Science & Tech

How and why do seasonal changes affect our mood?

Isabella Coxon (she/her)

At university, the winter months are always tricky. The days become shorter, exams are around the corner and, if you're like me, the heating stays off until the last possible minute. Generally, people report experiencing more positive mood during the spring and summer months, and more depressive symptoms in autumn and winter. In more severe cases individuals can struggle with Seasonal Affective Disorder (SAD), which is particularly prevalent in temperate climates (areas whose coldest months average between 0 and 18 degrees Celsius). So, what is the science behind seasonality and mood?

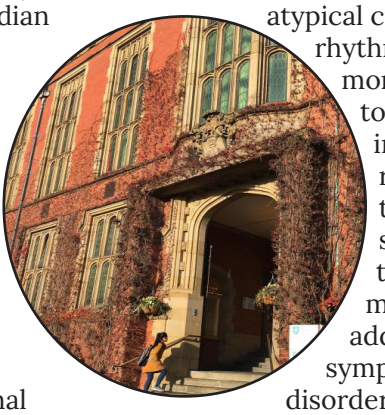
The diagnostic criteria for (Winter) Seasonal Affective Disorder is: (1) a syndrome in which depression developed during autumn or winter and remitted the following spring or summer for at least 2 successive years, (2) meets criteria for a major depressive or bipolar disorder, and (3) has no other psychosocial explanation for mood. Common symptoms of SAD include changes in appetite, decreased energy, hypersomnia, irritability and avoidance of social situations. More severe symptoms include apathy, feelings of blameworthiness and hopelessness, and suicide ideation. Full understanding of the causes of the relationship between mood seasonality are unknown, but multiple theories have been put forward, generally theorising that there is atypical variation in the brain.

The role of Serotonin:

Serotonin is a chemical in the brain that contributes to feelings of well-being, and is associated with mood, emotion, sleep and appetite. It's derived from a substance called L-tryptophan. Tryptophan supplements have produced positive effects in individuals for whom light therapy hasn't been helpful. Lower levels of serotonin neurotransmission has therefore been correlated with feelings of low mood. Furthermore, molecular genetic research has identified possible associations between certain genes and SAD. Serotonin levels in the brain vary with the seasons, and is at its lowest between December and January. In line with this, medications like SSRIs, that increase serotonin levels, have been effective in treating SAD.

Sleep cycles and biological clock:

One theory suggests that SAD is correlated with a phase-shift delay and an irregular circadian rhythm. The circadian rhythm refers to the body's internal time-keeping system in a structure within the hypothalamus, which persists without external stimuli. With relevance to SAD, it is involved in regulating: sleep/wake cycles, hormone release, body temperature, and appetite.



Changes to external stimuli, particularly the amount of exposure to daylight we experience, can disrupt our internal rhythm. Such disruption can impact the body's regulation, contributing to symptoms of SAD. This theory led to the development of light therapy as a treatment, which has been found to correct disrupted or shifted rhythms and improve mood symptoms. Phototherapy (the use of UV rays) has also been shown to reduce symptoms in individuals with SAD, but showed no effect on non-seasonal depression. It is unclear whether individuals with SAD have atypical circadian rhythms or are more susceptible to changes in circadian rhythm. Light therapy is a symptomatic treatment, meaning it addresses the symptoms of the disorder, rather than the underlying cause. While effective in some cases, this demonstrates the current lack of understanding of the disorder.

What can you do to alleviate symptoms of low mood during the colder months?

SAD affects a small percentage of the population (one in 20). Nonetheless, treatment methods for it can be beneficial to everyone when it comes to feeling better during winter. In a UK study Individuals with SAD most frequently reported that getting outside and socialising were their most used method of alleviating symptoms. Others also mentioned that 'keeping busy' with indoor activities and an SAD lamp was also helpful. The efficacy of methods is dependent on individual characteristics, so it's important to try out different methods until you find the right one for you.

Individuals likely to be struggling with SAD are normally prescribed with light therapy, and anti-depressants if symptoms still persist. If you are struggling, you should reach out to your local GP or a support group.

Support groups/services in Sheffield and the UK:

Rethink Mental Illness - https://www.rethink.org/help-in-your-area/groups-in-your-area/

Campaign against Living Miserably (CALM) - https://www.thecalmzone.net/

Seasonal Affective Disorder Association (SADA) - https://www.sada.org.uk/

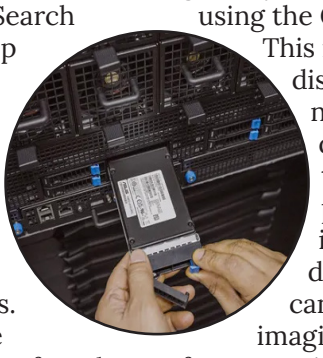
Image credit: The University of Sheffield

Discovery of new prime number blows mathematical records out of the water

Matthew Rowe (he/him)

Recently, both the largest Mersenne prime and the largest prime in general was found; this is a very important discovery in the mathematical area of number theory. This was the 52nd Mersenne prime ever found, and between the 51st and 52nd, it took mathematicians using specialist software 7 years.

A Mersenne prime is a prime number of the form $2^p - 1$, where p is a pre-existing prime number. To start with, these numbers are small, the first three being 3, 7, and 31 but very quickly ramp up, with the 10th Mersenne prime already reaching 27 digits. In 1995, in an effort to find these huge numbers, the Great Internet Mersenne Prime Search (GIMPS) was set up to corroborate efforts by several mathematicians as well as releasing free software for the sole purpose of finding Mersennes. Unexpectedly, the mathematician who found its latest discovery only joined the search in October 2023.



Luke Durant, an ex-NVIDIA employee turned researcher, was the person responsible for the discovery; he did this by creating a "cloud supercomputer" of GPUs globally, all simultaneously using the GIMPS software. This resulted in the discovery of a prime number 16 million digits larger than the 51st Mersenne prime, resulting in a 41 million digit number I can't even begin to imagine. But in the form mentioned earlier, this is represented as $2^{136,279,841} - 1$.

New prime numbers are a very relevant concept with applications within mathematics and computer science. After the searching process, these numbers need to be checked since the Fermat probable prime test used in the preliminary test is relatively simple and these calculations have many stages where it can go wrong. For example, the 49th Mersenne prime, $2^{74,207,281} - 1$, took roughly 34 quadrillion steps. Checking these primes helps consolidate otherwise hard to verify algorithms as well as being a great test for hardware.

In mathematics, and specifically number theory, primes have always been an area of great interest. Mersenne primes have a particular link to perfect numbers; these are numbers where the number itself is equal to the sum of all its divisors. This tells us that if $2^p - 1$ is a prime, then $2^{p-1}(2^p - 1)$ is a perfect number. There aren't many real life applications of this but it's important to understand how these groups of numbers interact.

Durant received $3000 for this discovery but is choosing to donate his prize towards the Alabama School of Math and Science, giving funds back to the institution originally behind the search.

Image credit: Dhiraj Singh/ Bloomberg via Getty Images

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Global average temperatures in 2024 set to breach 1.5°C threshold

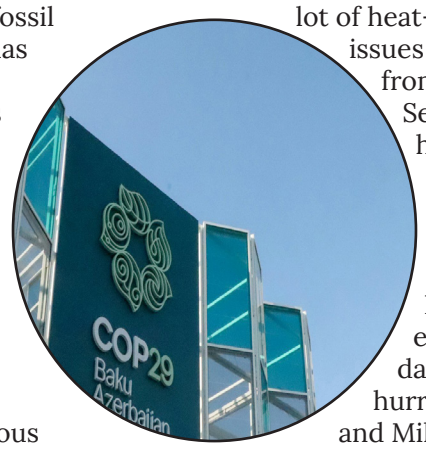
Elizabeth Hudson (she/her)

Scientists have said that it is now almost certain that 2024 will be the warmest year on record. According to data from the European Copernicus Climate Change Service, global average temperatures are set to exceed 1.55°C of warming above pre-industrial levels by the end of the year. This projection surpasses the previous record of 1.48°C which was set in 2023.

Early warming in 2024 was boosted by El Niño, a natural weather phenomenon where surface waters in the East Pacific Ocean are warmer than usual, releasing excess heat into the atmosphere. This is thought to have contributed towards the record-breaking temperatures seen this year. The El Niño phase ended in April 2024, but temperatures have continued to stay worryingly high for the remainder of the year. In fact, for the first eight months of 2024, average monthly temperatures were higher than those for the same months in 2023.

This milestone of 1.5°C warming is significant as it marks the reaching of a global limit set by the Paris Climate Agreement in 2015. This agreement was a pledge made by almost 200 countries to tackle the causes of global warming, namely greenhouse gas emissions such as carbon dioxide, methane and nitrous oxides. These gases are released in large quantities from activities such as burning fossil fuels, transport and farming practices.

A single year of above 1.5°C of warming will not count as a breach of the Paris Agreement however, as a sustained temperature rise over a number of years would need to be observed for this to be the case. It is a wake-up call, nevertheless, for policy-makers to address how we can start to take action to cut carbon emissions and prepare for the impacts of climate change.



Reducing fossil fuel usage has become a contentious talking point at this year's COP29 climate talks held in Baku, Azerbaijan. Countries at the previous Conference of Parties summit, held in Dubai last year, had agreed to "transition away from fossil fuels". Talks at this year's meeting appear to be going back on this statement, with many people fearing that oil-rich countries are going to simply continue exploiting their valuable resources to further their own economic growth, at the expense of other countries who are starting to feel the effects of extreme weather caused by climate change.

2024 has already seen an unprecedented number of extreme weather events. Torrential rain caused flooding in Spain in October 2024, which killed more than 220 people and left large areas damaged by floodwaters and covered in mud. Temperatures in Delhi, India reached 49.9°C in June 2024 which resulted in a lot of heat-related health issues and 219 deaths from heat stroke. Severe cyclones hit parts of India and Bangladesh displacing around 800,000 people. Even Florida couldn't escape the damage of two hurricanes (Helene and Milton) in quick succession which caused severe flooding to coastal communities. Four US states have also experienced a number of devastating tornadoes, Canada's forests are seeing their longest fire season ever, and even Dubai had to shut down briefly in April 2024 due to heavy rain which caused flooding chaos across the city.

"The warmer temperatures [are making] storms more intense, heatwaves hotter and heavy rainfall more extreme, with clearly seen consequences for people all around the world," says Professor Hawkins, a professor of climate science at the University of Reading. He, and other scientists, are keeping a close eye on what happens as we move into 2025. Climate experts are hoping for the arrival of the opposite, cooler phase to El Niño (known as La Niña) which will hopefully result in a slight drop in global temperatures. It is not certain, though, given the unpredictable nature of current weather patterns.

Most experts feel that the only way to really stabilise global temperatures is to work together to cut global carbon emissions and invest in carbon capture technology. An agreement on carbon emissions targets across all nations would be a step in the right direction, as is hoped for at COP29; however, competing agendas and motives from different parties mean that this is likely to be easier said than done.

Shown below is a graph of each years increase in temperature, in °C.

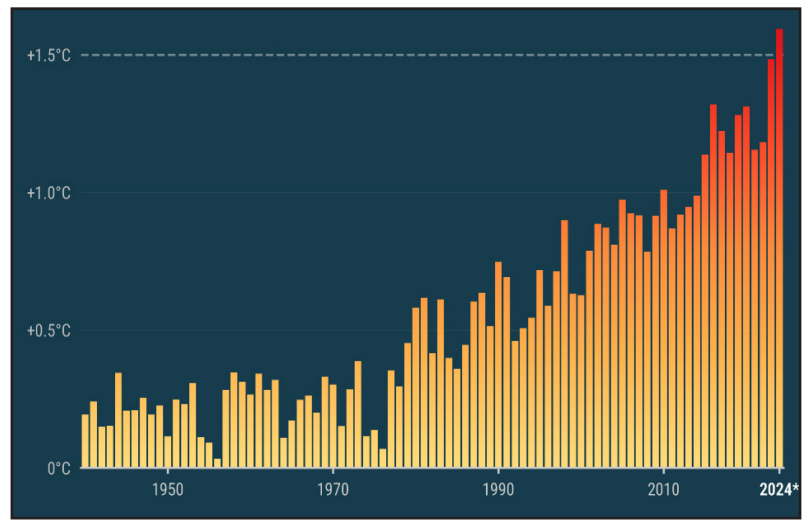
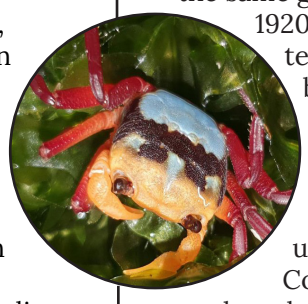


Image Credits:
COP: Matthew TenBruggencate - Unsplash
Valencia Flood: Alberto Saiz/ AP
Graph: Copernicus Europe

Recent ecological discoveries cover both modern and prehistoric era

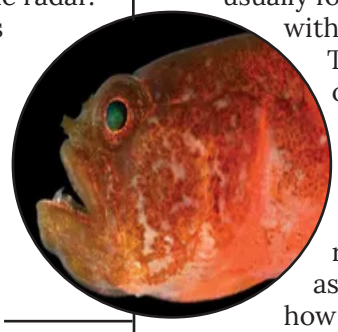
Matthew Rowe (he/him)

So far this year, there has been a brilliant number of new, and old species both discovered and uncovered. These both impact us today and improve our understanding of prehistoric times.



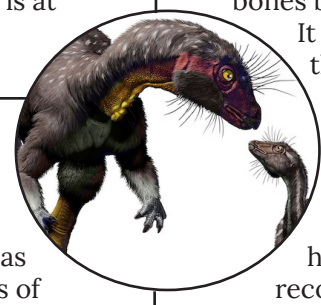
Three-coloured crab

Pictured on the right is the Three Coloured Crab (*Lepidothelphusa menneri*). This was discovered earlier but was only published in January this year. Scientists had been aware of crabs with the same genus since 1920, but due to its tendency to hide beneath leaves and roots, this colourful crustacean managed to slip under the radar. Concerns have been raised about pet industry exploitation, and during my research, I found a worrying amount firsthand.



Grumpy Dwarfgoby

Living up to its name, the grumpy dwarfgoby was recently disovered by researchers in the Red Sea. Despite its rather offputting, deep sea look, this fish is only 2cm long, hence the dwarf prefix. Similarly to its small size, its angry red colouring is just a product of camouflage, usually found hiding within red algae. The discovery of this distinctive new species gives a lot of hope to researchers as it shows how much new biodiversity is still undiscovered in the Red Sea. However, due to coral bleaching, the dwarfgoby and whatever else is swimming around down there is at high risk.



Fona Herzogae

Moving the focus to the land before time, a recent discovery in Utah has led to a new species of burrowing dinosaur letting itself be known.

Fossils have indicated that this dinosaur was roughly the size of a dog, had muscles developed for digging and lived in groups.

Many other factors show this ability to dig, such as the fossil being full as opposed to scattered like most above-land dinosaurs and the pelvic bones being fused.

It was also found that these dinosaurs likely had a downy coat, similar to that of geese.

This discovery has helped the records of the small group of burrowing dinosaurs greatly.

Image Credits:
Crab: Indoorecosystem.net
Dwarfgoby: BBC Discover Wildlife
Fona: Earthsky.org