KINESIS

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ARE PANDEMIC OUTBREAKS ACTUALLY THAT DIFFICULT TO PREDICT AND PREVENT, OR ARE WE JUST NOT LEARNING FROM OUR EXPERIENCES?

PANDEMICS: HOW DO YOU PREPARE FOR A GLOBAL VIRAL OUTBREAK?

Written by Sofia Sancho

We are in the midst of one of the biggest pandemics the modern world has experienced. The outbreak of the new coronavirus, COVID-19, is rushing along without resistance. In the last 20 years, we have had several pandemic and epidemic outbreaks, two of which were coronaviruses. We find ourselves asking if, with the lessons learned from earlier outbreaks, COVID-19 actually could have been prevented?

In the autumn of 2002, a new coronavirus known as Severe Acute Respiratory Syndrome (SARS), began spreading from southern China. In August of 2003, 8098 people had been diagnosed with the virus and 774 people had died. Despite apparent differences, especially in rate of spreading, SARS shared many characteristics with the novel coronavirus.

But if SARS was so similar to COVID-19, and we managed to stop it from transforming into a pandemic, how come we were seemingly surprised by the new coronavirus? Truth is the outbreak did not really come as a surprise. Since 2018, the World Health Organisation (WHO) has added "Disease X" to their list of priorities. Disease X represents an unknown pathogen, and was added to the list to remind the organisation of the threat of diseases we are not already familiar with, making sure that there will always be funding and resources to fight new pathogens.

The causes for viral outbreaks are complex, with biological and socioeconomic factors diligently intertwined. One important factor

Art by Rosie Jarrett

is human-animal contact. As our societies have evolved, our contact with animals, both wild and domesticated, has increased. This has opened up many opportunities for animal-exclusive pathogens to evolve and infect humans. SARS, and most likely the COVID-19 outbreak, can be trailed back to Chinese animal markets, a hotspot for these interactions.

In some parts of China, eating wild animals from markets is an important part of the culture. It is easy to put the blame on others, and even though the government is now banning said markets, completely getting rid of them is going to take time and compromise. But even if prohibiting Chinese animal markets could have prevented this specific outbreak, it wouldn't have stopped zoonotic diseases from evolving, as zoonotic events are not uncommon nor exclusive to China or Asia. The world we live in today makes the question of the next pandemic outbreak a "when" rather than an "if". We are still far away from being able to prevent viral outbreaks, but we have become better at preparing for them. The quick response from Chinese authorities is a good example of this: borders were closed, cities quarantined, and hospitals built in a very short time, which is crucial for slowing down transmission.

Although it may seem far away at the moment, this pandemic will pass. When that time comes, instead of being consumed by if and how this specific pandemic could have been prevented, we need to learn from our mistakes. We can use this lesson to move towards the day we can prevent pandemics.

Antibiotic Resistance is (Not) Futile

The evolutionary race between humans and bacteria has been raging on for millions of years but what happens when you inadvertently give the enemy a helping hand...

Written by Victoria Danquah

Anyone familiar with the popular, disturbingly accurate pandemic simulation game Plague Inc. will know that acquiring antibiotic resistance is one of the most powerful tools you can use to strengthen your pathogen and decimate the human population. But how dangerous is it in real life?

Long story short. The World Health Organisation has declared antibiotic resistance as one of the top three most important health threats of the 21st century. Furthermore, the UK government has predicted that by 2050, antibiotic resistant infections will be responsible for 10 million deaths per year, more than all cancer deaths combined.

Antibiotic resistance is the mechanism pathogens use to become resistant to many drugs normally used to treat common infections, rendering them without an effective treatment. This means that minor health nuisances such as bronchitis and ear and skin infections have the potential to develop into deadly diseases such as toxic shock syndrome, sepsis and pneumonia.

One of the most infamous antibiotic resistant bacteria, Methicillin Resistant Staphylococcus Aureus, also known as MRSA, peaked at 1,652 deaths in England and Wales in 2006, but has since been on a decreasing trend, thanks to changes in clinical practice.

There are two main methods that bacteria use to gain antibiotic resistance: Mutational resistance and Horizontal Gene Transfer.

Mutational resistance: a small population of bacteria can develop a random genetic mutation that can inhibit or evade the action of a drug. For example, in the presence of β-Lactam antibiotics such as penicillin, MRSA develops changes to the structure of its cell wall so that penicillin can no longer target it. This new drug–resistant mutation allows the bacteria to survive and multiply in the presence of antibiotics, eventually colonising the non-resistant population. The new mutation often makes the first and second lines of infection treatment ineffective.

Horizontal Gene Transfer: when foreign DNA is transferred from one pathogen to another. This can be seen as sexual reproduction for bacteria. While antibiotic resistance is a natural process, human activity has greatly exacerbated the issue.

One possible factor is the excessive use of antibiotics in farm animals. An independent report by economist Jim O' Neill, commissioned by the UK government in 2015, found the following risks:

· In the US, more than 70% of all medically important antibiotics are used on farm animals

· Drug resistant strains can be passed onto humans via animal contact

· Drug resistant strains can be passed onto humans by eating the meat of antibiotic resistant animals

· Drug resistant strains can be spread into the environment through exposure to excrement. This poses the greater risk of spreading community-based infections, since water from irrigation can cause excrement to infect rivers and drinkable water supplies.

These concerns have already begun to take shape. In 2006, the cause of a spinach E. coli outbreak in the US was traced back to crop water irrigation,

believed to have been contaminated by pig and cow manure. This outbreak resulted in three deaths.

Using antibiotics allows animals to grow fatter without increasing their food supply, so it is a very cost-effective practice in the farming industry. Farmers in developing countries may be more reliant on these methods, as a constant supply of quality animal feed is not always available.

There are currently clinical trials taking place to test novel treatments for antibiotic-resistant infections, such as antimicrobial peptides. Their mechanisms for destroying bacteria include inhibiting protein synthesis via DNA and RNA inhibition and disrupting the bacterial cell membrane by forming pores in the membrane. By selecting amino acids with certain properties, these peptides can have a higher affinity for bacterial cells than human cells, thus resulting in low toxicity in humans. This will help the positively charged antimicrobial peptides to tell the difference between the bacterial and human cells.

While there is a demand for new antibiotics, developments of such treatments are putting a huge strain on pharmaceutical companies, with development costs reaching over $1 billion and a failure rate of 95% for most potential antibiotics. One solution to filling this funding gap is the introduction of insurance premiums with fixed annual payments that will go towards helping new antibiotics become available on national health systems such as the NHS. Other ideas include a funding program that will help make new antibiotics available while helping pharmaceutical companies recoup any financial losses. Most governments have been reluctant to implement these plans in recent years due to the significant costs of such measures.

Antibiotic resistance is a complex matter both biologically and economically, which makes for a fun addition to a thrilling and nihilistic game about human extinction, but also a disaster that can be just a few genetic mutations away. Some food for thought next time you play a round of Plague Inc.

Art by Amy Zhang

Written by Aisha Farida Aminu

WASTE IN OUTER SPACE

WHO'S CLEANING AFTER THE SPACE RACE?

The space race is back. What started in 1955 as a competition between the USSR and the US has evolved into a partnership that has brought us numerous benefits, including weather forecasting, digital maps for navigation, and the internet. Now, with billionaires joining the space industry, and the frequency of space exploration increasing, we have to ask: what about all the waste that's left out there? Who's in charge of cleaning it up - and what does it mean for the future of our planet?

Humans are waste-producing beings. Entropy dictates it. However, waste isn't confined to our planet but goes wherever we go, which includes outer space. Typically, to re-enter the Earth's atmosphere astronauts reduce the weight of their capsules by discarding an abundance of supporting equipment. With only 12 trips to the moon to date, there is approximately 400,000 pounds of waste on the lunar surface with items ranging from wet-wipes to more than 70 discarded probes.

Also, according to the European Space Agency (ESA), over 50 years of space exploration and the launch of 6,600 satellites has led to an accumulation of 3,600 satellites in orbit with only 1,000 of them active. This leaves 5,600 disused floating satellites at risk of colliding with active satellites, hitting a spacecraft, or even falling back to Earth. In fact, every year, about 200,000 pounds of space waste falls back to Earth. A possible future scenario is that travelling out of the Earth's atmosphere becomes impossible without hitting floating debris, thereby limiting space exploration.

Many countries have joined the space race - China, Japan, India and the UAE included. Each country's mission aims to be grander than that of its competitors. With Mars being the center of attention and the potential for 'space tourism', the introduction of 'commercial' spacecraft into the race by private companies like Boeing, Elon Musk's SpaceX, Jeff Bezos's Blue Origin, and Richard Branson's Virgin Galactic, is making it cheaper to travel to outer space at increasing frequencies. This implies that more people will have the ability to visit outer space. Yet, remember: wherever we go, we take our waste with us. Can you imagine the amount of disposable cups, water bottles, cutlery, and other necessities that would be needed to fly civilians from Earth to outer space, only to be dumped amongst the pieces of debris already floating in outer space?

Rather than promoting debris avoidance protocols as a reaction to accumulating space waste, countries and private organisations need to invest in methods to reduce space waste. Most of the countries involved in the space race have issued debris mitigation guidelines. The US's Space Surveillance Network monitors and catalogues man-made space debris while Japan's space agency is testing equipment aimed at knocking such debris out of orbit so that it is burned in the Earth's atmosphere.

The ElectroDynamic Debris Eliminator (EDDE) created by StarInc began a trial test in 2013, to capture debris with a net and bring it back into the Earth's atmosphere and is estimated to be able to remove 36 objects per year. RemoveDEBRIS, a British satellite research project launched in 2018, has tested technologies that use nets to capture and contain floating space waste and is also testing a dragsail to slow down debris as it re-enters the Earth's atmosphere. With the vast amount of waste in low-orbit around the earth, it would take more than one EDDE and RemoveDEBRIS to clean up outer space.

Other proposals are reminiscent of science fiction. The US Airforce began exploring the idea of a laser broom in the 1990s to vapourise small pieces of space waste enough to slow it down as it re-enters the Earth's atmosphere, where it would burn up. But this would prove difficult as space waste is not stationary and the laser broom being operated from Earth runs the risk of unintentionally changing the course of the object's orbit or hitting a spacecraft instead. The ESA aims at identifying, capturing and upcycling space waste and is researching methods to create artificial shooting stars and a gigantic sun reflector through the captured waste. The ESA also plans to launch a four-armed space waste collection robot by 2025.

Cleaning up the waste in outer space remains a technological puzzle with financial and political implications. The most feasible precautionary action is to design spacecraft that do not create additional waste, and modify the behaviour of astronauts to reduce the amount of disposable items used and discarded in outer space. Who should be burdened with this responsibility? Should each nation and private company independently tackle the space waste problem, or should they put aside their competitive differences and work collectively for safer space exploration and a secured future for our planet?

Art by Elena Kayayan

Written by Altay Altug Shaw

ESCHEWED OUTCOME FOR ESKETAMINE

NICE does not recommend a new nasal antidepressant. What does this mean for patients?

For a lot of people, the thought of dealing with mental health disorders is a frightening task to contend with. It is thought that about a seventh of individuals in England, will report a common mental health problem per week. With only an estimated quarter of those with a condition receiving needed help, the drive for better support is ever present.

Esketamine was recently being touted as a new antidepressant medication. The drug acts on the NMDA receptor, an ion channel found on nerve cells. Targeting of such receptors has been the focus for treating neurodegenerative disorders such as Alzheimer's and Parkinson's. However, the issue with such targets is trying to preserve normal physiological function without targeting the negative attributes of previous conditions.

For this reason, such treatments have been risky, especially with little known about long term effects of such medications. Esketamine itself is still in its infancy in that regard. Having previously been used as a general anaesthetic, US trials have shown its positive effects for those with previously untreatable depression.

Art by Cveta Gotovats

Esketamine has had fast acting effects for individuals with treatment-resistant depression. In 2016, double-blind trials for its delivery demonstrated rapid mood improvements. This trial concluded that a dosage of 20mg/kg would be ideal to ensure treatment was successful as well as ensuring its tolerability. A further study conducted in 2018 demonstrated that the effect of the drug persisted, up to nine weeks after patients were taken off higher dosages of the drug.

In a randomised clinical trial carried out in 2019, participants who had taken esketamine with an oral antidepressant took longer to relapse into depressive patterns of behaviour, as opposed to those receiving placebo following a test period of 16 weeks. Esketamine had shown a good short term effect, previously unseen by other drugs in such trials.

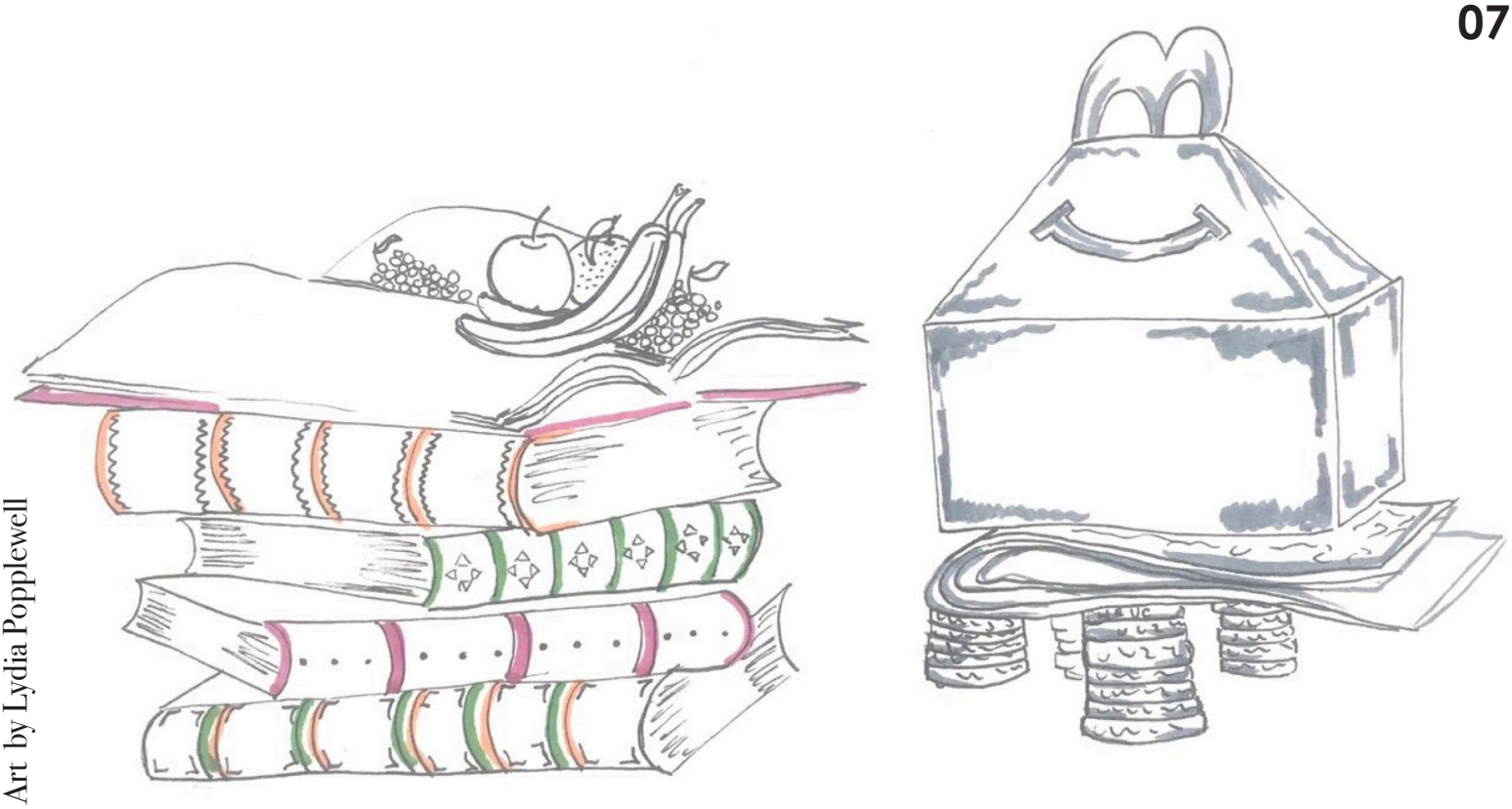
This appeared to be a turning point for the antidepressants in the USA. With an estimated 16 million individuals in the States diagnosed with depression, and the condition being the leading cause of disability worldwide, it reiterated the need for urgent action by healthcare systems to provide appropriate diagnoses and treatments.

However, little research has been carried out into the long-term effects of withdrawal or reduced dosage of the medication. Despite FDA approval coming in February 2019, it seemed like not enough research had been carried out to detect all possible side effects. Those receiving the medication in the USA have experienced symptoms of disturbed speech, uncertainty and disequilibrium. In addition to this, the FDA reported eight deaths following the use of esketamine after suicide-related patterns of behaviour started to increase, though the FDA claimed it was not related to the use of the drug, due to "lack of a consistent pattern".

On 28th January 2020, NICE made the announcement that it would not be recommending the use of esketamine with SSRIs (selective serotonin reuptake inhibitors) for public use. It cited the lack of long-term evidence of withdrawal and side effects as well as a lack of comparison to medications being used today. NICE also questioned whether it was the medication or positive life choices that were having a beneficial effect on the individual, following the initial treatment.

Due to the unknowns and the costs involved, NICE has made no statements to as whether the treatment will continue. The draft guidance that this verdict was given stated that the cost of treatment was not worth the initial use of the medication.

In the meantime, it looks set that esketamine will not be used for official treatment in this country. Thus, the long wait for new and improved antidepressants continues.



Art by Lydia Popplewell

Health Inequalities Explained

Why is there a 10-year difference in life expectancy between the rich and the poor? Is it time to prioritise equity over equality?

Written by Amalia Choupi

People of lower socioeconomic status may live up to 10 years less compared to their more affluent counterparts in the same country. Surprisingly, this pattern is observed in countries where the health system is tax-funded and healthcare is provided free of charge to everyone without discrimination. Recognising this paradoxical situation is of utmost importance if we want to reduce worldwide discrepancies in life expectancy within and between countries.

A positive correlation between socioeconomic status and health outcomes is well established, since socioeconomic status is determined by factors like income, education, housing conditions and occupation. Poor housing and working conditions expose individuals to unhygienic conditions and physical risks. Moreover, an inability to buy food can lead to undernutrition and weaken the immune system. Diet quality is also linked to socioeconomic status, as people of lower socioeconomic status often choose energy-dense foods high in refined sugars, salts and fats to maximise their caloric intake and minimise cost.

Education is also a determinant of socioeconomic status, that is critical for explaining the persistence of health inequalities in the developed world. Education is powerful in shaping attitudes and lifestyle choices. For example, learning the adverse effects of smoking on health can significantly impact one's stance towards it.

In countries with a free meritocratic education system, individuals' progression will depend on themselves and not on their wealth. However, since we are all different, we cannot all thrive in the same system. For example, if grades only depended on group work, those who work better on their own would not produce the same results with people who perform better in groups. The ones who advance academically are more likely to end up in a high socioeconomic class, resulting in a lower socioeconomic class composed of people with behaviours that promote ill-health. Maybe it is high time we focus on equity instead of equality, achieved in this case by a free education system. Designing an education system that accommodates and cultivates personal differences could allow more individuals to progress academically and adopt healthy behaviours and lifestyles.

Maybe the rigidity of the system and not differences in wealth are causing differences in health outcomes. Therefore, if developed countries do not want only the poor to suffer from diseases, those in power should shift their attention away from wealth - money is one of the reasons that leads to health inequalities - and focus on deconstructing this rigidity.

Can We Inherit Trauma?

Epigenetics allows for environmental factors to influence expression of our genes. Could this include emotional distress? Written by Zehra Beril Evcil

Emotional trauma and stress can change a person; not only can these factors contribute to serious psychological and emotional damage, but they can alter the characteristics and genome expression of the progeny.

Epigenetic studies show that the environment changes the expression of one's genome via mechanisms such as DNA methylation. Methylation is a process where regions of DNA are switched off by the addition of methyl groups, inhibiting the binding of transcription factors (proteins that enable gene expression) to the DNA. As gene expression changes, the cell itself changes. But these changes are thought to be erased when fertilization occurs due to its washing-out effects.

While some researchers still believe that inherited epigenetics are caused by methylation, some suggest that small noncoding RNAs (sncRNAs) could have a role too. These noncoding molecules complement messenger RNAs, disrupting or amplifying their activity, but do not produce proteins like other RNAs. In other words, sncRNAs affect protein production.

Isabelle Mansuy, a researcher from the University of Zurich, believes that stress influences sncRNAs. She and her team conducted experiments on sncRNA from sperm cells, which are prone to stress. The main theory behind their research was that, when the sncRNAs have an effect on mother's RNA, this could change the course of the zygote's growth. During the experiment, she mated untraumatized female mice with traumatized male mice, separating males from the mothers and offspring to prevent their behavior impacting the offspring. This was repeated for six generations. According to Mansuy, the descendants of the mice showed depressive-like behavior similar to that observed in the separated males.

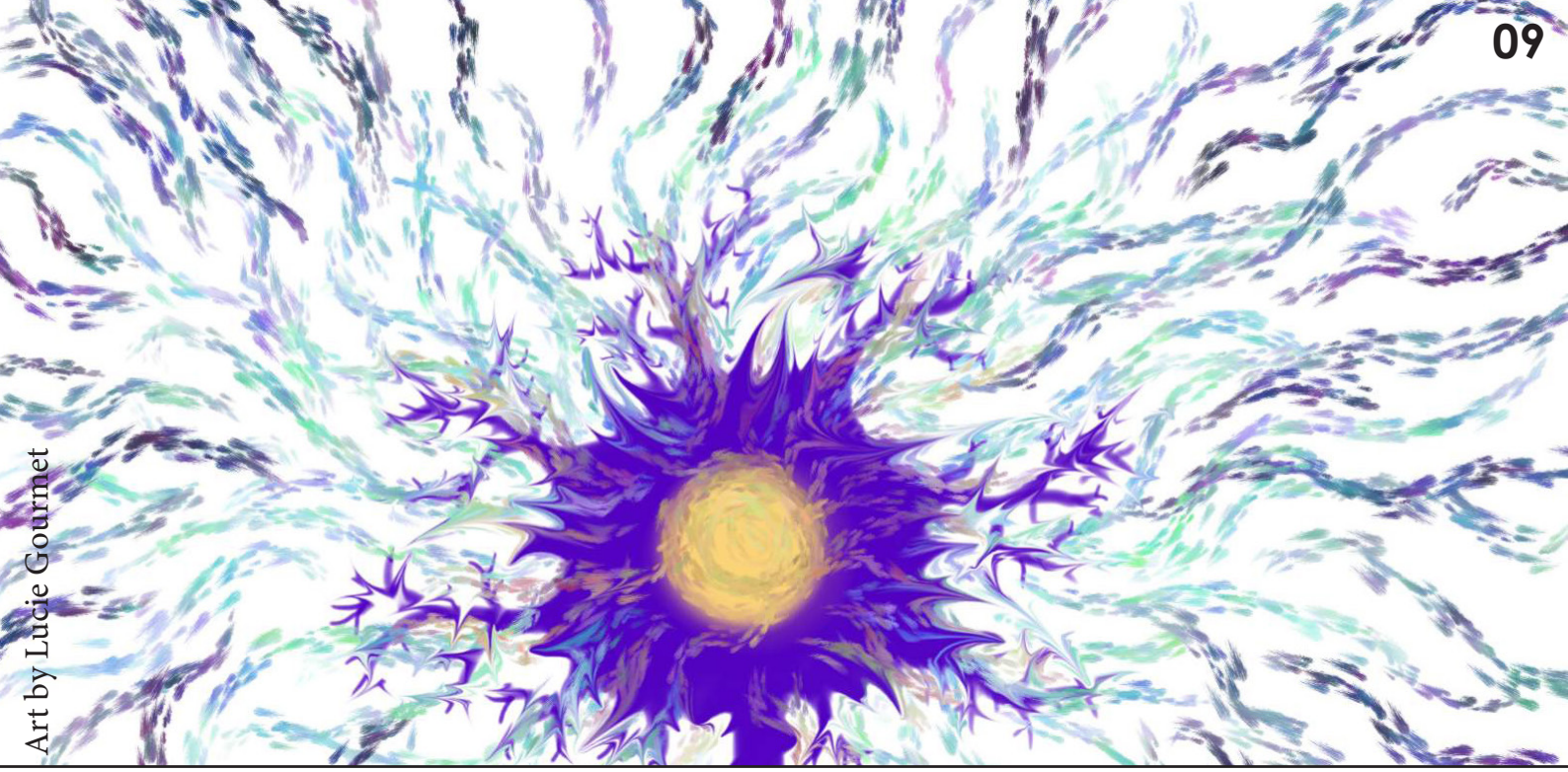
Likewise, another scientist, Tracy Bale, found biological evidence that trauma can affect sncRNAs in sperm. She also conducted an experiment with mice, stressing them with loud noises and bright light, which caused differences in sncRNAs. She injected sncRNAs from traumatised mice into embryos to see if these behavioural differences persisted. These mice displayed low levels of corticosterone (the mouse equivalent of cortisol), a hormone involved in the stress response. This showed that changes to the DNA with sncRNAs do cause a behavioral difference in progenies, specifically stress.

These experiments show that stress might be inherited in animals, but does this process occur in humans?

Some articles suggest people who experienced racial discrimination have epigenetic changes that affect factors such as schizophrenia, bipolar order, and asthma. Similarly, a study conducted in 2015 highlights that children of Holocaust survivors displayed epigenetic changes influencing cortisol levels. However, the study was criticized due to its small control group and short duration, as it should have been carried out in several generations. Furthermore, the effects might be due to parental and social relationships rather than epigenetics.

Art by Lucie Gourmet

Whilst more research needs to be done, and the current studies do not conclude that trauma and stress are inheritable, the social consequences of epigenetic inheritance could be huge. It could change how people think about how their lives are transformed by their progenitor's experience. Maybe we would even change our current lifestyles if we knew that our experiences can affect the lives of our children.



Art by Lucie Gourmet

Infectious Memory

Viral communication between neurons during memory formation

Written by Alexandra Gilbert

As viruses have done since the dawn of evolutionary time 1.5 billion years ago, they cajole the host cell's machinery into manufacturing viral proteins. The efficiency of this strategy makes for lethal, incurable illnesses, but also for essential functions in the body. On an evolutionarily ancient timescale, encounters with viruses have led to their incorporation into our genome. So much so that endogenous viral mechanisms are essential for forming and maintaining long-term memory. How is this possible?

The immediate early gene Arc, found exclusively in neurons, was recently found to have the characteristic features of a retrovirus. Most importantly, it plays an essential role in memory.

The transmission of Arc genes is bizarre and challenges traditional views of long-term memory formation and maintenance. During synaptic plasticity, neurons dynamically change the nature of their connections: their shape, their receptivity to other neurons, and their internal environment. For instance, receptors are inserted into the synaptic membrane so that the neuron becomes more sensitive to incoming signals and is more likely to fire when exposed to a new stimulus.

Interestingly, the way Arc genes regulate memory and synaptic plasticity is similarly activity-dependent. After transfection of the Arc capsid into neighbouring "host" neurons, the genes lie dormant, concentrated at the dendrite. When the neuron is activated, its genetic machinery transcribes the Arc gene into proteins that aid in the trafficking of receptors to the synaptic membrane. Once transcribed, Arc proteins maintain this newly formed synaptic strength, not only allowing for memory consolidation and reconsolidation in hippocampal neurons but also plasticity in the visual cortex. The result is that we are able to adapt to new visual stimuli.

When Arc is knocked out, mice show signs of diminished ability to adapt to new stimuli and form new memories, reiterating the integral function that this virally-derived regulatory gene serves in memory consolidation. Scientists have also examined the effects of enhanced Arc function. In the visual cortex, overexpressed Arc increases the capabilities of adult mice to learn new visual stimuli to the same level as young, developing mice.

The growing interest in Arc genes doesn't only feature advances in our understanding of memory. Scientists propose that Arc's unique trafficking mechanisms could be used in a variety of applications, such as viral vectors, which are commonly used in synaptic imaging research and in delivering gene therapy to neurons of choice. Generally, viral vectors are composed of the Rabies virus, but its use in the delivery of fluorescent labels or gene therapies can trigger immune responses. Since Arc genes are endogenous, they provide a safer alternative to traditional viruses. Additionally, reports arise describing the ability of Arc capsids to encapsulate not only their own RNA, but other genes and proteins, which opens doors to gene therapies targeting other molecular players within the synapse.

Is the virus-like Arc gene pushing the frontiers of gene therapy and treatment for cognitive impairment? The gene holds beneficial functional significance, at least preliminarily. Future research will reveal just how significant this ancient vehicle may be.

From Weed to Wonder Cure

What's the current state of medical marijuana? Written by Zoe Hill

Current social media is awash with 'miracle' cannabis-based treatments – a child experiencing uncontrollable epileptic seizures takes cannabidiol (CBD) oil and the seizure gradually subsides. Viewers are amazed, and left thinking – how? Cannabis products are rapidly increasing in availability on the UK high street. These products claim to relieve everything from anxiety to insomnia. So, why the hype? And why is a supposed miracle cure not available for prescription?

THC, CBD, and the endocannabinoid system

CBD and delta-9-tetrahydrocannabinol (THC) are the two main compounds derived from the Cannabis sativa plant. THC is psychoactive, causing the 'high' from recreational marijuana, and is more extensively researched than CBD. THC appears to alleviate symptoms of chemotherapy-induced nausea, tremors, and chronic pain. CBD is currently at the forefront of epilepsy research due to its potential as an anticonvulsant for drug-resistant epilepsy.

CBD and THC target the CB1 and CB2 receptors in the human nervous system, which have different properties of action and different distribution across the brain and peripheral nerves. Both of these receptors are indirectly involved in the regulation of neurotransmission in the brain, which produces changes that induce a psychoactive effect.

CBD and THC in use

The number of publications on medical marijuana is increasing each year, reporting positive efficacy of medical cannabis for different diseases. In its herbal form, the CBD to THC ratio is much lower and not regulated. Medical CBD currently prescribed on the NHS is typically a 20:1 CBD:THC ratio, limiting psychoactive side effects of THC. Some of the potential uses of medical marijuana are discussed below:

CBD as an anticonvulsant: Cases have reported dramatic seizure reductions as significant as 50 down to 2 a day. This reduction persists with continued CBD treatment, alongside weaning off of traditional anti-epileptics. This is particularly promising as it has been effective in drug resistant epilepsy, providing symptomatic relief from otherwise untreatable cases.

Reducing tremor: Herbal cannabis (non-prescription) is popular amongst sufferers of Parkinson's disease. Research findings show that antagonising CB receptors helps to reduce tremor. If refined, such treatment could aid mobility and prevent patients having to take large doses of L-DOPA, the current drug used for Parkinson's disease.

Chronic pain: Peripherally located CB2 receptors, when activated, could help to reduce stimulation from touch and reduce chronic pain. These effects could also occur in the central nervous system and help individuals with neuropathic pain, a disabling condition, find a new lease of life.

Medical cannabis; now and the future

In the UK, cannabis is a class B drug, the group of 'second most harmful and addictive illegal narcotics'. Despite its psychoactive effects, and concerns over the increasing strengths of the drug, a surge in cannabis research rocketed 5-10 years ago. Previously conducted trials show a positive relationship between medical cannabis and neurological symptomatic relief. However, the limitations of this research result in a lack of power to initiate legal change. Most clinical trials have small sample sizes and short follow-up periods, preventing the derivation of statistically significant conclusions. The new regulations of prescribing CBD-based treatments for drug-resistant epilepsy and chemotherapy-induced nausea are so constrictive, they limit prescription to patients that are legally entitled to the drug. Huge investment is required into research and policy before medical cannabis could become a readily accessible prescription drug.

The recognition of medical cannabis as a treatment for neurological symptoms resistant to conventional drugs has undeniably increased in recent years. The drug can significantly improve quality of life for patients, potentially outweighing any harmful effects. However, we still lack a comprehensive understanding of how cannabis alleviates symptoms, and its potential links with the development of schizophrenia and other long-term health complications are still being explored. It is important to remember that medical cannabis is not a cure, but symptomatic relief. Much more vigorous, longitudinal research is required before any significant changes in regulations are likely to take place.

Art by Vera Liu

Magic Medicine

Written by Noah Eckstein

Magic mushrooms are helping people with treatment-resistant depression.

There is an old Lakota proverb which says that when a man moves away from nature, his heart becomes hard. In today's society, it is becoming increasingly easy to avoid nature. We are consumed by a routine of technology, emails, DMs, scrolling, and alerts that constantly notify us to pay attention to our devices. Native Americans teach their children that a relationship with nature is fundamental in creating a prosperous and fulfilling life. A walk through lush fields of green grass, where large oak trees sway in the wind, is a great way to de-stress.

Take a deep breath. What's that popping out of the moss-covered ground? It's a liberty cap mushroom, filled with psilocybin, a naturally occurring psychedelic prodrug found in over 200 mushroom species. After eating handfuls of them, your vision becomes distorted in a kaleidoscope of colour and a six-hour journey commences.

Humans have been ingesting psychedelic mushrooms for generations. Some historians believe that indigenous North African cultures used magic mushrooms for ceremonial purposes as far back as 9,000 BC. In the 1950s and 60s, scientific research into psychedelic drugs (mainly coming from the United States) was abundant, with studies showing promising breakthroughs in the treatment of depression and anxiety. However, following President Nixon's introduction of the Controlled Substances Act in 1970 (as part of his administration's crackdown on drugs), psilocybin, mescaline, LSD and DMT were made illegal, halting all research progression.

Over the past ten years, scientists have started researching these substances again. The Centre for Psychedelic Research at Imperial College London is looking into how magic mushrooms in particular can aid in the treatment of depression. The results from their first trial, nicknamed Psilodep 1, were captured in the documentary "Magic Medicine" created by British filmmaker Monty Wates. UCL's Society for the Application of Psychedelics (SAP) recently held a screening of the documentary, followed by a panel discussion with psychedelic researchers.

The documentary follows three participants with treatment-resistant depression out of the 20 who took part in the overall trial. Each was given one low dose of psilocybin (10mg), followed by a larger dose (25mg) one week later.

Dr Robin Carhart-Harris, head of psychedelic research at Imperial and leader of the study, said: "We have shown for the first-time clear changes in brain activity in depressed people treated with psilocybin after failing to respond to conventional treatment."

Immediately following treatment, patients reported a decrease in depression and an improvement in quality of life. Notably, fMRI imaging showed a disruption in the participant's resting brain blood flow and functional connectivity post-treatment. These changes in brain activity were associated with reduction in depression that lasted up to five weeks post treatment.

"Magic Medicine" also gained access to the 'trips' of the participants. In a particularly memorable scene, we see a man, Andy, who is riddled by years of depression, lying still in a converted hospital bed now decorated with neutral mood lights and bouquets of flowers. Participants of the study take psilocybin in capsule form and are then advised to place a blindfold over their eyes and lie back. Two therapists are at Andy's side, helping guide him through his experience if anything too difficult surfaces or if he needs a hand to hold. In a pre-interview before his second session, Andy tells the camera that he attributes his depression to difficulty at work. Yet, during this trip, he shouts "no" over and over again, at what he perceives to be a vision of his father suffocating him as an infant. The scene is difficult to watch and his pain is unmistakable. One might think, how could such a traumatic experience be helpful for his depression?

Michelle Baker Jones, a psychedelic integration counsellor and member of the Imperial Research team, says that it is vital for a psychiatrist to help people integrate these types of experiences into their lives. In fact, the difficulties that arise during psilocybin trips are important for the person's healing process, as they are facing their deepest fears head-on instead of suppressing them further.

Dr. James Rucker, a psychiatrist involved in the study, believes more controlled trials are needed to assess whether the effects can be replicated with a greater number of participants. The Imperial team is currently working on Psilodep 2, a test on how psilocybin compares with antidepressants.

These initial findings are encouraging, a first step toward psychedelic therapy for the masses. "Magic Medicine""continued to follow the participants for six months after their second treatment. For the most part, the pangs of depression struck back and participants returned to their prescribed antidepressants. Because of the legal status of psilocybin, it is challenging to conduct studies that require re-administration of psychedelics every 5-6 weeks. Arguably, this would help patients stay away from conventional antidepressants by creating a new routine consisting of psilocybin and therapeutic integration.

As more research is conducted around psychedelics and their curative potential for mental health problems, the stigma surrounding these substances will slowly erode. Likewise, as our society becomes more technologically advanced, mushrooms could show us a path toward reintegrating nature into our routines. The future is bright.

Art by Lucie Gourmet

The Gender Bias of Depression

Why do women experience disproportionately high rates of depression compared to men?

Written by Lucy White

Just under twice as many women are affected by depression as men, and the Global Burden of Disease report by the World Health Organisation (WHO) found it to be the leading cause of disease burden in women aged 15 to 44. Despite this, treatment for men and women is much the same, and many animal studies investigating depression use only males in order to avoid complications due to the fluctuation of hormones associated with the menstrual cycle.

This gender difference in rates of depression is true globally, and no significant difference has been found in countries where women have, on average, a lower socioeconomic status than men. Social factors may play a role - for example, education, income, rates of abuse, and how 'acceptable' it is deemed for women to seek help for depression, perhaps leading to a higher rate of diagnosis in women compared to men. However, they are unlikely to account for the discrepancy on their own.

According to the WHO, 50% of mental health disorders begin by age 14 - the same age at which the difference between rates of depression (and other mood disorders, such as anxiety) between girls and boys becomes apparent. Sex-differential development of the brain may be a potential origin of this phenomenon. Several differences between male and female brains have been found in areas associated with emotion and memory.

A 2019 study took Magnetic Resonance Imaging (MRI) scans of 729 people, aged 5 to 25, to map the growth of different areas of the brain. The amygdala (part of the limbic system, involved in emotional responses) and the hippocampus (involved in learning and memory) were both found to have sexually dimorphic qualities. Amygdala growth, by volume, slowed significantly in females at around age 13, but this did not occur until the early 20s in males. Hippocampus differences were less marked, but males showed faster hippocampus growth during their late teens than females.

The amygdala and hippocampus have been implicated in many mental illnesses, including depression.

The amygdala is particularly associated with the processing of negative emotions, and, when activated, can trigger a stress response. Over-activation of this response, or under-activation of negative feedback loops designed to control the extent of this response, can lead to depressive episodes. Studies have shown that when depressed people view images of sad faces, their amygdala is more active than in healthy people. Similarly, several studies have suggested that people suffering from recurrent depression have reduced hippocampal volumes compared to unaffected individuals.

It is notable, therefore, that these two parts of the brain develop differently in men and women, especially around the time of puberty, when many mental health issues are thought to manifest.

However, the mechanism behind depression is complex, and the discrepancy in rates between men and women is unlikely due to one factor only.

Hormones may also play a role. Researchers at Michigan State University found a neurological circuit involved in the stress response that is controlled by testosterone. Testosterone has previously been shown to affect mood: men who

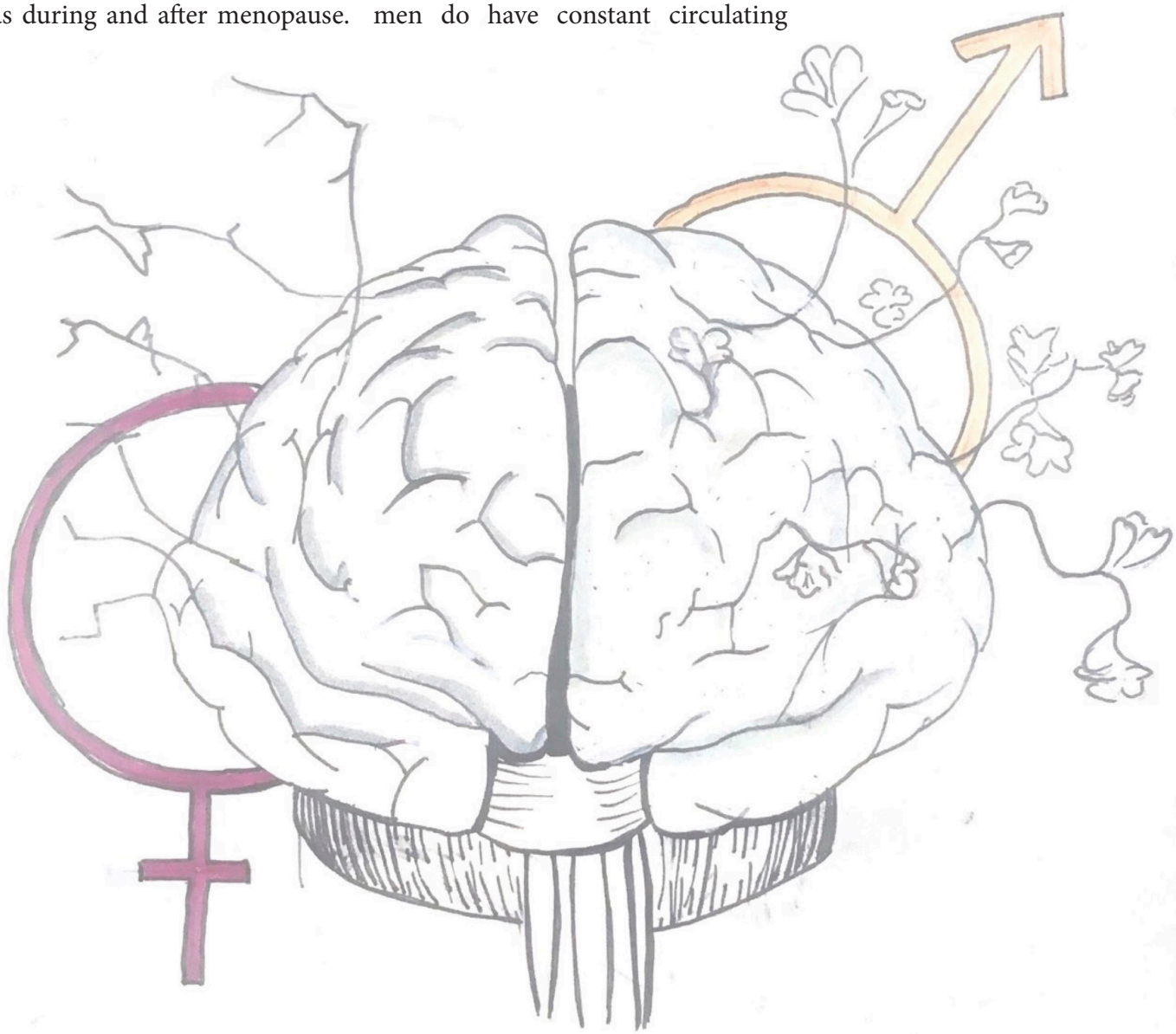
suffer from hypogonadism (low testosterone levels) have increased incidence of mood disorders, and administration of testosterone has also been shown to improve mood. In this study, using male and female mice, the circuit, which runs between the ventral hippocampus (involved in stress and emotion) and the nucleus accumbens (involved in reward), was seen to have lower activity in males than females under stress. Upon removal of testosterone, male rats showed depression-like behaviours. The opposite was true in females: when testosterone was administered, females became "resistant" to depression-like behaviours.

Women commonly suffer from depression at points in their life associated with hormonal changes, such as during puberty, after birth, as well as during and after menopause. Interestingly, rates of depression in men and women align in older age - post-menopause - suggesting that female hormones, such as oestrogen, may have an effect on depression. Some studies have indicated that artificially giving oestrogen through Hormone Replacement Therapy (HRT) in the perimenopausal period may help to prevent post-menopausal depression. Women taking the oral contraceptive pill, which contains oestrogen, also appear to have lower rates of major depressive disorder.

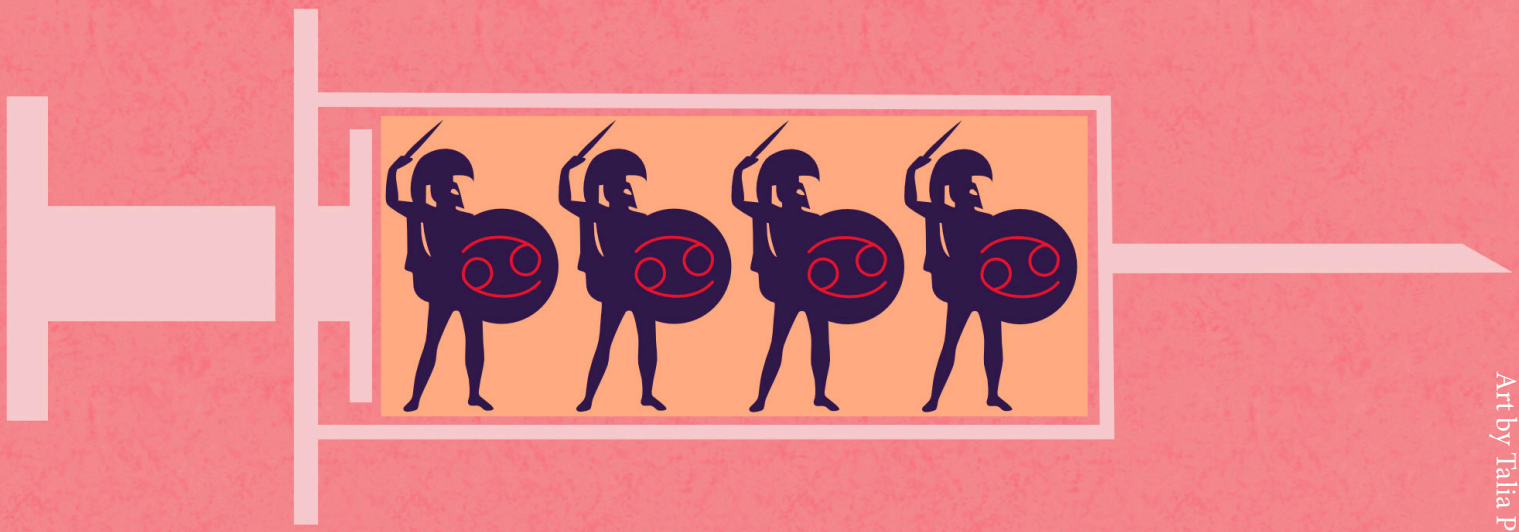
Taken together, this evidence suggests that oestrogen may be protective against depression. Why, then, is it women who experience nearly double the rate of depression that men do?

Although oestrogen is typically considered the 'female hormone', men do have constant circulating levels of oestrogen. In the male brain, testosterone is converted into oestrogen by the enzyme aromatase. By contrast, women have higher levels of oestrogen, but the concentration varies depending on menstrual cycles and their stage in life. It is thought, therefore, that while oestrogen is protective against depression, fluctuating levels of oestrogen may have the opposite effect.

All of the aforementioned factors are likely to play a role in the disparate rates of depression between men and women. However, depression is complex and not well understood, so it is likely that many more factors are at play, including societal factors and aspects of biology that are as of yet outside of our understanding.



Art by Lydia Popplewell



Art by Talia Pittman

FANTASTIC VACCINES AND HOW TO TREAT EXISTING CANCER

Written by Javier S Bautista

Causing 165,000 deaths every year in the UK, cancer represents one of the leading causes of death worldwide. In the last decade, the possibility of using vaccines to fight cancer has emerged, but how can they be effective?

Vaccines can treat existing cancer by stimulating the patient's immune system. Cells from the patient's own immune system are removed and exposed to the cancer cells or the epitope (the surface of the antigen recognised by the antibodies). There are two other variations in the design of cancer vaccines: either a donor's bone marrow is split into stem cells and T-cells which could be exposed to parts of the cancer cell and inserted into the patient, or the patient's own immune cells could be infected by an exogenous virus carrying DNA which encodes for proteins involved in detecting the epitope presented by cancer cells. These T-cells, containing the manipulated DNA, are also known as "genetically engineered T-cells" and, in addition to depleting cancer cells, they can reduce the cancer relapse in patients by taking advantage of the "memory" immune system.

Several therapeutic vaccines have already been designed. In the USA, the Food and Drug Administration (FDA) has approved numerous vaccines, including Bacillus Calmette-Guérin (BCG) to treat early-stage bladder cancer and Talimogene laherparepvec (T-VEC) to treat advanced melanoma skin cancer. However, the effect of these cancer vaccines may be reduced in patients with a weakened immune system due to age, sickness or the presence of large tumours, suggesting that vaccines might only be useful for fighting smaller tumours or early-stage cancers. In the future, the issues associated with non-efficient monotherapy may be approached by employing combinational therapy with radiotherapy or chemotherapy, which has been shown to have greater clinical benefits.

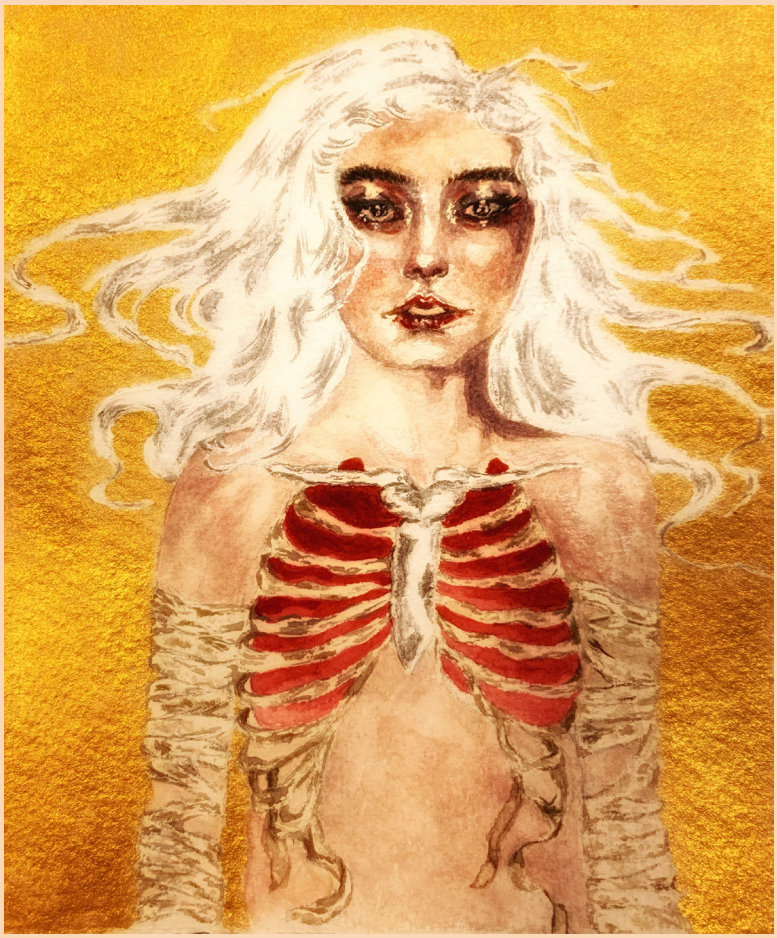
At this point, cancer vaccines may seem very appealing. However, although they have been reported to treat cancer, most of these vaccines are still in clinical trials. In the UK, patients usually gain access to this therapy through ongoing clinical trials. Additionally, there are two social factors that may affect their future prevalence. On the one hand, even with the approval of these vaccines by The Medicines and Healthcare products Regulatory Agency in the UK, high prices may deem these treatments inaccessible for a wide range of the population. Provenge, used to fight advanced prostate cancer, may cost around £50,000 per vaccine - an exorbitant price that may not necessarily be covered by the NHS. On the other hand, with the growth and evolution of the anti-vaxxer movement, some patients may be reluctant to choose this therapy. This could potentially extend to campaigns against the development of these vaccines, decreasing the funding to improve this novel therapy.

Although it may sound like science fiction to use a virus to kill all types of cancer cells, this research is happening right now. We still need to wait to see how successful this therapy could be, but hopefully, one day, we can successfully fight cancer.

IS IT NEVER TOO LATE TO STOP SMOKING?

Written by Alexandra David

HIDING FROM THE CATASTROPHE: THE PROTECTIVE LUNG CELL POPULATION THAT REPLENISHES DAMAGED CELLS IN EX-SMOKERS.



Art by Emily Wang

State-of-the-art results were recently published in Nature by Yoshida and colleagues, who analyzed a population of lung cells that line the airways across 16 people, including smokers, ex-smokers, those who never smoked, and children. The results were astonishing – the subjects with a history of smoking had a specific population of cells with a mutational damage profile as low as those expected in individuals that never smoked.

Tobacco smoke is by no means beneficial to you, or to your lungs. In fact, 72% of lung cancer deaths in the UK are caused by exposure to tobacco smoke, and smoking has such profound effects on the mutational burden of your lungs that it can add between 1,000 and 10,000 mutations per cell. In an article for the Wellcome Sanger Institute, Dr. Kate Gowers from UCL compares these damaged cells to ticking time-bombs, waiting for the next mutation to tip them into cancerous cells.

In the past, it was thought that mutations to your cells were irreversible, even after quitting smoking. However, in their research, Yoshida and colleagues point to a mitotically quiescent population of cells that are able to hide and escape the tobacco-induced mutations. When you quit smoking, these cells can magically activate and replenish the damaged cells, leading to up to four times more healthy cells in ex-smokers than in smokers. Even more astonishing is that the effects can be seen almost immediately after quitting.

These results highlight that there are significant benefits to quitting other than just inhibiting additional lung damage. The authors emphasize that it is really never too late to quit, pointing out that some subjects had smoked more than 15,000 packs of cigarettes over their life, but after a few years of stopping, a large amount of cells in their airways showed little mutational damage left from smoking tobacco. As such, our lungs seem to have a striking regenerative capacity that can reverse damage caused by smoking.

This doesn't mean that you can keep smoking indefinitely without facing serious health consequences. Heavy smokers who don't quit are still at very high risk for lung cancer, and tobacco smoke can still significantly damage deeper lung tissue, leading to chronic, irreparable diseases such as emphysema. The study serves to demonstrate that it is never too late to quit, but the sooner you do, the better.

THE TRUTH BEHIND GHB AND ITS IMPLICATIONS FOR THE LGBTQ+ COMMUNITY

Written by Sophie Maho Chan

LOOKING BEYOND THE SURFACE LEVEL OF THE NOTORIOUS DATE-RAPE AND CHEMSEX DRUG

Imagine this: You walk into a club, and in the corner, you see two girls taking a selfie together. As one of the girls posts the picture on her Instagram story, the other reaches into her bag. Isn't it a little late for lipstick? But instead, with practised ease, she pulls out a little dropper bottle filled with a translucent liquid and adds a few drops into her sprite.

What she just used is GHB - otherwise known as 'G' or liquid ecstasy. Chemically, GHB is a fatty acid derivative of GABA, an inhibitory neurotransmitter that slows brain signal transmission. While easily manufactured, GHB is also a naturally occurring chemical in the brain, binding to the same receptors involved in GABA pathways. Thus, GHB is a depressant that produces similar effects of euphoria and relaxation as alcohol, but without the less desirable side-effects of hangovers and slurred speech. For this reason, as well as its price of £1 per millilitre, it is a drug on the rise among partygoers.

But as always, there is a negative side to the story — and in the case of GHB, the consequences are life-threatening. If taken even a single millilitre above one's tolerance, it can lead to a slippery slope of unconsciousness, coma and even death. According to the Global Drug Survey in 2018, one in four women and one in six men out of 1,000 have overdosed from GHB in a year. Furthermore, if regularly consumed, addiction can develop within 2 weeks and once past the two

months line, attempts at withdrawal can lead to memory loss, epileptic seizure and insomnia.

But that is not the end. GHB has also been considered a notorious 'date rape drug' for decades, and its media coverage in such cases has made a comeback in recent years — particularly in the LGBTQ+ scene. Notorious cases include Reynhard Sinaga, often portrayed as 'Britain's most prolific rapist', who was sentenced on January 6th 2020, as well as the serial killer Stephen Port in 2016.

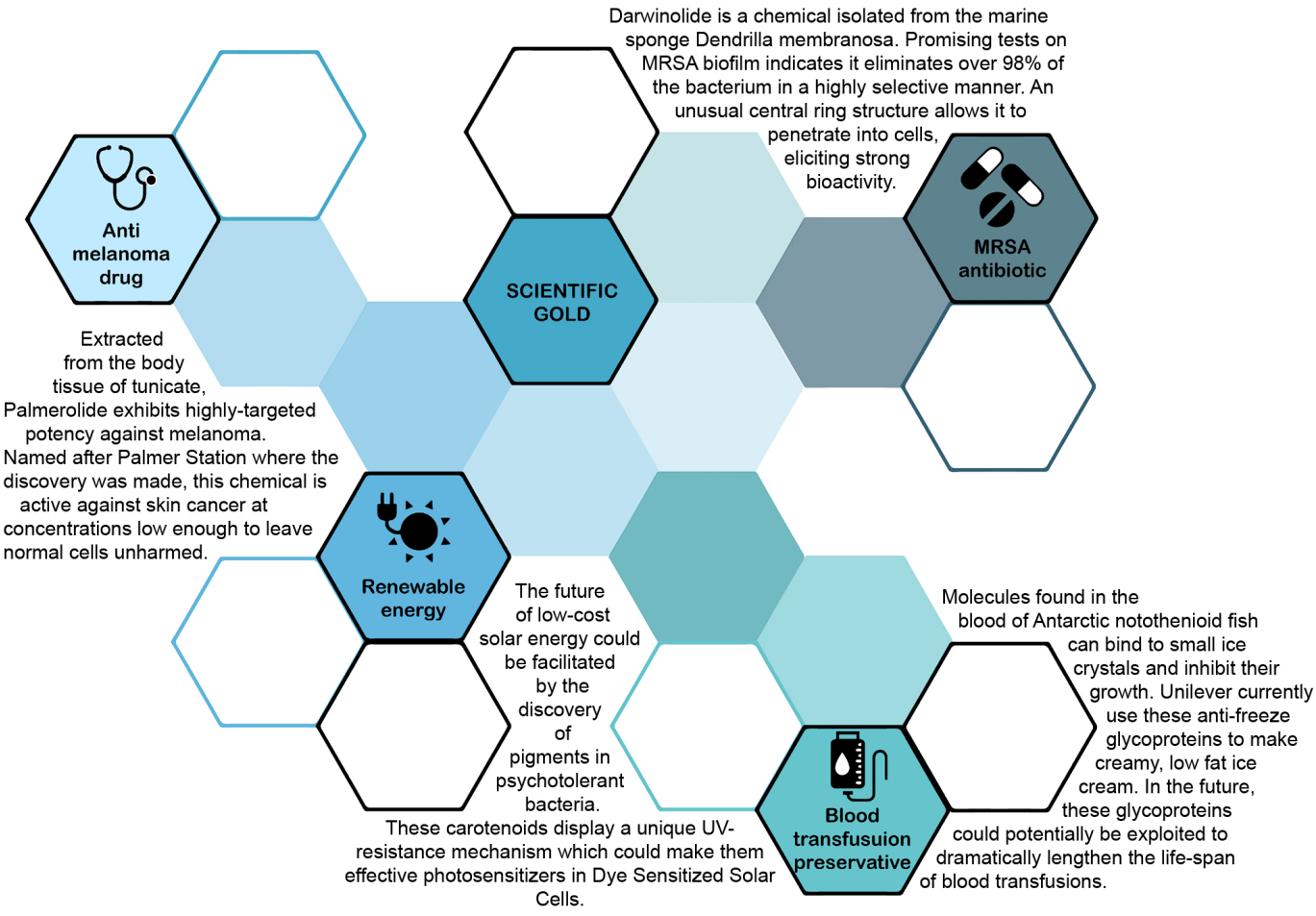
The question is, how did GHB become such a popular recreational drug? And more importantly, what does this mean for the LGBTQ+ community?

The LGBTQ+ community suffers disproportionately from GHB-related cases and deaths. London-based gay rights activist David Stuart describes how GHB-related deaths are reaching "epidemic proportions" and compares it to the AIDS crisis. He hears of GHB-related deaths at least twice or thrice a month, especially since it has replaced ecstasy as "the drug of choice" in the community. Statistics back up his claim: currently, GHB has the third-highest death toll in Europe, and according to a study by Imperial College London, GHB-related deaths are increasing every year, especially among men.

What's more terrifying is that experts suspect that these numbers are severely underreported, due to GHB's undetectability and the overall indifferent attitude of society towards GHB and the LGBTQ+ community. In fact, in the UK, GHB is only classified as a Class C drug — punishments for its possession is more lenient than those for weed. Once we broaden our perspective, one thing becomes clear: this GHB epidemic ultimately ties back to broader sociocultural processes. For example, some academics have attributed the comeback of GHB to the accessibility of cheap drugs through online shopping and the development of pills like PrEP in recent years. As HIV was for decades seen as a 'gay virus', such inventions have been linked to the rejuvenation of hook-up culture and GHB-fueled chemsex parties within the community. However, with dating apps today, it can also be argued that chemsex parties are more dangerous than ever, with those involved often having a severe lack of responsibility towards others. Finally, it is an understatement to say that the GHB crisis is largely overlooked by the general public and policymakers. Is this because society has a tendency to brush ''problems of minorities' aside?

GHB is no laughing matter, especially within the LGBTQ+ community. To tackle this issue, we must first look beyond the surface-level stigma against drugs and chemsex, and remind ourselves of the importance of empathy and responsibility towards others within our society.

Art by Iona Jenkins



FROZEN ASSETS: THE ANTARCTIC'S BOOMING BIOINDUSTRY

Why cashing in on the region's species richness is such a complicated business.

Written by Charlotte Getz

The marbling Antarctic desert imposes a glassy reflection in the expanse of white sky above. It's a scene of serenity, only disturbed by one small hut standing solitary against harsh winds. This little building shelters a six-metre deep diving hole used by scientists collecting marine samples. The warmth of the temporary base - which bears more likeness to a port-a-loo than a research facility - is actually a relative luxury for the divers. But what great impetus impels them to endure the tribulations of working in this inhospitable and lonely continent?

Whilst the pursuit of knowledge does indeed take scientists far and wide, money often proves to be an effective additional motivator. Thousands of researchers have taken up residency in the South Pole and are now on the hunt for a hidden treasure trove of biomolecules, which prove valuable for industry. This search for commericalisible compounds is termed 'bioprospecting'.

The unique extremities of the Antarctic environment gives the region a special allure to bioprospectors. With temperatures plummeting to -90°C plus high UV-radiation, only organisms that employ atypical adaptations can survive. Secreted compounds - which either defend against pathogens or kill competing organisms - are thought to hold particular industrial importance. Scientists have purified totally novel compounds from every sample, despite only having ventured into Western Antarctica. The diversity of metabolites is suspected to result from biological promiscuity amongst species, since Whole Genome Sequencing indicates high levels of horizontal gene transfer.

Bioprospecting may mark a new epoch of scientific industrialisation in the Antarctic. One success story is the isolation of proteases from local krill. Cold-adapted enzymes like these have an increased catalytic rate, meaning that lower and safer concentrations are effective in medical applications. Patenting the enzyme now gives the owners exclusive rights to the biomolecule for twenty years - in exchange for public disclosure about how to use it.

Criticism of the patent system has been intensifying since the 1800s, when the great Victorian engineer Isembard Kingdom Brunel described it as "immense evil". Pharmaceutical patents have been met with particularly strong opposition as many

Art by Aisha Aminu

drugs have become too expensive for patients. But financial incentives are necessary to drive discovery – and this need is exacerbated in Antarctica, where research is especially costly. Increasingly, scientists face a burgeoning economic pressure to fund their research. In the UK, the requirement for work to deliver "demonstrable benefits to the economy" is even embedded in the government's Research Excellence Framework.

Contention surrounding patents strikes the very core of the Antarctic Treaty's remit. Firstly, it poses a tricky question about sovereignty within the region. Fifty-three states jointly govern the continent and each have differing domestic patent laws, which significantly complicates profit sharing. Secondly, the commercial nature of bioprospecting could undermine scientific collaboration; an ethos which is enforced in legislature by the Antarctic Treaty. However, the current system requires patent documents to be published upon application and some argue that this practice allows for dissemination of information.

Perhaps the most poignant concern surrounds the environment, which many fear could be irreversibly degraded as collateral damage of escalating activity in the region. From crabs clinging onto ship hulls to rats hiding in cosy research stations – could scientific presence really pose a threat? It appears that bioprospecting itself causes minimal damage, since just a teaspoon of soil is needed for "proof of concept" during patent applications.

In fact, bioprospecting could instead offer a truly clean method of industrialising Antarctica. Currently the region has a GDP per capita of just above one dollar, compared to the UK's $36,600. Now, an emerging bioprospecting economy could yield the money needed to drive sustainability efforts.

There is universal recognition that preservation of this unique ecosystem is in both environmentalists' and biologists' interests. But to ensure it is practiced sustainably, a framework for bioprospecting must be written into the Antarctic Treaty. Recent amendments to comparable laws about the conservation of krill required several years of discussion before reaching any consensus. Evidently in Antarctica - with fifty-three countries sitting at the negotiating table - legislative change moves at a truly glacial pace.

CAN MATHEMATICAL MODELS PREDICT WHETHER YOUR RELATIONSHIPS WILL LAST?

Written by Dan Jacobson

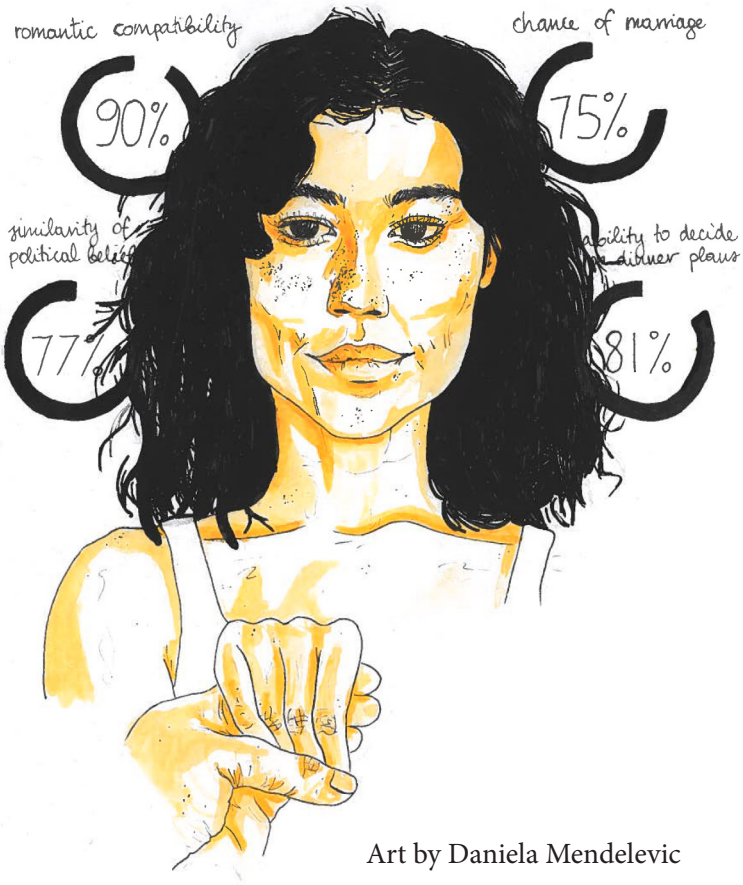
Modern relationships are governed by algorithms and big data: could we learn something from this?

Question: If you were offered the opportunity to find out who you are most compatible with, would you take it?

Answer: Yes, please save me from awkward pints and the politics of bill-splitting and let's get straight to the point.

We are in the midst of a paradigm shift in how relationships are formed and conducted, one governed by algorithms and data. As of 2018, Tinder registered 57 million users worldwide, processing 1.6 billion swipes per day, whilst dating website eHarmony, in 2016, was estimated to hold 120 terabytes of data about its users. Whilst Tinder matches individuals mainly on location, and previously a "likeability" score, eHarmony is known to use predictive models, the details of which they keep fairly close to their chest. But how close are we to developing models that could be useful in explaning and predicting compatibility based on more than a dating profile?

From my perspective, the most interesting research into individual compatibility takes a game theory approach, using knowledge of how people respond strategically in times of conflict to predict whether a relationship will succeed. Initially, this seems both counter-intuitive and pessimistic, as this might assume that a relationship's success rests solely on conflict. However, this could provide guidance for understanding how a relationship works. For example, if Person 1 is dissatisfied in a relationship, they can either confront Person 2 and potentially upset them, or move on. If confronted, Person 2 can accept blame, or reject it and potentially resulting in fighting. In this way, the risks and rewards of cooperation and conflict can influence a relationship's success.



Art by Daniela Mendelevic

The drawback of this method is that it is mainly theoretical. In 2004, building from these ideas, psychologist John Gottman, who has pioneered research into marital stability, collaborated with applied mathematicians James Murray and Kristin Swanson. They developed a model to describe how partners react during a conversation based on general mood, current mood, and their partner's influence on them. This two-equation model has been shown to predict divorce with 94% accuracy, using only a few minutes of their interactions.

The researchers found that the most telling feature in determining marital longevity was the "influence" that each individual has on their partner, measured as the threshold at which one person triggers a response from the other, especially negatively. Whilst it might be assumed that a large threshold, indicating a high ability to compromise, may be indicative of long-term romantic success, the opposite was found to be true. Couples who chose not to let issues go unmentioned tended to give room for discussion about their relationship, allowing emotions to be presented in a healthy environment, rather than remain hidden.

This article stems from my ongoing fascination in the intersection between mathematical models and relationships. But is there any real value in studying this subject? Whilst I personally do not see the value of applying mathematics to predict success within individual relationships, simply due to sheer variation, I do believe that, someday, mathematics will have the power to reveal patterns that are indicative of successful relationships across a population. My hope is that these findings could influence our behaviour, allowing us to create more meaningful connections with each other. Currently, the way we conduct ourselves in relationships is influenced by all sorts of factors, from past experiences to Jane Eyre. Why not include data?

Uncovering Human Interaction

Portable neuroimaging devices developed at UCL carry huge potential for understanding human interaction.

Written by Maria Kossowska

Techniques for functional brain mapping are critical for the diagnosis of neurological disorders and other non-invasive procedures. Yet, one of the greatest challenges embedded in these scanning techniques is for patients to remain still whilst the brain is being mapped.

Movement introduces noise into the brain scans, decreasing their ability to provide reliable data that can be interpreted effectively. This characteristic of functional brain mapping techniques has not only made it more challenging to map the brain activity of children, who struggle to remain still, but also makes it impossible to investigate the neural activity that occurs when individuals are walking or during everyday interactions outside the laboratory environment. There is a need for wearable devices that allow the tracking of millisecond by millisecond activity changes in the human brain.

Gareth Barnes's Functional Imaging Laboratory based in the Division of Bioscience at UCL, works on developing wearable magnetoencephalography devices, using optically pumped magnetometers (OPMs).

Essentially, OPMs consist of wearable sensors the size of a Lego brick that are placed over subjects' heads using personalised 3D printed scaffolding to hold the sensors in place. OPM is currently in use at UCL to investigate non-invasive language mapping in children and measuring activity from the human hippocampus during movement. OPMs could potentially aid researchers in understanding the patterns of naturally occurring human interactions, an area that is yet to be investigated. Before the invention of OPMs, there was an attempt to study neuronal activity during a conversation. The study aimed to identify brain regions involved in the turn-taking system between two participants using the functional magnetic resonance imaging (fMRI) technique. In other words, they aimed to determine what brain areas are associated with withholding one's utterance and waiting for the next possible moment to speak, as to not overlap with the other speaker.

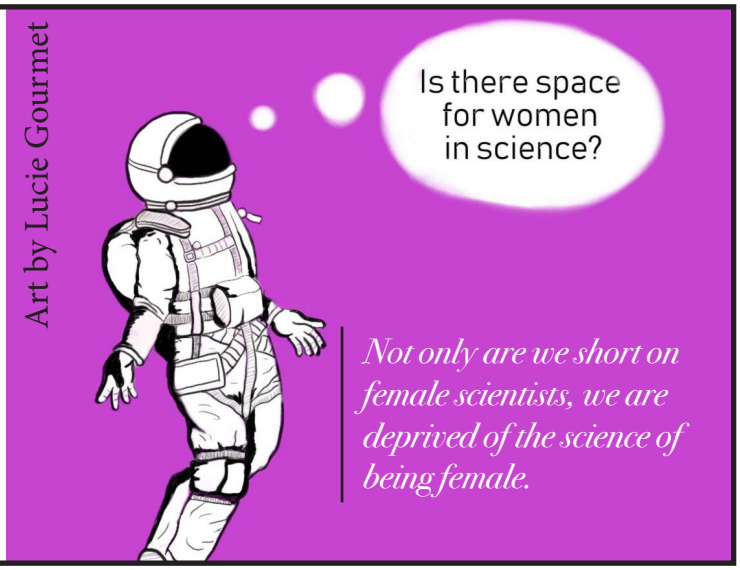
However, using fMRI to study turn-taking phenomena has been criticised by sociologists, who have highlighted that the central feature of human interaction is its natural occurrence. Studying the human brains of two people having a conversation using microphones and headphones, whilst enclosed in two different giant magnets that make spooky and loud noises, based in two different giant magnets that make spooky and loud noises, based in two different cities, is far from a naturally occurring interaction. Yet, this study could make a big contribution to our understanding of human interaction. OPMs would allow the speakers to conduct interaction in an unconstrained environment.

The demand for wearable brain imaging devices is required to investigate and treat the human brain. OPMs seem to be the solution for the mentioned problems encountered in research. More interestingly, they could also shed light on questions of human interaction.

Art by Maddie Throssell

Androcentric Bias in Science; Does Woman Know Thyself?

Written by Ellie Jackson



As a scientist, one of the things that is favoured most is objective results; this is how we make sense of the world around us. However, from philosophers in ancient Greece through to the clinical trials of today, about half of the human population has been overlooked. Yes, I'm talking about the ladies.

Androcentric bias refers to a preference for men or masculine interests, and is still a prevalent problem in 21st century research. As a species, we are obsessed with how men and women differ, with over 30,000 scientific articles published on sex differences between 2000 and 2015. So how come over 70% of patients in studies of heart diseases are male? Why did the US have to pass a bill in 1993 mandating that women must not be excluded from clinical research?

This is unsurprising when we look at the stark truth of gender bias in science. The Nobel Prize is the highest accolade for scientific research, but in the 118 year history of the award, only 21 women have become laureates in Physics, Chemistry and Physiology or Medicine combined, compared to 586 men. These small numbers serve to highlight a much larger issue: how can science ever be fully objective without sufficient female representation?

The extent of this bias reaches one of the most famous scientific developments in history: evolution. Even the greatly hailed work of Charles Darwin had gender bias. He argued that women were less evolved than men by means of natural selection; males had to prove intelligence and strength to mate with a female partner, whereas females simply had to provide sexual attraction.

Other scientists at the time postulated that as men traditionally were hunter-gatherers while women reared children and maintained the home, males were exposed to greater evolutionary pressure and thus had evolved more than females. Science was being used to reinforce women's place at a lower social standing. Some of Darwin's contemporaries used phrenology (the study of skull shape and size) to justify women's inferiority.

We are well aware that there are physiological differences between males and females - we possess different sex chromosomes, gonads and hormone profiles - but are our brains really that different?

The truth is, in all studies of brain sex differences, there are such vast differences within male and female groups that there is no significant difference. Yet researchers still hunt down these differences and have become obsessed with quantifying the male and female as two separate entities.

Such obsessions are dangerous. Women have been blatantly excluded from many clinical trials and scientific studies on the basis of avoiding data anomalies. This has affected women in many ways, from female astronauts being pulled from space flights because space suits were designed to fit male bodies, to women being more likely to be injured on police raids as stab vests are not designed for breasts.

Arguably, the most severe problems are in healthcare and drug development. Yentl syndrome describes the female-specific manifestation of heart failure, the second largest killer of women under 35. As women present with different symptoms to the standardised male subject, they are more likely to be turned away from the emergency room or to be treated incorrectly. Even though there are now rules in place for how sex differences in clinical trials are adressed, 70% of heart trial patients are still male. Not only does androcentric bias skew our perspective of women, it is actively putting women at risk.

It is important that we are aware of the history of gender bias in science, and use it to conduct better, more impartial research. It is about time we update our ideas about the importance of the female in scientific study.

Written by Simi Ayeni-Yegbe

SCRAPPING THE SCHIZOPHRENIA STIGMA

THE RIDDLE: KNOWN BY MANY BUT UNDERSTOOD BY FEW.
THE ANSWER: SCHIZOPHRENIA.

HOW CAN THE COMMON SCHIZOPHRENIA MISCONCEPTIONS BE OVERCOME?

Schizophrenia is a commonly misunderstood disorder that affects 20 million people worldwide.Although the cause of schizophrenia is unknown, evidence suggests that a person is more likely to develop schizophrenia due to a combination of environmental, genetic, physical and psychological factors. People with schizophrenia may experience delusions. For example, some strongly believe that a person on TV is talking to them personally; some experience hallucinations, which often includes hearing critical or abusive voices. Withdrawal from social contact is also common.

There are many misconceptions associated with schizophrenia, some of which are due to the way schizophrenia sufferers are portrayed in the media. These myths have a negative impact on their relationships and jobs. Sadly, humans sometimes fear things that they don't understand. As a result, some individuals with schizophrenia have experienced friends suddenly drawing away after they've been diagnosed. In a 'Time to Change' blog, Sarah, who has now recovered from schizophrenia, recalls: "I felt so crushed and deflated… when a lifetime friend judged me and broke ties with me because I'd been hospitalized with psychosis."

Unfortunately, the discrimination faced by people with schizophrenia can even lead to death. Those with schizophrenia have a 5.6% risk of suicide. Let's consider some common misconceptions and address why they're untrue.

"Schizophrenia results in a split personality." Although the word schizophrenia is derived from the Greek words schizein ("splitting") and phren ("mind"), individuals with schizophrenia don't have a split personality. Schizophrenia may cause a person's behaviour to become more unpredictable, but they don't become a completely different person. Schizophrenia is often confused with dissociative identity disorder, in which people feel the existence of other identities within themselves.

"People with schizophrenia have sudden mood swings." Schizophrenia can be triggered by stressful situations, so may appear to develop suddenly, but the symptoms actually develop gradually in most people. However, initial symptoms may not appear to be schizophrenia-related, such as social isolation.

"People with schizophrenia are violent." Films and programmes sometimes portray the 'crazy serial killer' as a character with schizophrenia. Unfortunately, media reports are also to blame, as when violent acts are committed by people with schizophrenia, their mental illness is often emphasised. As a result, many come to the false conclusion that schizophrenia leads to violent acts. However, this is far from the truth. In fact, a person with a mental health illness is less likely to carry out a violent act than to have one committed against them.

Art by Louisa Norton

What can be done to tackle the stigma? Although our society has made a lot of progress in overcoming the misconceptions around mental illness, more positive words and actions are needed to completely overcome the stigma. We should view mental illness with the same seriousness as a physical illness. Some people with mental illnesses don't talk about their symptoms because of the discrimination they may face, refraining from getting treatment. Needless to say, this only worsens the situation.

So, next time you hear someone making a rude remark about mental illness, don't be afraid to readjust their thinking. Who knows who will overhear your conversation and appreciate your concern? Who knows if that one conversation will bring us a step closer to scrapping the schizophrenia stigma?

An Interview with Professor Michael Duchen

Written by Kellerine Quah

Professor Michael Duchen is a Professor of Physiology in the Department of Cell and Developmental Biology at UCL. His current research interests cover a wide range of issues in mitochondrial biology and cellular signalling.

Professor Michael Duchen, a Professor of Physiology in the Department of Cell and Developmental Biology at UCL, shares his experiences of a life and career in science

Tracing back his interests in experimental biology, Prof. Duchen recalled his childhood memories of visiting his father's laboratory, where the laboratory technician would show him the workings of histological sections and staining on the microscope whilst awaiting the arrival of surgical specimens. Later, he studied Medicine at the University of Oxford and at St George's Medical School, University of London. Prior to specialisation, he worked in neurology for six months as part of clinical rotations, during which he was inspired to return to experimental research.

He recounted: "Neurology was fascinating but deeply frustrating because we saw patient after patient, with dreadful, debilitating diseases, for whom we could do nothing. And for all of these patients, we could make a diagnosis, and then there was no effective treatment… It seemed obvious that the only way we're going to advance is to understand basic science better. At the time, I had the option to go back to clinical medicine if I wanted to. But by the time I'd been [at UCL] for about a year, I didn't really think about it anymore – I was enjoying the basic science too much. I found it fascinating and it's gone on being fascinating ever since."

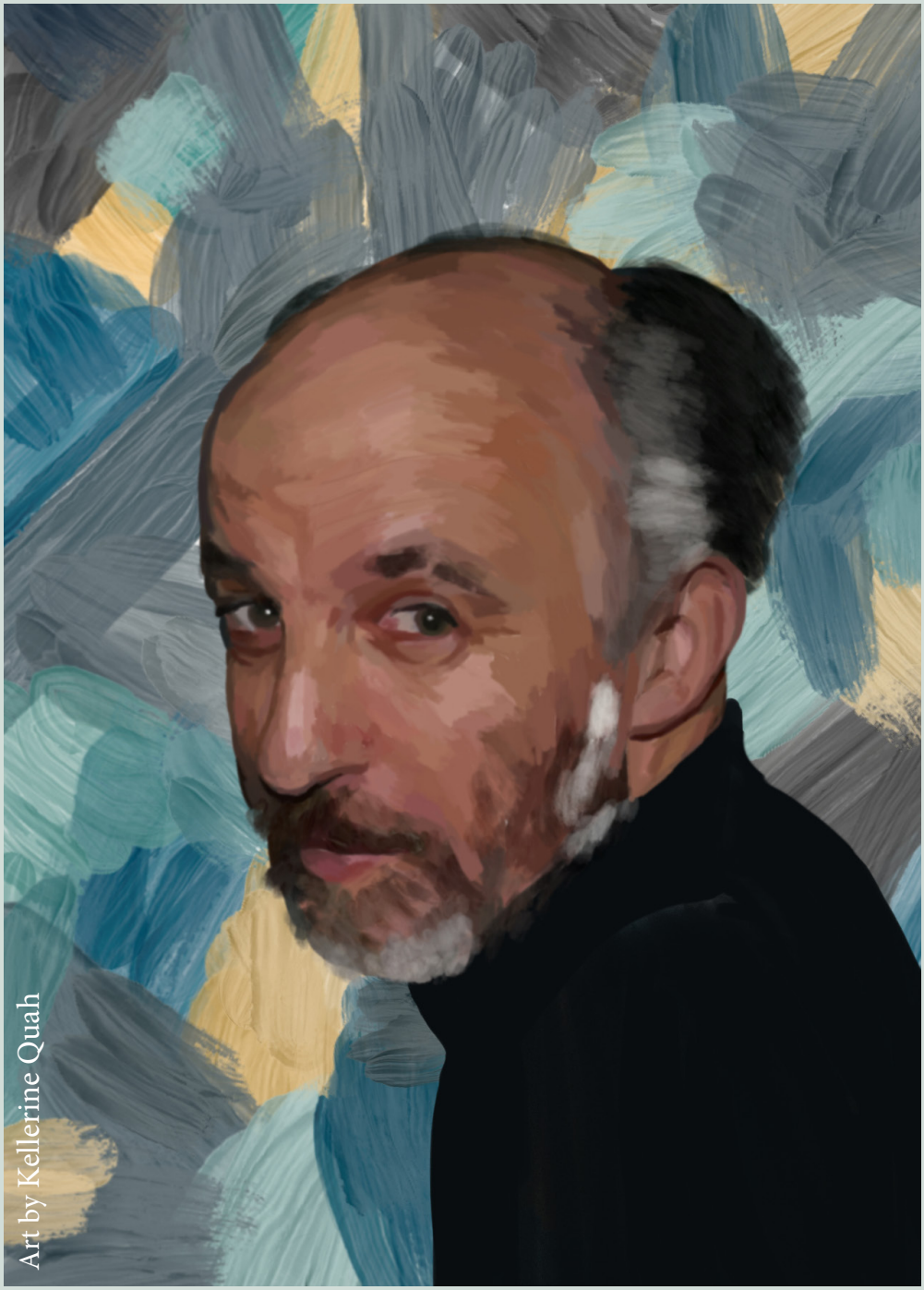
mi·to·chon·dri·on
noun
organelles reponsible for most of a cell's supply of adenosine triposhphate (ATP), a form of chemical energy

Prof. Duchen described his career as atypical; while students are encouraged to gather various experiences from different laboratories to learn from different experts and to demonstrate research independence, Prof. Duchen has remained at UCL since his PhD, over thirty years ago. While he acknowledged that his career path is not one that is generally recommended, he shared that family commitments and research opportunities led him to remain in the same laboratory.

"I can't think of any major hurdles I've had to jump... I've been lucky. I think scientific careers now have changed, so it is more competitive and more difficult. I always worry about students who seem to be doing things because they ought to... I think the guiding principle is, if you have a [scientific] problem that's really, really interesting - and you think it's important - it's likely to develop well, and you're likely to go far."

Entering the field of mitochondrial biology was mostly by chance, he recalls. In the late 1980s, attempting to understand mitochondrial contributions to cell physiology was uncharted territory. At the time, he studied mitochondria out of curiosity. Over the decades, he has witnessed the growth of mitochondrial biology in recognition and relevance.

"It's been a very exciting journey. I've watched the field in my lifetime go



Art by Kellerine Quah

We would like to thank Professor Duchen for his generosity in giving his time and in sharing his life experiences with us.

from being really embryonic to a field that I think now, is mature enough, that we can start seriously thinking about mitochondria as potential therapeutic targets in human disease… And I rather like the sense of having almost squared the circle, so going back to where I started – the frustrations in neurology, and now thinking that there are some potential outcomes of all this work over thirty years that might feed back into clinical medicine and lead to new therapeutic strategies in otherwise intractable diseases. I think if we can channel back what we've learnt into clinical medicine, that would be wonderful. I'd love to see that."

As a graduate tutor, an editor of several journals, and a father of four children, Prof. Duchen certainly did not dismiss the difficulties of time management. His advice is to systematically work through each task. He emphasised that it was important to establish one's priorities – in his case, not being an over-perfectionist, whilst not compromising quality.

"For me, one of the most important aspects of our work is an absolute confidence in the quality and integrity of our experimental work. I am not interested in a quick opportunity to add another paper to our publications list without being sure that the work is done as well as it can be."

Still, he felt that not placing one's self-worth solely on scientific output was important. "It becomes increasingly hard to admit that one might have been wrong," he shared. "Having a range of interests and not being totally dependent on my scientific work for a sense of self-esteem is extremely important to me."

From cooking to music, gardening, and birdwatching, Prof. Duchen shared that these interests were important in keeping the mind lively and active. Yet, the most important thing to him in life?

"My children," he candidly shared without hesitation, "they matter more to me than anything else."

Science Isn't Objective, But That's Okay

Written by Jacqueline Hsing

Scientific Objectivity. These two words express the idea that science, or rather good science, is impartial and free from values, biases, and interests. The perceived objectiveness of science is why we use it to argue truth and establish authority when it comes to debates, ranging from climate change to the efficacy of medical drugs.

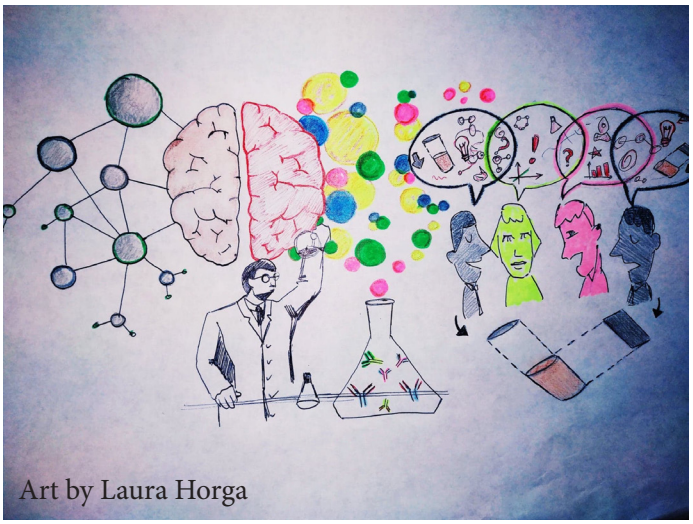
But how attainable is objectivity in science, really? Harry Collins and Trevor Pinch argue in their book The Golem: What Everyone Should Know about Science that science is not the straightforward result of experimentation and observation. Instead, they argue that science comes from the interpretation of ambiguous results and that "in science, facts do not speak for themselves, at least not exactly". This is because experimental results, and their acceptance, are "co-determined by the facts as well as social and psychological factors". Scientific activity is a cultural pursuit that is transformed, interpreted, and utilised by people in a specific way. There is no normative framework to rationality - our justification is based on knowledge relative to our specific culture or society.

It's more than just experimentation and observation - social negotiation is involved in the production of scientific knowledge, too.

That isn't to say that the integration of values in science is bad - science ultimately relies on epistemic values. This is how we choose which theories are valid and which are not. Take gravitational waves, for instance. How do we know that they exist? To know that our experimental results are valid, we must break what Harry Collins calls the "experimenter's regress": the loop of dependence between theory and evidence. The experimenter's regress goes like this: when an experiment is executed for the first time, the result is always uncertain. Scientists either have to know the right answers in order to know that their experimental results are valid, or explicitly know that the experiment is working in order to get the right answers.

So, we cannot truly be sure that the gravitational wave detector is correctly measuring gravitational waves, unless we already know that they exist. We might say that replication of the same experiment might reinforce valid claims, but why do those count as "good" experiments? What about the other experiments that failed to detect gravitational waves? After all, N-rays, a hypothetical form of radiation, were confirmed by separate scientists before being declared illusionary. Since there is no cognitive or objective criteria to determine whether a claim is valid, the only way to break the experimenter's regress is through the social negotiation that occurs between scientists.

It is important to examine this social negotiation in order to acknowledge that science is more complicated than a linear transition from evidence collection to rational theory. Science is used to legitimize a perceived truth as much as it is used to illuminate. So, if we just believe that science is objective and truth revealing, we leave no room to debate the values which have played an integral part in the creation of scientific evidence and fall into the trap of debating the science itself.



Art by Laura Horga

Therefore, in order for science to keep its epistemic integrity, the myth of scientific objectivity must be deconstructed. By actively recognising the values ingrained in the production of scientific knowledge, we can promote science that is transparent and trustworthy. Ultimately, the interplay of values in science isn't inherently bad. Just when we mistake science as value-free do we make the mistake of creating an elitist and unrealistic view of science.

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