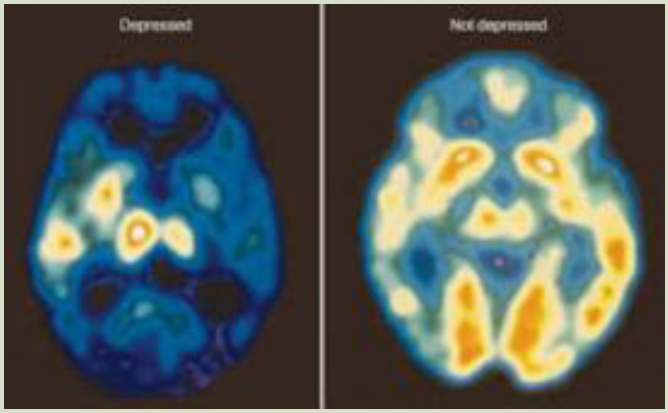
Dhanya B

Depression is one of the most common mental illnesses around the world, but not much is known about its pathology. Pathology is the study of the cause, origin and nature of a disease. This means little is known about the biological nature of depression as a disease. The symptoms of Major depressive disorder (MDD) are persistent low mood, often accompanied by cognitive dysfunction, physical symptoms, and impaired social function.

Currently, the diagnosis of MDD relies on patients' reports and behavioural assessments. MDD remains an unresolved treatment challenge for many physicians and patients. Increasing evidence has been accumulated in recent years regarding the impact of MDD on the structural and functional processes occurring in the brain. Neuroimaging studies have the advantage of being noninvasive and repeatable and may be able to provide precise evidence to clinics for more successful individualised therapies.

Magnetic resonance imaging (MRI) has been used to investigate the pathological changes in brain anatomy associated with this disorder. MRI can identify structural changes in depressive patients in the living person, which could contribute to clinical diagnosis and treatment. Numerous studies that focused on grey and white matter have found significant brain region changes in major depressive disorder patients, such as in the frontal lobe, hippocampus, temporal lobe, thalamus, striatum, and amygdala.

According to previous reports, the change in the volume of frontal regions has been considered to be the most common region to have anatomic abnormalities in MDD.



The anterior cingulate cortex (ACC) plays a role in cognitive processes and mood regulation. A negative correlation was observed between the Montgomery-Asberg Depression Rating Scale score and cortical thickness in the ACC. The volume of grey matter in the left middle frontal gyrus was found to be decreased in untreated depressive patients and to increase after drug treatment. These changes are associated with emotional bias, (a distortion in cognition and decision making due to emotional factors), apathy (lack of feeling and emotion), and loss of motivation.

The thalamus is a complicated sensory information node that controls emotion, memory, and arousal. Dysfunction and structural disruptions in the thalamus can lead to an amnestic syndrome (a group of disorders that involve loss of memories) due to impairments in recall and recognition. Significant volume reductions and changes in shape have been seen in the left thalamus of patients with MDD. Based on a shape analysis of the vertex, the dorsal aspect of the left thalamus was found to be negatively correlated with the severity of depression (Hamilton Depression Rating Scale).

The striatum is an important part of basal ganglia. A large number of neuroimaging studies have reported significant changes in the striatum of MDD patients. Functional magnetic resonance imaging (fMRI) has shown that striatal activity was reduced in reward systems. Defects and decreased reward network connections were found to be linked to depression severity. These findings suggest that abnormal striatal activity plays a key role in disease progression. The striatum contains the putamen, the caudate, and the ventral striatum. The results of previous studies have shown that, compared with a control group, the volume of the bilateral putamen is significantly decreased in MDD patients. Previous results also suggest that the putamen plays a key role in mood, cognitive processes, motivation, and regulation of movement. The putamen is a component of the hate circuit and has connections with the orbitofrontal cortex (OFC) and the ACC. Increased functional activity in the putamen has been found in MDD patients, which may lead to a weakening of their ability to control emotions and a low threshold of provoking feelings of hatred toward themselves or others.

How does depression affect the brain?

Dhanya B

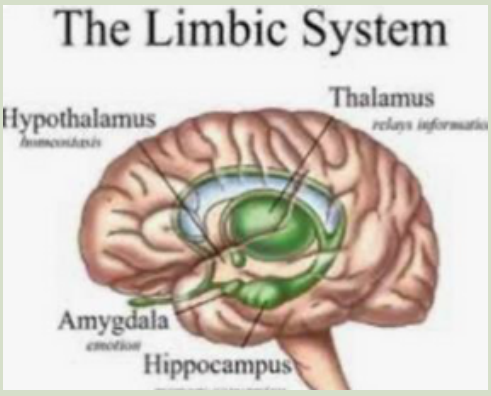
The hippocampus is associated with memory recall and the rules of reward. Research has shown that the hippocampus is smaller in depressed patients than in than people in a healthy control group. Hippocampal atrophy is when the hippocampus decreases in size, and can be associated with cognitive decline, especially when it comes to memory. Antidepressant treatment research and a longitudinal study of electroconvulsive therapy found an increased grey matter volume in the hippocampus in MDD patients after treatment.

This suggests that the increased hippocampal volume was associated with clinical improvement. A study reported that people with depression who are over 40 years of age, or those with severe or multiple episodes, were more likely to have a small hippocampus. Additionally, other studies have found that a small hippocampus may be associated with illness duration in MDD. According to an fMRI study, decreased brain activity in the hippocampus was reported in depressive patients. Reduced grey matter volume and reduced functional activity in the hippocampus can lead to negative emotion and the inability of cognitive processing in patients with depression.

Key characteristics of major depression include the overemphasis placed on negative events and emotions (negative bias), and the state of anhedonia (difficulty in experiencing pleasure). Together, these factors cause the depressed patient to feel as though everything is terrible and that nothing is really worth doing. Two important brain regions for this are the amygdala, for negative emotions, and the nucleus accumbens, for pleasure. A lot of evidence indicates that the amygdala is particularly active when negative emotions are experienced. With regard to depression, neuroimaging studies in humans show that in response to viewing sad faces, the amygdala of depressed people is extremely active when compared to the amygdala of non-depressed people, yet when viewing happy faces, amygdala activity is not distinguishable between the two groups. Therefore, an overactive amygdala may contribute to depression.

The inability to cope with stress plays a major role in developing depression. An overactive amygdala, (mis)regulated by the prefrontal cortex, is a key component of this. Additionally, the overactive amygdala can create a cognitive bias towards interpreting the world, and oneself, negatively. The increase in negative thoughts and emotions seems to occur alongside dysfunction in the brain's reward system, particularly in the nucleus accumbens (NAc), where the rewarding effects of dopamine are decreased. These biological findings are consistent with behavioural observations of a negative cognitive bias and anhedonia in people suffering depression.

The general population still frequently associates depression with bad lifestyle and 'psychological weakness '. Studies involving adults with moderate to severe depression have showed that only 40% of people noticed an improvement in they're symptoms after taking antidepressants. In order to be able to provide depressed patients the most effective treatment possible we must gain insight into the pathology of depression and its effects on the brain. Defining depression at a neurobiological level will enable psychologists to provide effective medications and therapies that are tailored to the patient, which could increase their chances of responding to the treatment, reducing the burden of depression.



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Endometriosis

The most common and most ignored disease that affects 176 million women globally.

Arisha A

What is endometriosis?

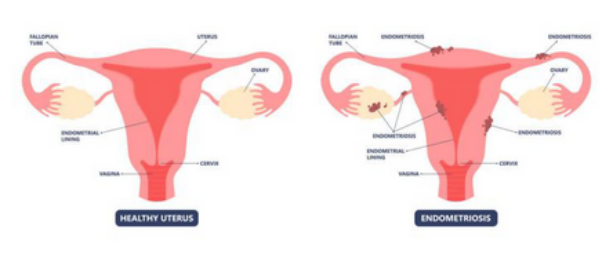
Defined by the World Health organisation endometriosis is a disease in which tissue, similar to the lining of the uterus, grows outside the uterus. It is considered a chronic disease that can cause severe pain during periods, fatigue, nausea and in worse cases infertility. The location of the endometriotic deposits is usually on organs within the pelvis. The growth of these endometriosis lesions can cause chronic inflammation of the pelvis and adhesions to form, as the tissue cannot be shed through menstruation.

Why does it occur?

Doctors and researchers do not know the exact cause of endometriosis. At present there are a few theories presented as to why endometriosis occurs.

For a long time, the most widely accepted theory has been the Retrograde Menstruation theory. This claims that menstrual blood, containing endometrial cells, flows backwards through the fallopian tubes and into the pelvic cavity during menstruation. The flow of endometrial cells causes the growth of endometriosis lesions in places they should not be. However, there are numerous clinics and experimental evidence that undermine the validity of this theory. For example, it does not support the presence of endometriosis lesions outside of the pelvic cavity, in isolated areas like the lungs and lymph nodes.

Another theory is Cellular Metaplasia. Cellular Metaplasia describes the abnormal conversion of one cell type into another. In the case of endometriosis, abdominal cells can change into endometrial like cells, causing endometriosis lesions in places they shouldn't be. Therefore, cellular metaplasia states that endometriosis can occur without the input from endometrial cells from the uterus. This theory is widely believed to explain how endometriosis can occur in areas that are not near the pelvis.



Diagnoses of endometriosis

Despite endometriosis being a common disease that can wreak havoc upon those who suffer from it, it is extremely underdiagnosed with an irrationally long time of 8-13 years between the first symptom to a definitive diagnosis. This is due to the symptoms being nonspecific and there currently being no exact tests that can identify endometriosis. At present, the confirmed and definitive diagnoses of endometriosis can only be obtained through surgical means. Scans and blood tests can show indicators to endometriosis but do not show enough for a confirmed diagnosis of the disease. The surgical options are either a laparoscopic procedure or an invasive surgery to examine the endometriotic deposits. The laparoscopic surgery involves a small incision being made upon the patients' abdomen, and a laparoscope (a type of telescope with a small camera attached to the end) is then guided into the pelvic cavity so the surgeons can examine the area for endometrial lesions.

Treatment

The most common treatments for endometriosis (that do not include surgery) are centred around pain management and controlling symptoms, as there is currently no cure for the disease. Endometriosis tissue is affected by hormones in the same way that endometrial tissues inside the uterus are. Therefore, hormonal changes that occur during the menstrual cycle can cause endometriosis pain to worsen. Hormone therapy alters hormone levels by preventing the ovaries from producing oestrogen and stopping ovulation. Therefore, through supressing periods, endometriosis pain can be relieved and stopped from worsening. The most common of hormonal therapies is the birth control pill, either the oestrogen and progesterone combined pill or the progesterone pill. The progesterone pill works by causing the lining of the uterus to thin which leads to the stopping of regular periods. Therefore, it prevents retrograde menstruation from occurring and stops the formation of endometrial lesions in the pelvic cavity. Gn-RH (gonadotropin releasing hormone) analogues are another type of medication that can be used for endometriosis treatment. Gn-RHs are a synthetic form of the hormone gonadorelin that is released by the hypothalamus in the brain. They stop the pituitary gland in the brain from producing luteinising hormone and follicle stimulating hormone.

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When Gn-RH analogues are used continuously for longer than 2 weeks, ovarian function significantly decreases causing the production of oestrogen to decrease. As a result, the endometrium (the lining of the uterus) and endometriosis lesions do not form. This can significantly reduce the progression of the disease and reduce the pain. However, as Gn-Rh analogues are effectively mimicking menopause in the body, the continued long-term use of the drugs can lead to deterioration of bone microstructure and puts patients at a risk of osteoporosis. Another option of treatment is to remove endometrial lesions via surgery. Physicians usually do this during the diagnoses stage, if they find any endometriosis lesions during the laparoscopic surgery, they will attempt to cut them out.

Impact upon women

In the UK endometriosis is the 2nd most common gynaecological condition, affecting up to 1.5 million women and those who are assigned female at birth.

Many women feel as though they are being ignored by their GPs when they voice their concerns over the possibilities of having endometriosis. Stigma and societal normalization of women's pain have become massive barriers to the diagnoses and care for endometriosis, leading to millions of women being left in debilitating pain with no one listening to their concerns.

While there are treatment options available, they do not work for everyone, have side effects that can worsen the patient's quality of life and have a high chance of disease reoccurrence. Endometriosis can have a detrimental impact upon women's physical and mental health, personal life, career and relationship with physicians.

However, improvements are being made within the medical and research community with new trials and treatments being created and tested.

Advancements in endometriosis treatment

Currently, there is no cure for endometriosis nor is there one perfect treatment. However, there are multiple research labs who are attempting to gain a better understanding of why endometriosis occurs in order to create better treatment options. The National Institute of Child Health and Human Development conducted a study upon mice, in which they tested the potential use of a magnetic hyperthermia procedure. Magnetic hyperthermia utilises heat to remove disease causing tissue. This procedure involves delivering magnetic nanoparticles to specific areas of the body so the nanoparticles can accumulate in endometriosis tissue. Then an alternating magnetic field is applied, causing the nanoparticles to generate heat, which kills the endometriosis tissue. This could potentially form a long-term treatment of endometriosis when further clinical trials and more research are conducted.

Researchers at Edinburgh university have presented results of a study suggesting that the painful symptoms of endometriosis could be lessened with the drug Dichloroacetate (currently being used in cancer treatment). Researchers have found that cells from the pelvic wall of women with endometriosis have a different metabolism rate, compared to women without endometriosis. The cells in women with the disease produce higher amounts of lactatea harmful waste product formed from glucose metabolism. During the trials, the drug dichloroacetate caused the amount of lactate produced by the cells to reduce and for the cell metabolic function to return to normal. Therefore, researchers at Edinburgh are hoping this could be a possible treatment for women who do want to take hormonal therapy and to prevent the reoccurrence of the disease.

Ultimately, endometriosis is a common disease that should be paid more attention to by physicians. Awareness of the disease should be increased, as such a large population of girls and women can suffer from it without any knowledge of what is happening to them. Severe and debilitating pain during periods is not normal and women's pain and concerns should be listened to instead of being dismissed.

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The evolutionary history of the Moas: an extinct giant from New Zealand

Anna E

Imagine a 12-foot-tall ostrich which weighs as much as a large lion, with a bulky and strong beak, similar to that of a parrot, running on its two legs and making deep throaty roaring noises. That's probably something close to a Moa.

New Zealand has stood out in the field of evolutionary biology both because of the nearly 45 million years which it spent without the presence of mammals, and the shockingly vast number of animals having gone extinct there in the last 800 years since human settlement. New Zealand's cool climate preserves DNA well, and the country has many fossil deposits from the last ice age. This has allowed it to provide landmark DNA research: the DNA from the moa providing some of the first genetic sequences from extinct birds and the first microsatellites (short repeating segments of DNA) from any extinct species. Ancient DNA, recovered from sources like bone, hair, and sediment, have helped challenge old ideas about the evolution of some New Zealand birds, better understand their lifestyles and uncover previously unknown historic creatures.

The breakup of Gondwana, a supercontinent that included what is now Antarctica, South America, Africa, Australia, and New Zealand, had a significant effect on the evolution of flightless birds. As Gondwana split apart, different groups of birds became isolated on separate landmasses. Over time, some of these birds lost their ability to fly, partly due to a lack of predators after the mass extinction 66 million years ago, and partly because flying was not necessary for survival in their new environments. This led to the independent evolution of flightless birds on different continents, such as the ostrich in Africa and the kiwi and moa in New Zealand. New Zealand, however, has unique experience of having had no mammals on its island from when it split with Australia until human intervention, allowing 245 species of birds to thrive with little competition to their survival. 32 known species of flightless birds evolved, filling the ecological niches that mammals would otherwise fill, such as grazing, hunting and seed dispersal, so much so that the ecosystems suffer to this day from the extinction of 16 of these species.

Previously, ratite birds like kiwis, emus, moas and ostriches were believed to have evolved from one single flightless ancestor on Gondwana which diverged with the splitting of the supercontinent. This would explain why no such birds are found in the northern hemisphere and would explain their morphological (physical appearance-based) similarities. However, mitochondrial genome sequencing of the flighted Madagascan elephant birds showed that they were the closest relatives of the kiwi, having diverged 50 million years ago, at least 5 million years after New Zealand was separated from Gondwana. Therefore, the ancestral Kiwi must have been a small volant (flying) bird when reaching New Zealand and not a large flightless herbivore like other ratites, as originally assumed.

Kiwis were never able to grow to be as large as many ratites, due to the presence of the moas who evidently evolved first and so had already filled that niche, providing competition for resources needed by any other large flightless birds. It's therefore safe to assume that moas also evolved flightlessness independently of other ratites and were the first of them to reach New Zealand.

The Moas were herbivorous flightless birds, the largest ever known to have lived, with long strong legs and no wings. They were covered in shaggy feathers and could grow up to 12 feet tall making them a prime example of island gigantism (the phenomenon of animals evolving larger bodies when isolated due to a lack of predation). It is estimated that these birds could have lived to over 60 years old due to the 9 years they took to reach sexual maturity.

The separation of the north and south islands as well as the formation of new mountainous habitats allowed the divergence of 9 different moa species in total which all had significant morphological differences (ranging from 3 to 12 feet tall and showing varying degrees of sexual dimorphism). This caused classification of these birds and estimations at their evolutionary history to be almost impossible before the use of DNA sequencing. The incredible resilience of these birds was shown by their survival of the Oligocene Drowning event (a rising of sea levels causing the drowning of most flightless bird species) as well as the formation of mountains, rainforests, and environmental changes which New Zealand experienced as tectonic shifts moved it south. It's therefore even more unfortunate that 150 years of human interference hunted these birds to extinction.

These birds pushed the limits of avian biology and evidence the huge impact that island isolation can have on evolution.

Wordsearch

Biology Bazinga Wordsearch!!!

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CLASSIFICATION
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PATHOLOGY
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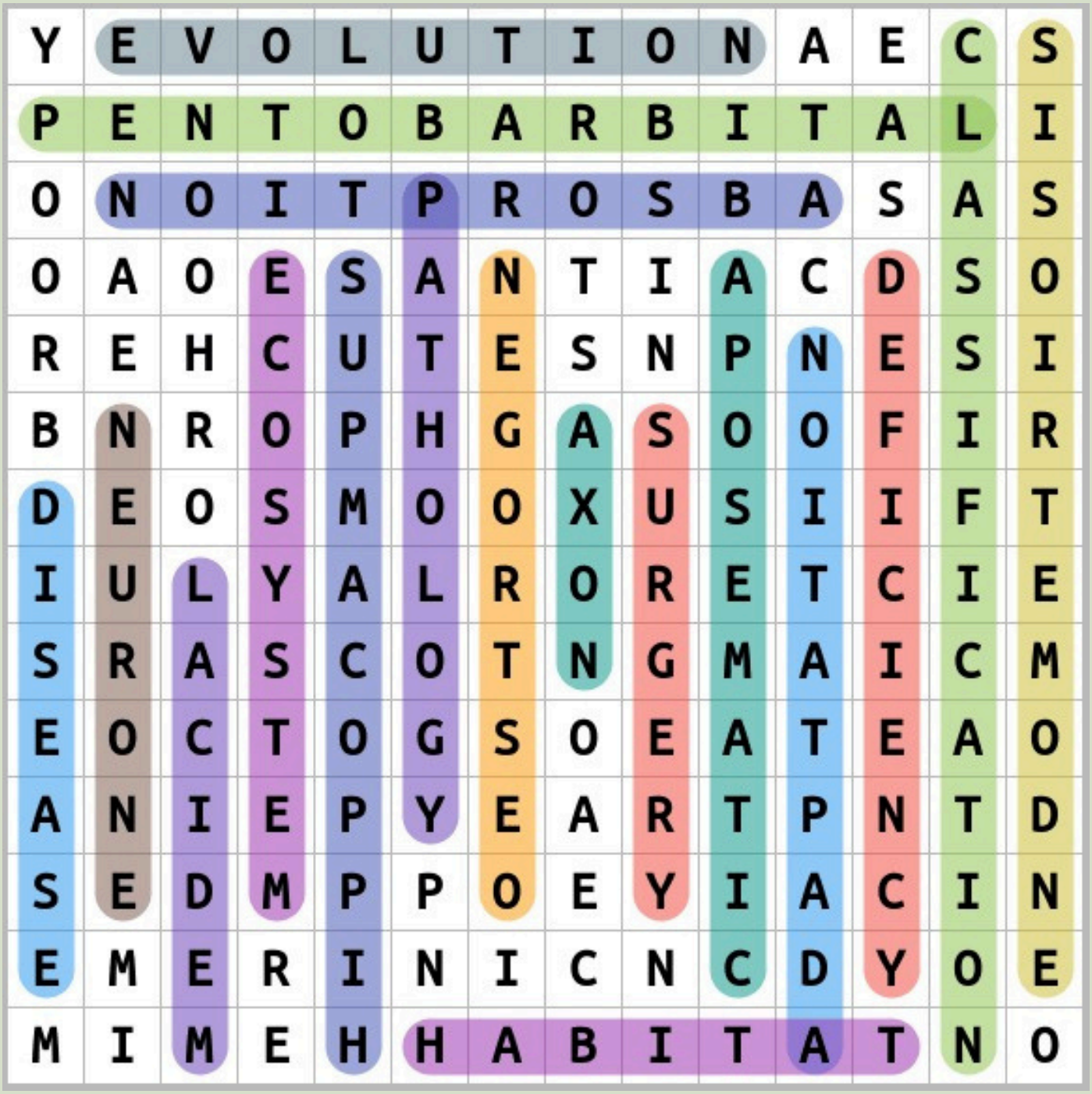
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