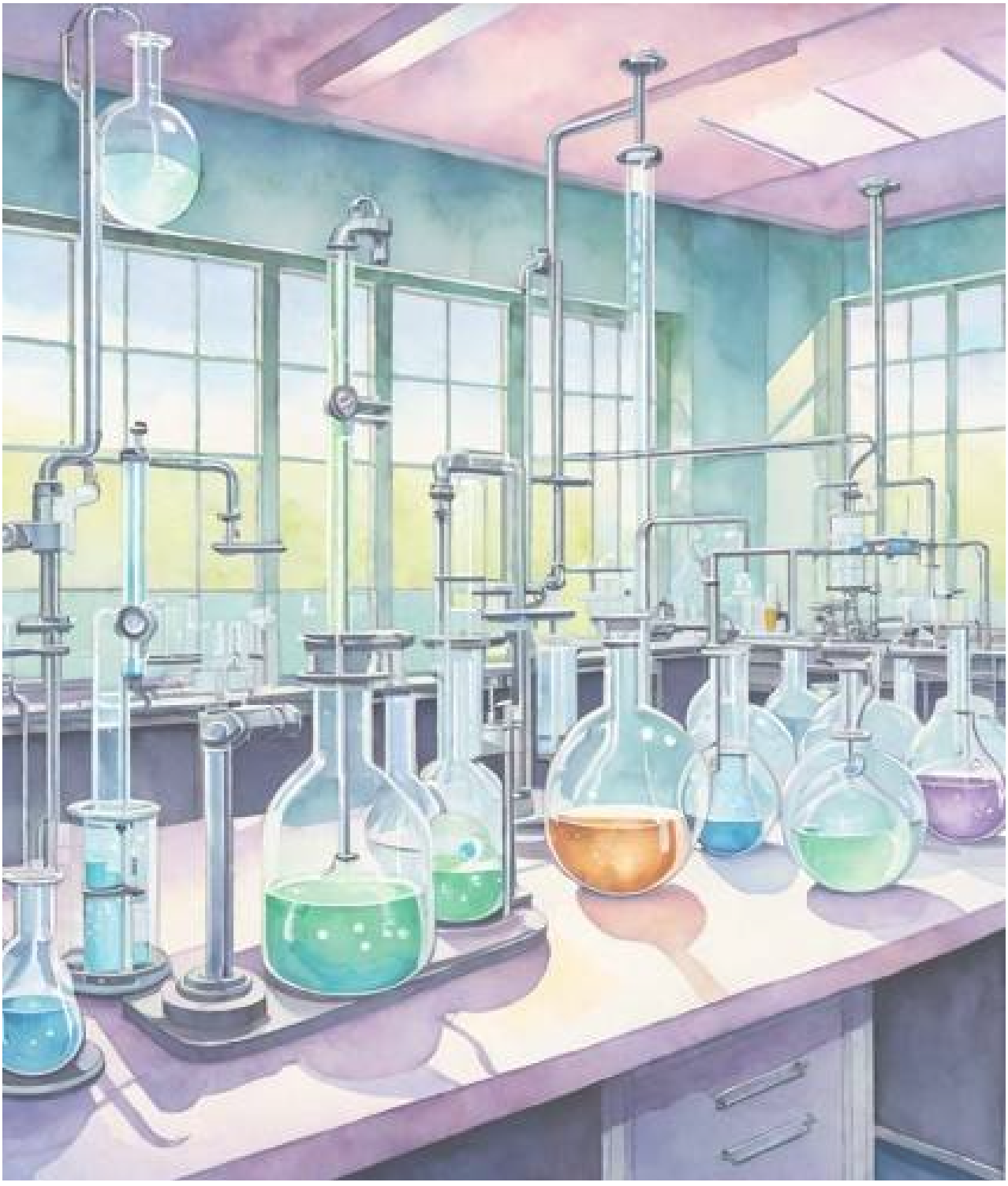
ISLAND SCHOOL 2024



SCIENCE JOURNAL

MIDDLE PHASE

INTRODUCTION

Dear Readers,

It is with great pleasure that we finally present to you the Science Journal 2024. Through the intensive efforts of both our writers and their assigned editors, we hope to provide you with an engaging and informative reading experience, regardless of your background in science. Each submission is a testament to the unique passions that exist at Island School, united only by the singular attribute of pure scientific curiosity and exploration.

The articles curated this year have been some of the most varied in the publication's history. From physiological and mental disorders, to the applications of chemical and physical ideas in the real world, to explainers about everyday phenomena, we as the Editorial team are confident that there is something for everyone, whether you consider yourself a science geek or a casual reader.

Each year's edition continues to improve upon its predecessor. We didn't think it was possible to surpass the number of pitches in recent years, but once again, Islanders have showcased their signature enthusiasm and drive to make this endeavour possible. We hope that we as the Editorial team have done justice to your wonderful works, helping to disseminate scientific knowledge and curiosity across the student body.

Finally, there is a great amount of gratitude to be given out. Firstly, thank you to every editor who has diligently been with their assigned writer through the whole publication process. It is your efforts that elevate the quality of the journal and make it worthy of publication. Secondly, thank you to all the writers. It is no exaggeration to say that this would not have been possible without the boundless creativity that you embody. Thirdly, thank you to Mr Bayne for his unwavering support throughout the process. Finally, thank you to the readers who continue to oil the machine of the Island School Science Journal. We hope that the Science Journal 2024 will inspire you to stay curious, pursue the sciences, and perhaps even write an article yourself next year!

Happy Reading!
The Science Journal 2024 Editorial Team

Thank you Mr. Cawson for lending his lab for us to take a photo :D

EDITORIAL TEAM

Top Row: Alex Hwang, Eric So, Shubhan Tilve, Peter Yoon, Isabelle Woo, Andy Chan, Dorottya Papp, Aileen Yang, Maddie Tsai, Chianne Chung

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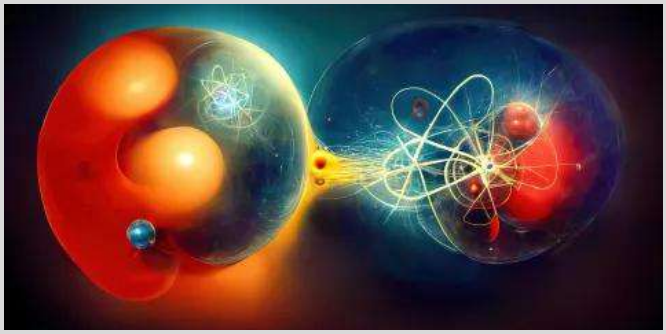
STANDARD MODEL- PARTICLES AND STATIC ELECTRICITY

Jayden Han 7NM



Subatomic Particles include molecules for example electrons, neutrons, and protons. The electrons give off negative energy on objects and when you touch it, it could give a shock. Quarks are another example, they include all of the physics topics. One last example is the positron, which has the counter objective of the electron.

Quarks are elementary particles and colourful, formed matter. They are among the smallest known particles in the universe. Quarks are known as fermions, which means they have half-integer spin. They are also known to have a powerful nuclear force, one of the four root or main forces in the world. Electrons are practically smaller than quarks because quarks still don't have an estimated size.

Standard Model is a tree of many topics about physics that talk about how the particle can exist without being destroyed. It talks about atomic and subatomic particles for example the quark is a subatomic particle that includes the four essential topics of physics. There are more particles, for example, an electron, which leads us to our topic, static electricity.

Static electricity is a spark made of electrons, neutrons, and protons. It has 2 main variables which are negative and a positive charge of static electricity. A negative charge means to conduct too many electrons or too few protons. The meaning of a positive charge is a charge that casts too few electrons or too many protons.

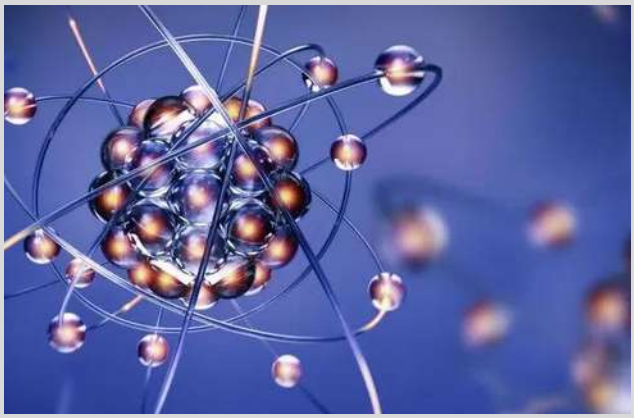
The concepts of protons, neutrons, and electrons are easy to understand. Neutrons mean they are neutral - they are molecules of no charge. Protons are positive charges, and electrons are negative charges. Lastly, Quarks are the only discovered particle that collaborates with all four physics concepts.

Static electricity is mainly made by friction, making contact with two surfaces together while putting some pressure will make static electricity forms in between. The smoothness, roughness, pressure, speed, and other properties all matter in this topic depending on how big of a charge you want to make.

During your childhood, when you went down a slide, did you ever feel a sudden shock? Static

electricity is the reason why! The friction between your finger and the slide conducts the static electricity and it travels around your body. It's trying to find lower ground, and when you step down the slide, it shocks you. The concept of static electricity could bring a bunch of nostalgia back from your childhood!

Many metals, for example, copper, give off a miniature bit of negative charge, which allows it to have magnetism and magnetise positively charged objects. It doesn't matter if it is already a magnet or not. And this is how magnets are attracted to all sides of a metal.



Initiating from 600 BC or 600 BCE, Greece unravelled the fact that amber could magnetise lightweight objects (e.g. Feather). Greece was the first place to unearth the mysteries of static electricity and magnetism.

If you rub a certain material against another, it can flow the electrons to one another. This is fascinating because sometimes the attraction becomes so immense that it can travel through thin air, glass, and many more.

The travelling of static electricity doesn't just mean skimming to another surface, it can discharge. Some discharges are so full of negative energy (electrons) that they send a powerful shock that can hurt you.
You've heard of lightning, and that is a natural phenomenon that uses static electricity. The electrons build up in the clouds then when they build enough power, the electrons form a streak straight down to Earth, seeking the ground.

The way that static electricity forms in clouds is a surprising thing. The water particles (Named hydrometers) stored inside the clouds put into action and start to collide with each other.

The triboelectric method is a way that clouds make flashes of lightning. This occurs when the two colliding materials in the cloud exchange their electrons creating an imbalance in charges. This doesn't just work in clouds, it can work anywhere with the right equipment.

The things that occur in the cloud are: that the ice crystals and the water droplets interact and impact on each other, creating a swap of energy. After that, the friction between the molecules creates an electrical imbalance between the two things which creates static electricity. It results in some things having a positive charge and some negative charge.

The cloud creates an electric field that can make interactions and separations of the charges made by the ice crystals and water droplets. As the process repeats, the amount accumulates and creates a huge charge of electrons that are seeking ground. When the water molecules are

et out, the electrons take their chance and streak down to Earth.

Static electricity is a fascinating topic talking about the importance of electrons, the imbalance of the energy and what it can create, and of course, friction. It is surprising that if the world didn't have the attributes that the tree of static electricity has, then we wouldn't be in this world, and even if we were alive, everywhere would be as slippery as ice. I have learned to appreciate what the world has given to us and why we should be grateful for it.

Friction is a huge topic that helps static electricity generate the electrons needed for an electric charge and it's also used (when large amounts of attractive force) to help static electricity travel through a variety of surprising things!

Many people disregard the fact that friction helps us with many things from walking to even holding on to something. If friction didn't exist, we probably wouldn't too because most things can't be done without it. Before my time in secondary school, I was an ordinary person who didn't know that friction helped us in the world, but after research, I became aware of the variety of things friction helps us with.

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THE FERMI'S PARADOX

Marco Ishak 8FV

INTRODUCTION

In summer of 1950, Italian American Physicist Enrico Fermi, with fellow physicists Edward Teller, Emil Konopinski, and Herbert York was walking to lunch while discussing recent UFO sightings and the possibility of travelling faster than the speed of light, the conversation switched to other topics, until Fermi said, “But where is everybody?”.

Fermi's paradox is a question that states if there are so many galaxies, with so many stars, with so many planets, with some of them being habitable, if just a small percentage where to harbour life, become conscious, to evolve into a complex species that could potentially fly into space and be able to colonise other planets, why haven't we noticed yet?

Many theories attempt to explain the fermi paradox, some of which are reasonable, some of which extend the realm of possibility, and some which challenges the thought process of the human brain, some of which being:

FILTERS

Most people suggest that there are “filters” that are stopping life from becoming too complex, this could either be exciting or horrifying news, depending on how you view it. You could either think that we humans are ahead of the filters, after all the universe may have been way more hostile than we thought or developing life that might be more complicated than we think. Or you could think that the filters are ahead of us, and we would either be wiped out, or we are in for a rough time.

Fig 1: a visual repersentation of the Kardashev scale

AGGRESSIVE NEIGHBOURS

There is a scale of civilization's technological capabilities called the Kardashev scale in which there are 3 official types, type 1 civilizations can harness the energy of their home planet, we are around type 0.73 and expect to reach type 1 in a few hundred years. Type 2 civilizations are civilizations that control the energy of their home star, this would require concepts like the dyson sphere, a megastructure capable

of capturing the energy from a star. And finally, type 3 civilisations have the capabilities to control the energy of a galaxy. Type 3 civilizations might seem like an impossible task, but if we can make ships that can hold a hundred people for 70 years, we could potentially take over the galaxy in a few thousand decades.

There is an argument that there is already a type 3 civilization, roaming the galaxy and destroying every species that may become too powerful, however, this is an unreasonable suspicion. The Milky Way is big, it is around 100,000 light-years across, that means that if aliens were halfway across the Milky Way they would only see a bunch of apes discovering how to use primitive technology. Besides, even if they were close to us like Alpha Centauri, we probably would have noticed by now

QUIET NEIGHBOURS

Maybe aliens don't want to be known, after all why would they want to announce to the entire universe that they exist. It could be better to stay silent than to risk any unwanted danger that may come from outer space. This is assuming, of course, that aliens have the same thinking processes of a human being, it is uncertain that aliens think in the same way we do and their logic and understanding of the universe might be entirely different to what us humans may think.

NEIGHBOURS THAT DON'T CARE

We have been sending out signals to outer space for only 50 years, and there is a huge possibility that any aliens that might be out there will never hear our messages. Even if they did, there is a huge likelihood that our messaging technology is too primitive to be heard. It might be like trying to communicate with a modern human using neanderthal noises. Or perhaps aliens are too busy doing other things to hear our messages, like interstellar wars crossing several star systems, or maybe they are enjoying themselves in a virtual world.

HIBERNATING NEIGHBOURS

Also known as the aestivation hypothesis, it suggests that aliens might be waiting in hibernation for millions or quite possibly billions of years for the universe to cool down enough to make computing more efficient, or they might be taking advantage of star movements to shorten distances, so travelling becomes easier and more resourceful, They may also be waiting for a danger to pass like global warming or a lack of energy to be able to function.

NO NEIGHBOURS

Maybe we are alone in this universe, maybe we are the first life in the universe to ever exist. Maybe humans are the first, and probably the last species in the universe, and we are to discover what the universe has to offer, to experience the knowledge the universe has to offer us.

CONCLUSION

People of all cultures look up to the stars and ponder if somebody is up there, looking at us from afar, or maybe, they are looking up as well. Perhaps looking up at the skies and wondering who's out there is a universal question that unifies us all. Or maybe no one is out there, and we have the universe in the palm of our hand, that means we have to be the one to explore the universe first, after all, the universe is too beautiful to not be experienced.

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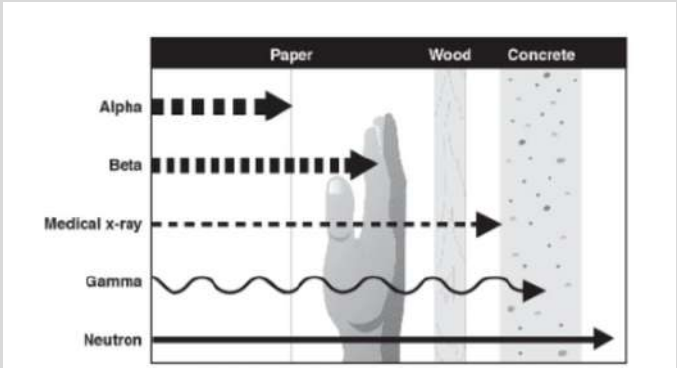
Tyler Au 8RF

INTRODUCTION

Radiation is often referred to as “invisible danger," because it has a dangerous threat to living creatures as it cannot be seen, smelled, or tasted. It is a spontaneous emission of ionising radiation from the nucleus of an atom, occurring when atomic nuclei become unstable and undergo decay. This process releases various types of radiation, including alpha particles, beta particles, and gamma rays. Radiation can be very beneficial in some fields like medicine, however, it also carries significant risks to human health and the environment.



TYPES OF RADIATION

Alpha particles are composed of two protons and two neutrons and have a positive charge. They are relatively large and heavy, so they are very weak and can’t penetrate very far. Even a sheet of paper is enough to stop alpha particles.

Beta particles, on the other hand, are high-energy electrons that are emitted from the nucleus. They have a negative charge and can penetrate further than alpha particles, but can be stopped by a few millimetres of aluminium or other materials.

Gamma rays are a form of electromagnetic radiation discharged from an atom's nucleus as part of the process of radioactive decay. They have a high frequency and can penetrate further than alpha or beta particles, requiring several centimetres of lead or several metres of concrete to stop them. An example of gamma rays in real life is food irradiation.

Ionising and Non-ionising radiation are also types of radiation. The term “ionisation” refers to the breaking of one or more electrons away from an atom. Ionising radiation carries more than 10 eV(Electronvolts), which is enough to ionise atoms and molecules and break chemical bonds. Non-ionising radiation is basically the opposite where there is not enough energy to ionise molecules.

HOW RADIATION CAN HELP US

Radiation actually helps us in more ways than you think. Here is an example. In an airport, you have to put your luggage through an x-ray or CT scanner to make sure you are not bringing any

illegal items. Well, that x-ray scanner uses ionising radiation to create pictures of what is inside the luggages. Full-Body Screening is also something that utilises radiation in an airport. Full Body Scanners are used to reveal hidden objects that could be hidden under clothing. There are two types of full-body screening that are in use around the world. Backscatter scanners and Millimetre wave scanners. Backscatter scanners send out low-energy x-rays towards the person being scanned. The scanner detects these x-rays and generates an image of the surface where they rebounded from, providing a visual representation of the scanned individual and any hidden items. Similarly, millimetre wave scanners use radiofrequency waves instead of x-rays, following a similar process to create an image.

HERE ARE SOME MORE EXAMPLES OF HOW RADIATION HELPS US:

Medicine: Radiation is very important in the medical industry and it is called radiation therapy. It uses different types of high-powered radiation to kill cancer cells. You might be wondering that this will kill other cells as well, not just cancer cells. But this type of therapy only targets fast growing cells, and cancer cells are fast growing. Since the other cells in your body don't grow fast, it won't get harmed by the treatment.

Buildings: Some buildings have smoke detectors, but how do they detect smoke? It's not like they have a camera to see if there's smoke or not. There are two main types of smoke detectors, photoelectric and ionisation. Photoelectric smoke detectors use a light source and a sensor to detect smoke. Ionisation smoke detectors use an isotope of americium which emits alpha particles to detect smoke. The alpha particles released from the americium ionises the air and allows small currents to flow through two metal plates. Any smoke that gets into the sensor changes the current, and the change in current sets the alarm off.

DANGERS OF RADIATION

Radiation has its own benefits and downsides. It can pose various threats to us humans and other living organisms. So it is important to have a Geiger counter (a device that detects radiation) to minimise risks of getting radiation sickness. Radiation is typically measured in sieverts and roentgens. The lethal dose of radiation is around 4-5 sieverts. Annually, normal people receive around 3 millisieverts. A millisievert is one thousandths on a sievert, in other words, 1000 millisieverts is 1 sievert.

One good example of why radiation is so hazardous is what happened at the Chernobyl nuclear power plant in 1986. The Chernobyl disaster was a nuclear accident that occurred on April 26, 1986, at the No. 4 reactor in the Chernobyl Nuclear Power Plant, located in Ukraine, which was then part of the Soviet Union. The disaster was caused by a combination of factors, including human error, design flaws, and inadequate safety measures.

During a routine test, the reactor experienced a sudden power surge that led to a steam explosion and a subsequent fire. An immense burst followed by a fierce blaze sent radioactive particles into the air, spreading into neighbouring countries like Belarus and Russia.

The immediate aftermath of the disaster saw 31 people die from acute radiation sickness, with many more suffering long-term health effects. The disaster also caused the evacuation of

hundreds of thousands of people from the surrounding area, and it had a profound impact on the environment and the local economy.

CONCLUSION

In conclusion, radiation is a double-edged sword. While it has numerous beneficial applications in fields like medicine, infrastructure, and research, it also poses significant risks to human health and the environment.

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MEMORIES

Alyssa Suen 8FV

INTRODUCTION

Memory is the continued process of information retention over time. Which is an essential part of the human cognitive system as it allows us to retain information and recall past experiences and events to frame our understanding and behaviours. It is also a system that stores what we learnt for future use. As such, memory plays a significant role in teaching and learning. Memories are very important but how exactly does it work? There are three main processes of how memory works. These three processes are encoding, storage and retrieval.

ENCODING

The first function is encoding. Encoding is the process of how information is learned, taken in and understood. Information is usually encoded through one or more of the following methods: Visual encoding (how something looks), acoustic encoding (how something sounds), semantic encoding (what something means) and tactile encoding (how something feels). Visual encoding is the process of transferring visual images to memory.Acoustic encoding is the process of storing sound and auditory information.. Semantic encoding is the process of linking data and information to concepts and meanings to memories. Tactile encoding refers to the process of using physical sensations and touch to store information. When information enters our memory system through one or more of these methods above, it transfers information into a format that we can remember and store in our memories. (Sus (MA) & Drew (PhD), 2023b)

STORAGE

The next function is storage. Storage refers to the process of where, how much, and how long encoded information is held within the memory system. There are two types of memory, short-term and long-term memory. Initially, encoded information is stored in short-term memory and then transferred to long-term memory if necessary. Information that is encoded acoustically is mainly stored in short-term memory and requires constant repetition to be memorized and stored there. In addition, both time and distraction can lead to forgetting information stored in short-term memory, as it only lasts between 15 to 30 seconds.

Short-term memory can only hold between five to nine items of information, with seven being the average amount. However, long-term memory has an immense storage capacity, and data and information stored there can be kept for an indefinite period of time. Information that is encoded semantically is mainly stored in long-term memory. However, long-term memory can also store information that is encoded visually and acoustically. Once information is stored in long-term memory or short-term memory, individuals need to recall or retrieve it to make use of information.

RETRIEVAL

The last function of memory is retrieval. Retrieval is the process of how individuals access stored information. Due to the differences between short-term and long-term memory, information stored in short-term memory and long-term memory is retrieved differently. Short-term memory is retrieved in the order when it is stored. While there are three ways of retrieving information stored in long-term memory, recall, recognition and relearning. Recall is when you can access information without any cues (by yourself). Recognition is when you can identify information that you have previously learned after reencountering it which involves a process of comparison. For example, you graduated from primary school a few years ago. You might not be able to remember all of your classmates's names but you might recognize a lot of them according to their yearbook photos. Lastly, relearning is when you hear something that you recognize or you hear something that reminds you of information that you learned or happened in the past which involves identifying information that you previously learned.

DUAL-PROCESS THEORY

Memory also operates according to a dual-process theory. Where the more unconscious system (system 1) interacts with the more conscious system (system 2). At each of these two systems, there are three processes: how we get information (encoding), how information is kept (storage), and how we use information (retrieval). In simple words, dual-process refers to some behaviors and cognitive processes are the products of two cognitive processes, known as system 1 and system 2. System 1 is more automatic and unconscious. System 2 is more effortful, analytical and intentional. (Harvard University, 2022)

CONCLUSION

To conclude, memory is a process that stores what we learn to use in the future. The three main processes of how memory works are encoding, storage and retrieval. Memories allow us to remember past experiences and events which frame our behaviour within the present. Without memories, we would struggle to retain information, recognize people or recall past experiences which is also why memories are such an important part of our cognitive system, making us who we are today.

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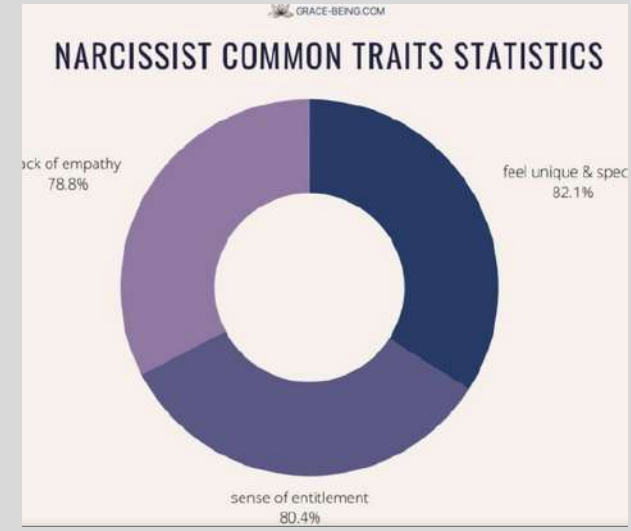
NARCISSISM

Ernie Tsui 8FV



INTRODUCTION

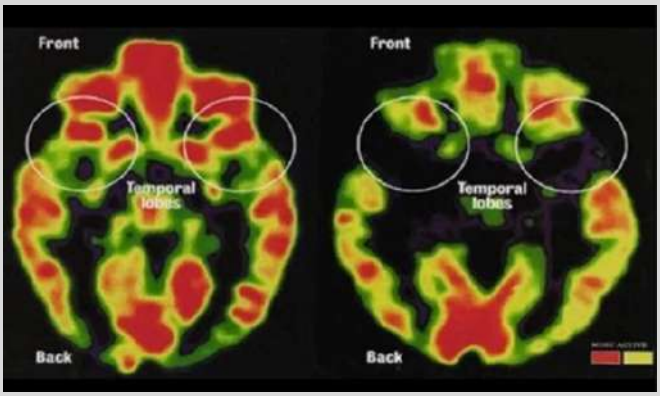
Narcissistic Personality Disorder (NPD) was first recognised in 1980's in the third edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-III). Only 6.2% of the population are diagnosed with NPD, of which 50-75% are men. However, NPD is extremely hard to diagnose, considering that narcissists never tend to acknowledge their abnormal behaviour.

SYMPTOMS OF NARCISSISM

The most common and acknowledged symptoms of NPD would be a lack of empathy and a sense of entitlement. To be precise, rather than not having a capacity to feel empathy, narcissists don't have the willingness to do so. The reason they don't feel empathy is that they want to avoid shame. They believe that being empathetic is shameful, and by doing this, they are admitting to vulnerability and giving up control of themselves and others. Narcissists' sense of entitlement comes from their need to feel superior to fill in the hole in their minds of not being good enough. They value praise and attention to feel important and worthy, so if you criticise them just a little, they would immediately be defensive to protect themselves. Besides these, other symptoms of narcissism include arrogance, needing to be in control, exploitation of others etc.

HOW DOES NARCISSISM AFFECT THE BRAIN STRUCTURE?

People with narcissism are hyperactive in their social pain network. This network consists of the anterior insula(AIC), and anterior cingulate cortex (ACC). It induces pain when facing emotions of rejection and loss. This abnormality causes narcissists to feel overly distressed when being left alone and looked down upon. Additionally, narcissists lack areas of grey



atter in their brain, and ave a lower cortical thickness and volume. This part of the brain is strongly associated with one's empathy, so a reduction of this area will cause people to have undeveloped emotional intelligence. The grey matter of the brain cortex is crucial to the abilities of people's reasoning and learning from experience, and people with a higher narcissistic scale were recorded to have less activity in those areas, which correlates with their low self esteem. (Pesqueda, 2022)

CAUSES OF NARCISSISM

There are several factors that cause a person to become a narcissist. Firstly, the childhood of a person has a grave impact on their futures, since that is the time when their brains start to develop. If parents have too much adoration for their child, they will grow up believing that they deserve everything. This is called "helicopter parenting"(coined by Dr. Haim Ginott in 1969), where parents are overprotective and over-involved in their child's life. On the contrary, the lack of warmth and constant neglect will cause the child to feel underappreciated, and believe that they are "destined for greatness". These are all types of abuse and bad parenting that leads people into becoming narcissists. Another reason people become narcissists is genetics. Although not everyone whose parents have NPD will become narcissistic, it still plays a big part in this disorder, since the unique brain structure of parents that have NPD can be passed down to their child. In research conducted in 1996 by researchers from Canada, they asked 483 pairs of twins to complete a personality questionnaire. Based on the results, the researchers concluded that genetics was the cause of 53% of narcissism in those pairs of twins.

TYPES OF NARCISSISM

There are two main types of NPD-vulnerable narcissism (VN) and grandiose narcissism (GN). Depending on which type people are, the way the act may vary. People with grandiose narcissism have high self-esteem, and are relatively more aggressive and manipulative. They also crave excessive attention and fantasise about their inflated self-image and perfectionism. Numerous celebrities display these narcissistic traits, such as Donald Trump or Madonna. However, people with vulnerable narcissism are more insecure and hypersensitive to criticism. They value recognition and admiration to fuel their self-worth and wellbeing. People with this type of NPD tend to have more empathy than people with grandiose narcissism. Unfortunately, they still lack the ability to care for others, as Dr. Craig Malkin has said in "rethinking narcissism", vulnerable narcissists "are just as convinced that they're better than others as any other narcissist, but they fear criticism so viscerally that they shy away from, and even seem panicked by people and attention." Vulnerable narcissism is highly linked with past child abuse and ignoration. Compared with GN, VN is less recognised, since most people believe that narcissism is only being arrogant and overconfident.

HOW NARCISSISTS AFFECT PEOPLE AROUND THEM

If NPD isn't treated, people who have it will negatively affect people around them. They might use tactics to manipulate and control people. Some examples of narcissistic abuse are "love bombing", emotional blackmail, and gaslighting. At the start of a relationship, a narcissist will shower their victims with affection and compliments in order to gain their trust and love. As time goes on, they slowly reveal their true intentions and will start criticising and victim blaming. Whenever you try to confront them, they shift the blame and will grow distant. As the victim has already grown attached to the narcissist, they will believe them and may develop anxiety and stress. As Elizebeth Keohan, a licensed certified social worker clinical (LCSW-C), has said, "Narcissistic abusers can make you question your own self-worth", so if you don't recognise those behaviours, these abusers will ruin your self-confidence. People who were victims of narcissistic abuse might develop post-traumatic stress since they will always be wary of people since they

have been abused by the person they trusted. They will also have trust issues, given that these traumatic memories might trigger a “fight or flight” response in their brain. In addition, clinical studies believe that narcissistic abuse will cause damage to the hippocampus, a brain structure that is important for memories and emotions such as stress. This will cause memories to fade, so the victim will not be able to have long-term memories.

Conclusion- To conclude, Narcissism is a complex disorder that can be developed by a person throughout their experiences in life. Narcissists can affect the people around them greatly, and by recognising the causes and symptoms of narcissism, you would be able to understand the challenges people face while having this disorder. As soon as you spot the signs of NPD from someone-or even yourself-do not hesitate to seek professional help. Moreover, we should promote kindness and empathy towards everyone so they would not have to suffer, and to make the world a more enjoyable place.

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GASTRIC ADENOCARCINOMA (STOMACH CANCER)

Stephanie Gong 8WB

INTRODUCTION

In 2020, there were more than 1 million cases of Gastric Adenocarcinoma (World Cancer Research Fund International, 2020). Stomach Cancer is one of 200 types of cancers and is in the top 5 most common cancers. In simple terms, cancer cells are cells that lose the ability to function and perform the tasks of normal cells. Their reproduction rate is also higher than normal cells and they do not go through the natural cell death process. So how does stomach cancer originate in the first place? Why is the survival rate of having Stage 4 cancer lower than Stage 1? How can changing your dietary and life choices be life-saving?

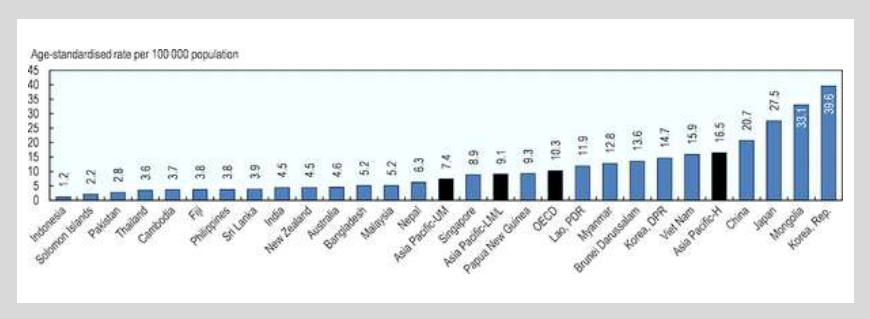

Fig 1: Cancer cases per 100,000 in 29 countries

WHAT CAUSES STOMACH CANCER?

Smoked and grilled foods along with alcohol can cause stomach cancer. They all contain chemicals known as carcinogens. Smoked and grilled food can lead to the formation of nitrosamines, which are carcinogens. While alcohol, nicotine, and moldy food, all contain carcinogens. Carcinogens are chemicals that contribute to DNA mutation and can lead to the formation of cancer cells. They mutate the DNA by binding to and modifying nucleotides.

Another preexisting condition is an infection caused by Helicobacter Pylori. This bacteria produces a toxin called CagA that can remove controls on cell growth and increase cell motility, leading them to become cancer cells once inside cells. (National Cancer Institute, 2013) But sometimes, stomach cancer runs in the family, and it could be in a person's genes.

WHERE DO CANCER CELLS ORIGINATE?

The "Adeno" in Gastric Adenocarcinoma means "glands". The cancer cells originate in the glands of the stomach wall which produce gastric juices.

Like all living cells, cancer cells need a constant supply of oxygen and nutrients. While forming a tumor, the cells send out signals known as angiogenic factors, which encourage blood vessels to grow into cancerous cells, wasting oxygen and nutrients.

DIFFERENT TYPES OF STOMACH CANCER

There are 2 different types of stomach cancer: intestinal and diffuse cancer. Intestinal cancer is where the tumor appears as a single mass and is located on the antrum (the lower, less curved part of the stomach). This type of cancer usually infiltrates and thickens the stomach wall.
The diffuse form of cancer is not a single mass, unlike intestinal cancer. Diffuse cancer spreads throughout all parts of the stomach, often forming masses of cancerous cells in the inner lining of the stomach.

HOW DO CANCEROUS CELLS SPREAD?

In the later stages, cancer cells may break away from the tumor where it first formed and spread to other regions of the body, which is known as metastasis. Most death-related cases of cancer are caused by cancer cells spreading and forming tumors in other regions of the body. There are 3 ways cancer cells can spread: Direct invasion is where the cancerous cells directly spread from the stomach onto the neighboring organs, including the liver, pancreas, and large intestines.

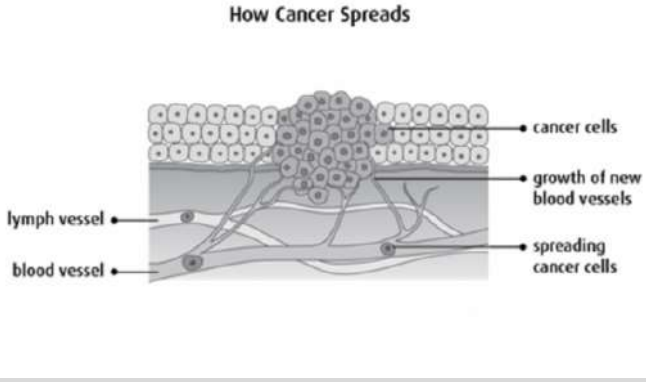

Fig 2: Diagram of how cancer spreads

The cancer cells can also enter the bloodstream and infect other organs. The most frequent organ that stomach cancer cells can infect using this way is the liver because the hepatic portal vein connects the stomach and liver. Through lymphatic vessels, stomach cancer cells may also spread to as far as the ovary, abdomen, and clavicular regions.

TREATMENT FOR STOMACH CANCER

Doctors first run a diagnostic on the patient. They undergo a physical checkup, usually followed by an ultrasound. This helps the doctor examine the inner parts of the stomach and if there are any abnormalities, doctors usually go to the next stage of the examination.

This is where the doctor usually uses gastroscopy or medical imaging. Medical imaging has two techniques: CT scan and Contrast Radiography

A CT scan produces a clear and structured image of the interior parts of the body. They can determine the size and shape of the tumor, and where it is located. It is where the patient is scanned for any metastases before doctors proceed to radiotherapy.
Contrast radiography is where the patient first orally consumes a substance called, “Contrast”. This substance is very bright on X-ray, so when the patient is scanned, the substance produces a contrast between the walls of the stomach, esophagus, intestines, and the other parts of the body. This helps doctors notice any abnormalities with the organs.

For gastroscopy, a long flexible tube is inserted through the mouth and into the stomach. It is equipped with a small camera to examine the insides of the stomach and an apparatus to take a small sample of tissue the doctor notices might be abnormal.
They then further examine the sample of tissue to determine whether it is cancerous or not. This process takes around 15-30 minutes. (Kenhub Stomach Cancer, 2023)

After doctors confirm cancer, they will need to figure out what stage the cancer is at to decide

hat treatment will be required for the patient.

Many other treatments vary depending on the patient's own needs. However, the most common procedure for removing a tumor is surgery. In the early stages, when the cancerous cells haven't spread to any other organs or lymph nodes, the surgeons only remove the tumor and part of the stomach. But in the later stages when the whole stomach along with some of the lymph nodes are affected, surgeons would have to remove the whole stomach. To ensure food can still pass through the esophagus and be digested. The surgeons connect the esophagus directly with the small intestines. Other types of treatments include Radiation therapy and Chemotherapy to kill the cancerous cells.

For the early stages, surgeons directly remove the tumor. But for stages 2 and 3, the patient will usually go under chemotherapy or radiation therapy to shrink the tumor size so it will be easier to remove.

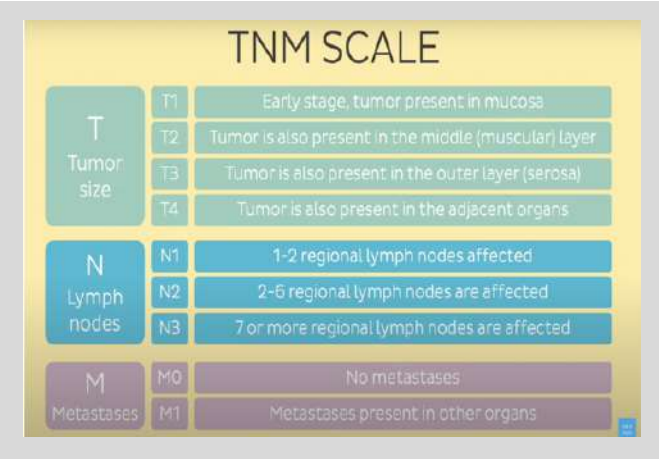

Fig 3: TNM scale

TNM SCALE

The TNM scale is used to describe the tumor size, how many lymph nodes are affected, and if there are any metastases.

Tumor Size: T1 is the early stage and the tumor is only present in the mucosa of the stomach wall.
T4 is the last stage of the tumor size where the tumor is also present in other organs.

Lymph nodes: N1 is where only 1-2 lymph nodes are affected, while N3 is where 7 or more lymph nodes are affected.

Metastasis: The patient either has no metastases or has metastases present in other organs. (Kenhub, 2023)

In your medical documents, you might see something like T3N3M0.

Survival Chances:
For Stage 1 cancer, where the cancer cells only affect the mucosa, the survival chance is around 90%. For Stage 2 cancer, where the cancer cells spread to regional lymph nodes, the survival chance is around 70%. For Stage 3, where the tumor infiltrates more and more into the layers of the stomach wall, lymph nodes, and some adjacent organs are affected, the survival chance drops down to approximately 30%. For Stage 4, where the cancerous cells spread to other organs across the whole body, the survival chance is only around 5%. (American Cancer Society, 2024)

HOW TO PREVENT STOMACH CANCER

Approximately 6 in every 10 people diagnosed with stomach cancer are 65 years old or older, so it is important to know what you can do to prevent this disease. (Mayo Clinic, 2018)

- Prevent Smoked and Grilled Foods
- Consume less alcohol
- Quit smoking
- Don't consume moldy food
- Eat more vegetables and fruits
- Visit often with your doctor who can give you checkups

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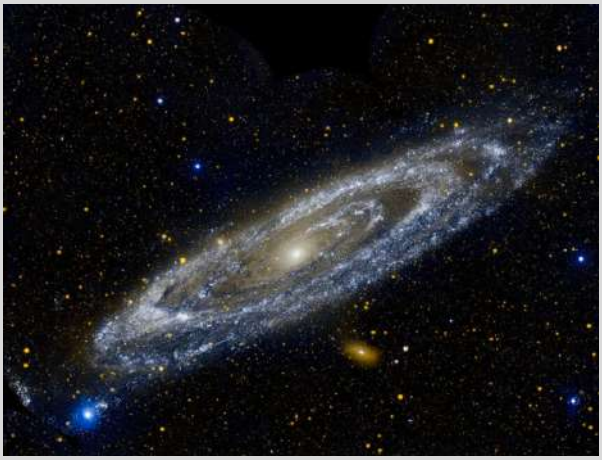
HABITABLE PLANETS AND THEIR RELATIONSHIP WITH INTELLIGENT LIFE

Victoria Higgins 9DS



INTRODUCTION

This essay will explore 6 main points regarding intelligent life which I have further deepened my understanding of. To start us off, this essay will be giving you some facts about our galaxy and our planets including the definition of light years, if Aliens actually exist or not, intelligent life, habitable planets, non-habitable planets and last but not least, planets in our solar system which are the most habitable.

According to NASA"s WMAP team, the universe is 13.7 billion years old, while The Milky way is about 13 billion years old. During the start there were a lot of explosions in the milky way, things exploded frequently. But, the first habitable planets were born 1-2 billion years later.

Earth is 4 billion years old, so there may have been trillions of opportunities for life to evolve on other planets in the past. Scientists have sorted out 3 types of Super Civilizations; Type 1 Civilisation would be able to use all the energy available on the planet. Humanity/Earth should reach type 1 in an estimate of a few hundred years. Type 2 Civilisation is able to harness the full energy of its own star. (So basically Earth's sun) Concepts like the Dyson Sphere- a giant sphere enveloping the sun- may be probable. Type 3 Civilisation has complete rule and control over its galaxy and its energy sources. An alien race like this would be godlike to us.

THE SEARCH FOR LIFE

Although many people have grown to believe that there are some other forms of intelligent life in other solar systems or galaxies, NASA have not yet seen any scientific evidence that supports extraterrestrial life, nor found any life on other planets. Even if there are alien civilizations, Earth and our solar system are in a direct galactic neighbourhood which is also known as the "Local Group", and everything outside of it is out of our reach forever due to the expansion of the universe.

Everywhere on this planet beyond the large living creatures such as elephants and whales. Almost everywhere on Earth that humans have looked at, we have found microbial life, with this being one of the main reasons NASA will continue to search for life outside of our planet.

Therefore five rovers and four landers have been sent to not only explore a wide range of rocks and soils, to try to fulfil the mystery to the past water activity on Mars, but also take panoramic images to return back to the scientists so that they can then proceed to select favourable geological targets to attempt to explain part of the story of water in Mars' past. . All of the machinery was sent to the surface of mars. Scientists have only explored a tiny fraction of Mars, and that's only one of the promising bodies to look for life in our solar system.

The definition of intelligent life means beings that can learn and understand things. Earth is the only world in our solar system that is known to host life; it has an atmosphere that is neither too hot nor too cold. The distance between the sun and Earth provides us with the right amount of warmth, sunlight and energy. Scientists often refer back to something called the "Goldilocks Zone", a term which is often used to describe the range of distance that a water can still remain a liquid before it boils away or freezes. Although there may be other planets with similar hospitable features to Earth necessary to sustain life, Earth remains one of a kind.

Habitable planets are a kind of planet where one can sustain life for a significant period. The essential needs for a planet to be habitable for human life or really any form of living species are liquid water, energy and nutrients. However, as researchers start to uncover more and more information regarding exoplanets, they have found that sometimes unexpected environments can sustain life, therefore the requirements for habitability on exoplanets are being reconsidered. There are possibly millions or even billions of planets that sustain life in the milky way. The scientific reasoning behind astronauts being sent to the surface of mars is to acquire and understand the workings of the planet, including the planet's evolution, and the preparation for the future human exploration. Not only is the surface of Venus harsh and hostile, it has a crushingly heavy atmosphere, has an extremely volcanic geology, and is completely inhospitable for life. Despite Mercury being the closest planet to the sun, the hottest planet in the solar system title belongs to Venus, thanks to its dense atmosphere. It has a temperature of 900 degrees Fahrenheit, 475 degrees Celsius. Hot enough to melt Lead, Zinc and 7075 Aluminum Alloy. Vikki Meadows, an astrobiologist who heads the Virtual Planetary Laboratory in NASA's Nexus for Exoplanet System Science says, "Venus gives us an example of an alternative evolution for planets.". Although the surface of Venus is insufferable for human life to live on, a study which has been conducted recently has suggested that the presence of an earthly gas called phosphine might well be in the Venusian atmosphere as well. The possibility of it remains unlikely. Scientists say that only further investigation will offer a definite answer.

With Mercury not only being the smallest planet in our solar system, as well as being the planet closest to the sun, it is therefore one of the most inhabitable planets in our solar system. It takes about 3 minutes, or 3.2 minutes to be exact, to travel from the sun to mercury. If compared to

Earth's moon, It is only larger by a bit. Covered in tens of thousands of impact craters which sounds similar to what our moon has. Named after the ancient Roman God, Mercury is the fastest planet, zipping around the sun every 88 Earth days. Mercury isn't habitable, and is an incredibly unlikely place to host life on because of the drastic temperatures and solar radiation which make up this planet that are too extreme for any form of organisms to adapt to. Scientists believe that there has never been life on Mercury due to the atmosphere on Mercury being so incredibly thin that it's almost non-existent. The atmosphere doesn't protect the planet from the harsh radiation of the Sun or radiation from space,

nor does it trap heat and provide a breathable atmosphere, therefore making Mercury's surface a vulnerable place for the Sun to shine upon.

Although Venus and Mercury are planets in our solar system which are inhabitable, there are still planets out there that have a chance of being habitable according to scientists and astronomers. Saturn's largest moon- Titan, is one of them. It is the second largest moon in our solar system, being even larger than the planet Mercury. This habitable planet in our solar system is an icy ocean world with a surface which is completely covered by a golden hazy atmosphere. Unlike other moons in the solar system, Titan has a dense atmosphere.

Other than earth's moon, Saturn's moon is known to consist of standing bodies of liquid, including rivers, lakes and seas on its surface. Similar To Earth, Titan's atmosphere is primarily nitrogen, including a small amount of Methane. This planet is one of the only other places in our solar system known to have an earth-like water system. This planet is also thought to have a subsurface ocean of water. This atmosphere and other unique characteristics make Titan the most habitable place in the outer solar system for humans.

Theories and assumptions regarding life outside of our solar system or our local group can be traced back to the start of human existence. There have been many people throughout the years claiming to have seen some sort of outerworld species, this has always turned out to be a false alarm. Many scientists and researchers have been trying to figure out the answer to this big question for centuries. They have made some good progress in searching for intelligent life, yet nothing has been found so far. Even though the possibility is slim, Nasa will continue to search for habitable planets and intelligent life in our universe. To quote Carl Sagan: "The universe is a pretty big place. If it's just us, it seems like an awful waste of space.".

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Chloe Ling 9DT

INTRODUCTION

Genetics is the study of a living organism's genes and how they are passed down from generation to generation in families. Certain traits or qualities from your parents such as your hair colour, skin colour and even types of diseases which are most likely to be passed or copied down due to genetics. A majorly focused topic in genetic studies is offsprings, specifically when the genetics of the child differ from the parents and/or past generations. It is worth noting that only 0.04% of the world's population consist of completely different genetics than their biological parents. During the course of our lifetime, our genetics can be modified due to random mutations such as exposure to high radiation, this can potentially be passed down to the next generation.

WHAT ARE GENES AND WHAT ARE THEY MADE OF?

A singular gene is the basic unit of heredity, it is responsible for a living organism's traits and features, which are commonly passed down from family or ancestors. Genes are a small section of a DNA on a chromosome which controls all of the chemistry in a cell. DNA is considered to be a set of complex instructions which can vary over 2 million bases depending on the person. DNA is composed of four nitrogen bases: Adenine (A), Thymine (T), Cytosine (C), and Guanine (G). These nitrogen bases pair up in a specific manner, with A always pairing with T, and C always pairing with G. This complementary base pairing forms the building blocks of DNA's double helix structure, resembling a twisted ladder.

HOW DO GENES VARY ON DIFFERENT HUMAN BODIES?

In some cases, the bases of a few DNA in a gene might vary upon different people. This is called a variant. A variant is when the DNA has a slightly different set of instructions which assist in an individual's development and phenotypes expressed. . This means that certain cells will produce different types of proteins, which may function differently. As there are technically only 4 nitrogen bases that can create a strand of DNA, it's not surprising that 2 random people could have 99.9% of the same DNA.

There are 23 chromosomes in each a sperm cell and egg cell, these reproductive cells form to create a foetus. The chromosomes then join together to create a “combined copy” of the parents. If the foetus were to become monozygotic or identical twins, they would exhibit a high level of genetic similarity, with DNA being approximately99%-100% identical. In contrast, dizygotic or non-identical twins only share around 50% of the same DNA. Regardless of whether or not the child/children are twins, the genetic composition of the offspring would still be consistent, where half the child's DNA originates from the father, and the other half from the mothers

HOW DOES DNA REPAIR AND REPLICATE ITSELF?

DNA possesses the ability to self-repair and replicate. When a strand of DNA is damaged, any faulty or damaged bases that could compromise the integrity of the entire strand are removed as a repair process.. Certain parts of DNA can directly reverse any damage caused, this is considered to be a very efficient repair method for parts of DNA which are prone to frequent damage.

Replication happens to ensure that each daughter cell, which is a cell that is being divided due to mitosis, gets a copy of the genome which successfully inherits genetic traits. There are 3 main steps of DNA replicating, unzipping, elongating and termination. Unzipping refers to the process of opening gaps in the DNA helix structure, allowing RNA to access the base pairs. Elongation is the stage in which the DNA strand increases in length due to the addition of nucleotides. Finally, the termination step signifies the completion of DNA synthesis,, the replication mechanics are disassembled and all daughter molecules are resolved.

IS IT POSSIBLE TO CHANGE OUR GENETICS?

There are many different types of modifying our DNA, but the most common and simple method is by genome editing. Genome editing is a method which can specifically alter the DNA of an organism. Through this technique, It can permanently add, remove or change the organism's DNA. By cutting into a strand of DNA, scientists can utilise the cell's own DNA repairing mechanism to add or remove certain pieces of genetic material. They can also replace a segment of the DNA strand with a specifically modified strand, resulting in a change in the DNA sequence. Most DNA editing methods are used in medical forms, in which it could remove or cure certain diseases that the patient might have. Not only can artificially modifying change our DNA, mutations are also a really common type of DNA changing. The main difference between artificial and mutational changing is that mutational changing cannot be specifically controlled. Mutation often occurs during cell division or due to a virus infection.

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ARTIFICIAL INTELLIGENCE IN HEALTHCARE

Ella Chan 9ER

INTRODUCTION

AI has been a big trend in recent years due to the increasing availability of data. It is commonly used in virtual assistance, like Siri or Alexa. Yet, have you ever wondered about AI's current usage and future possibilities in the healthcare industry? In this article, This article will cover how AI is used in healthcare diagnosis, the strengths and weaknesses of AI in the industry, and lastly, the potential that AI offers to healthcare professionals.

WHAT IS AI?

When you first hear the term “AI”, the first thing that comes to mind might be robots or ChatGPT. Nevertheless, the application of AI is confined to neither of those. As stated by Copeland (2022), AI, Artificial intelligence, is “the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings”.
Pros and cons

The applications for AI are endless and can be applied to a wide range of industries. For instance, the Healthcare Industry!

APPLICATIONS OF AI IN HEALTHCARE

The use of AI in healthcare continues to develop rapidly in recent times as numerous studies confirm its effectiveness in diagnosing several chronic illnesses, increasing staff efficiency, and improving the quality of care while optimising resources (Berry, 2023).

Even so, AI used in the healthcare industry is not new. It was brought into the industry in 1955, referencing a proposal from a Dartmouth College conference (Xsolis, 2021).

Still, the first healthcare-related AI programme was developed in the 1970s, when Stanford University developed MYCIN, a programme for treating blood infections which later began its operation in 1972 (Copeland, 2019). Though MYCIN was developed a half-century ago, its functions are substantial. MYCIN has the ability to require further information regarding the patients’ conditions, as well as provide additional laboratory test recommendations, to bring forward a reliable diagnosis, and then ultimately propose a course of treatment.

Though MYCIN is just one example of applications of AI in the industry, it is a rather significant milestone. Gradually, more and more expert systems were programmed with the main purpose of helping to diagnose patients, “drug discovery and development”, enhancing physician-patient communication, and transcribing medical documents (Berry, 2023).

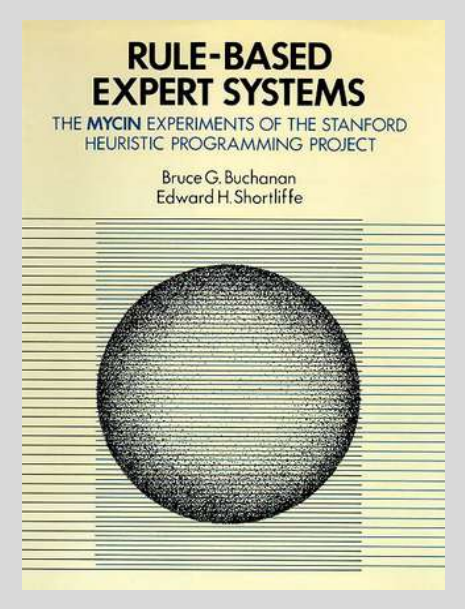

Fig 1: A book written by Bruce G. Buchanan and Edward H. Shortliffe about the MYCIN programme

Automated Retinal Disease Assessment (ARDA) is one of the newly developed AI models from Google Health that supports diabetic retinopathy screenings. The model diagnoses patients quickly, acts as a second choice for ophthalmologists, detects the conditions prematurely, and reduces the barriers for patients to access (Berry, 2023).

X-rays, MRIs, ultrasounds, CT scans, and DXAs are several frequently seen AI algorithms utilised to diagnose patients. CT scans, in particular, are assisted by AI to enhance the utility of traditional CT imaging by automatically diagnosing changes in organ features as an indication of diseases and to use as a true diagnostic tool to relate features to specific diseases (GlobalData, 2023).

Furthermore, the usage of AI assistants and chatbots can also improve patients' diagnosis experience by helping them find available physicians, schedule appointments, and even answer some of the patients' concerns (Berry, 2023).

POSSIBLE SHORTCOMINGS OF APPLYING AI IN HEALTHCARE

As applying AI in healthcare is generalising, patients, medical practitioners, and health insurers may all advantage from the productive and strengthened treatment results.
Yet, there are several shortcomings that we should not neglect.

Based on a Pew Research Center poll in 2023, though AI has demonstrated its ability to be accurate in diagnosing conditions or recommending treatments, approximately 60% of Americans state that they would be uncomfortable if their healthcare provider relied on AI to diagnose conditions or recommend treatments, while only 33% of the interviewees have concerns that AI would improve health outcomes (Tyson, Pasquini, Spencer & Funk, 2023).

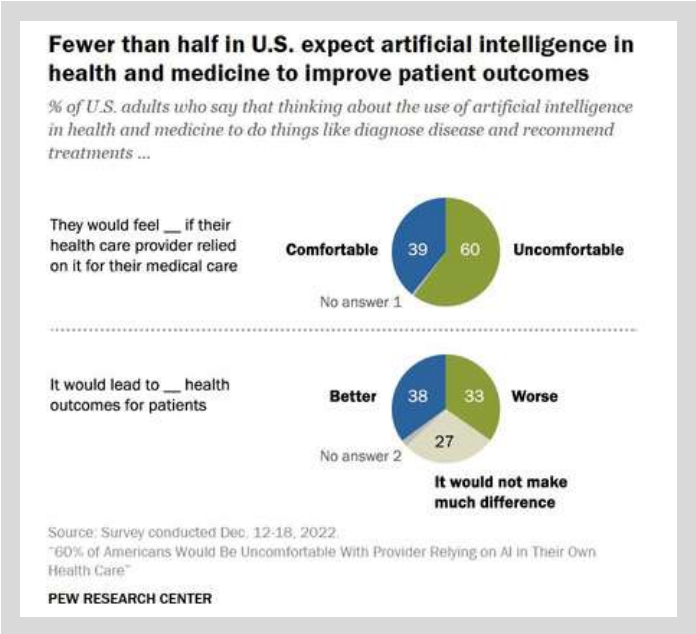

Fig 2: Diagrams about US adults' opinion on AI in Health and Medicine

Beyond concerns about the accuracy and effectiveness of AI, there have also been increasing calls to direct discrimination and bias in systems (Berry, 2023). Earlier in July 2023, Bloomberg examined over 5,000 images generated by Stability AI and discovered that the program enlarged stereotypes about race and gender, often illustrating people with lighter skin tones as holding high-paying jobs while individuals with darker skin tones were labelled "dishwasher" and "housekeeper" (Small, 2023).

The leakage of private personal health data is another crucial concern. Training AI algorithms often incorporate extensive data, which increases the chances of such data being exposed. As the algorithm memorises and retains the information or because third-party vendors may be exposed to data breaches (Berry, 2023).

FUTURE POTENTIALS OF AI IN HEALTHCARE

Now that we know how AI is currently used in healthcare, what are the future potentials that AI offers to healthcare professionals? Here are a few trends you can expect.

Patients with mental problems and ASD (Autism Spectrum Disorder) will most likely benefit from engaging in telemedicine apps (apps that provide remote clinical services) to patients due to the application of emotional AI algorithms. Additionally, speech analysis functions can be used by AI-powered healthcare apps to identify mental illnesses including dementia, depression, autism, down syndrome, and more (Dave, 2023)

Currently, numerous medical corporations are proceeding to hire software developers to adopt personalised healthcare treatments. Additional data needed will be collected through wearable technology, including wristbands or sensorized insoles (Feetme). With this information, the software will be able to provide personalized diet and exercise plans when all this data is collected in AI-enabled apps (Dave, 2023).

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AUTONOMOUS CARS

Jaya Xu 9NH

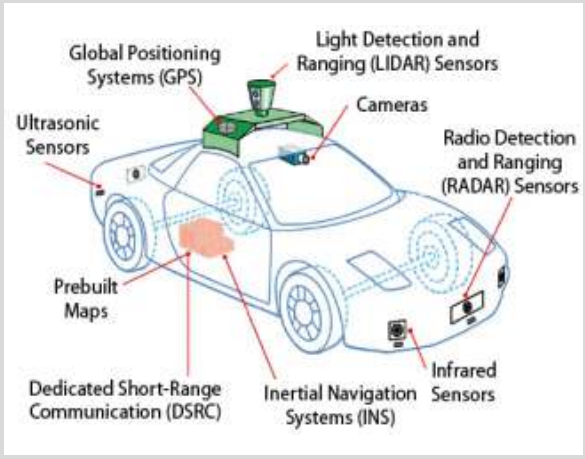

Fig 1: the technologies of autonomous cars

INTRODUCTION

Many people would think that autonomous cars still have a long distance from reality, however, the development of autonomous cars is growing rapidly and it is estimated that the global autonomous car market will be at $60 billion by 2030. The development and testing of autonomous cars include leading companies like Audi, Ford, Google, Tesla, BMW, Volkswagen, General Motors and Volvo. In fact, the Toyota Prius and the Audi TT have navigated over 140,000 miles of California streets and highways.

TECHNOLOGY USED

Autonomous cars are vehicles that are able to sense their environment and run without the help of humans. There are a variety of sensors on the autonomous cars. Their use is to create a map of their surroundings. The main functions of autonomous cars are radar sensors, lidar sensors, video cameras, ultrasonic sensors and GPS.

Radar sensors send out radio waves that bounce off distant surfaces to monitor the position of nearby vehicles. Lidar sensors(light detection and ranging) help measure distances, detect road edges, and notice lane markings with the creation of a 3D model of the car's surroundings. Video cameras have the usage of identifying vehicles, road signs, traffic lights and pedestrians. Ultrasonic sensors are placed on the wheels and watch out for curbs and other vehicles when parking. The GPS can calculate latitude, longitude, course and speed to navigate the car.

Fig 2: A waymo car on the road

THE ADVANTAGES AND DISADVANTAGES

Safety is improved by autonomous vehicles. It is estimated that autonomous vehicles can reduce 90% of accidents. Major accidents are caused by being drunk or being distracted, all caused by human errors. Automated driving systems are environmentally friendly, they decrease the waste of fuel by reducing unnecessary braking and acceleration. It is estimated that a platoon of self-driving cars on a highway can reduce fuel consumption by 10%. Most importantly, independent people with disabilities and seniors are able to travel independently by autonomous vehicles. It is a lot more convenient for them to travel to places without help from others. A disadvantage can be the loss of jobs. People who depend on driving can find their jobs replaced by autonomous cars. Jobs like bus drivers, taxi drivers and fast food delivery may need to find new employment. Machine error can be a serious problem for autonomous cars. Even though autonomous cars will decrease the amount of accidents that happen, they still can't eliminate the risk of accidents due to machine error. If the software of the technology used fails or breaks down, autonomous cars can put the passenger in a more dangerous situation compared to the person taking control of the vehicle by themself.

THE CHALLENGES OF AUTONOMOUS VEHICLES

Despite the fact that autonomous vehicles have many advantages and will be a remarkable change in people's lives, they still face many challenges. Poor weather is one of the significant challenges of driverless cars. Autonomous cars depend on a broad range of sensors to function well. However, poor weather such as snow, fog, or heavy rain will make it difficult for the sensors of vehicles to function correctly. As the accuracy of the sensors is negatively impacted due to poor weather, it may be a dangerous situation to the passenger when they face poor weather in their autonomous vehicle.

CARS WITH SELF DRIVING FEATURES

Google's Waymo project is an autonomous car that is almost fully autonomous but still needs the help of a human driver to take control of the system when necessary. The goal of the project is to make it easier and safer for people to get around. In 2021, Waymo began testing its robot taxi service in San Francisco and now the robot taxi service is offered to passengers in San Francisco. There are numerous sensors used in the Waymo vehicles, the most important sensors include the radar sensor, lidar sensor and cameras. The radar sensor is able to detect the distance and speed of objects such as cars which are in motion. The lidar sensor helps the car to build a 360 degrees view of the road and the objects around the vehicle. The cameras have a high resolution and can identify visual information like traffic lights. Many of the cars that are available to the public only have some autonomous features and have low autonomy. The features of many autonomous cars available in 2022 include a hands-free driving system, adaptive cruise control and lane centering system. A hands-free driving system doesn't need the driver's hands on the wheel but the driver is still required to pay attention. Adaptive cruise control will automatically adjust the vehicle's speed to match the speed of the vehicle in front of it. The use of the lane-centering system is to keep the vehicle in the centre of the lane. All of these autonomous features are available now and throughout time, the development of the autonomous vehicles will be more of a success in the future soon.

CONCLUSION

Autonomous cars are able to make a huge change to our transportation system, economy and daily lives. They are safe, environmentally friendly and accessible to independent people. However, they can lead to job losses and may have machine errors. The Waymo project is a leading success of autonomous cars and is an improvement to the world's access to mobility. One thing's for sure, the market size of autonomous vehicles will grow rapidly in the next decade.

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CIRCADIAN RHYTHMS: THE CLOCKS THAT REGULATE OUR LIVES

Sin Ying Cheung 9RR

INTRODUCTION

Have you ever noticed how you tend to feel more alert during the day, and more sleepy at night? I mean, that's kind of obvious. How about how your appetite and digestion seem to follow a daily pattern, with hunger peaking at around meal times and digestion slowing down at night?

These daily patterns aren't just pure coincidences. They are part of our body's 24-hour internal clocks or circadian rhythm, and regulate many biological processes such as our cycles of wakefulness and sleepiness.

In this article, we'll explore circadian rhythms, how they work, and why they are so important for our health and well-being.

WHAT ARE CIRCADIAN RHYTHMS?

Our bodies go through a daily pattern of physical, mental, and behavioural changes called circadian rhythms, responding to changes in an organism's environment. (National Institute of General Medical Sciences, 2023) Light and dark have the most significant impact, but tons of other factors also influence them.

HOW DO CIRCADIAN RHYTHMS WORK?

Almost every living thing has its circadian rhythm, from single-celled organisms to humans, with some exceptions being honey bees and bumblebees. In humans, nearly every tissue and organ has its circadian rhythm controlled by a master clock located in the suprachiasmatic nucleus (SCN).

The SCN is a small group of cells located in the hypothalamus, a region of the brain that controls many functions such as body temperature, hunger, and thirst. By using data from specialized light and dark-sensing cells in the eye, the SCN can synchronize the body's circadian rhythms with our surrounding environment.

For example, during the day when the environment is bright, the SCN sends signals to other parts of the brain to boost wakefulness, alertness, and activity.

HOW DO CIRCADIAN RHYTHMS VARY BETWEEN DIFFERENT PEOPLE?

Circadian rhythms vary between people due to genetic variations, age, daily routines, and environments. Some people are 'morning larks' and wake up early, have peak productivity early, and sleep early. Others are 'night owls'. They wake by late morning or midday, have peak productivity later in the evening and sleep late. However, studies show that teenagers who stay up late but go to school early, known as 'night owls', tend to have more abdominal fat than 'morning larks'. This puts them at higher risk of conditions like obesity and other illnesses.

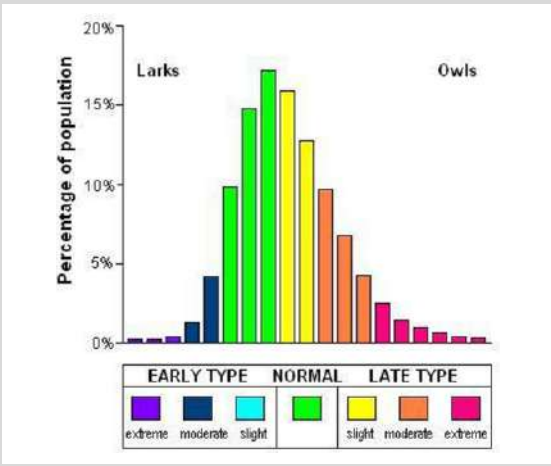

Fig 1: Graph of circadian rhythms

AN AVERAGE TEENAGER'S CIRCADIAN RHYTHM

2:00 Deepest sleep
4:30 Lowest temperature (easiest to sleep)
6:00 Sharpest blood pressure rise
7:30 Melanin secretion stops
9:00 Increase of cortisol
10:00 Body temperature rises throughout the morning (makes you wake up more easily)
14:00 - 17:00 Energy dip (you may crave a snack)
19:00 Highest body temperature
22:00 - 23:00 Melatonin secretion starts
And the cycle repeats

Moreover, teens are typically alert later in the evening, making it difficult to wake up in the morning. Research shows that melatonin levels peak later at night for teenagers, at around 11.00 pm. Not only that, but it also stays at a higher level until later in the morning. With this natural delay in melatonin production, you'll feel more energized at night, but sleepier in the morning. (Millpond Children's Sleep Clinic, 2023) Nevertheless, everyone is different, and not every teen will have the same issues.

FACTORS THAT AFFECT CIRCADIAN RHYTHMS

Circadian rhythms can be influenced by a variety of factors, such as:

Time zones: Our internal clocks are naturally tuned with day and night cycles, which is why they can be affected by travel and different time zones. When you travel to different time zones, your body's internal clock will still be following your original time zone. Your body will gradually adjust and reset to the time zone of where you've travelled, but that may take a couple of days. This is what's known as jet lag, the temporary sleep problem that can cause fatigue during the day, and trouble sleeping at night.

Light exposure: Our master clock (SCN) is quite sensitive to light exposure, and is crucial in helping our brain distinguish between when to wake and sleep. That's why irregular-timed light can easily disrupt our circadian rhythms. The circadian clock is the most easily affected around two hours before a person's typical bedtime. Using bright lights at that time can suppress the urge to sleep, so they may fall asleep and wake up later.

The colour and the kind of light you are exposed to also play a role. Blue and white lights emitted

from electronic devices like phones and laptops can also make it harder for a person to fall or stay asleep.

Habits: Diet, exercise, and other lifestyle choices can also affect circadian rhythms. For example, eating a large meal at night can affect sleep, while exercising in the morning can promote wakefulness.

Some habits that can disrupt the circadian clock include:

- Drinking caffeine at night
- Using electronic devices at night
- Eating and drinking at night
- Going out late and waking up early
- Not having a set sleep time
- Working late shifts

Of course, genetics, age, health issues, and many other factors can also play a role in having a healthy circadian rhythm. Children and teenagers tend to need more sleep than adults, as they're still developing. Additionally, people with neurological diseases like Alzheimer's might find it difficult to get an appropriate amount of sleep as it damages the neurons that keep them awake.

WHAT DOES CIRCADIAN RHYTHM AFFECT BESIDES SLEEP?

While having a late night or two is bound to happen now and then, frequent or long-term disturbances to our body clock can lead to various health problems, such as insomnia, depression, fatigue during the day, and a shortage of energy. Over time, being out of sync with our circadian rhythm can increase risks for conditions like obesity, cardiovascular disease, diabetes, gastrointestinal problems, neurodegenerative disorders, and countless more.

HOW CAN WE OPTIMISE OUR CIRCADIAN RHYTHMS?

Several things can help optimize circadian rhythms for better health and well-being, such as:

Exposure to daylight: Exposure to bright light in the morning can help reset the circadian clock and make us feel more awake while minimizing exposure to too much light at night can help us sleep better.

Regular sleep schedule: Going to bed and waking up at the same time every day, even on weekends, can help control your circadian clock and promote better sleep. You can also take small naps in the early afternoon if you feel tired, but try to avoid longer naps.

Healthy lifestyle choices: Eating a balanced diet, exercising regularly, and avoiding smoking and excessive alcohol consumption can help control circadian rhythms and promote better health. Avoiding caffeine and heavy meals at night can also help

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Healthy lifestyle choices: Eating a balanced diet, exercising regularly, and avoiding smoking and excessive alcohol consumption can help control circadian rhythms and promote better health. Avoiding caffeine and heavy meals at night can also help.

CONCLUSION

Circadian rhythms are our 24-hour internal clocks, managing our cycles of wakefulness and sleepiness, as well as various biological processes. Disruptions in circadian rhythms have been linked to lots of health concerns, but there are many ways that we can use to improve our circadian rhythms. By understanding and appreciating the important role of our circadian rhythms, we can take steps to promote better sleep, mood, metabolism, and overall health.

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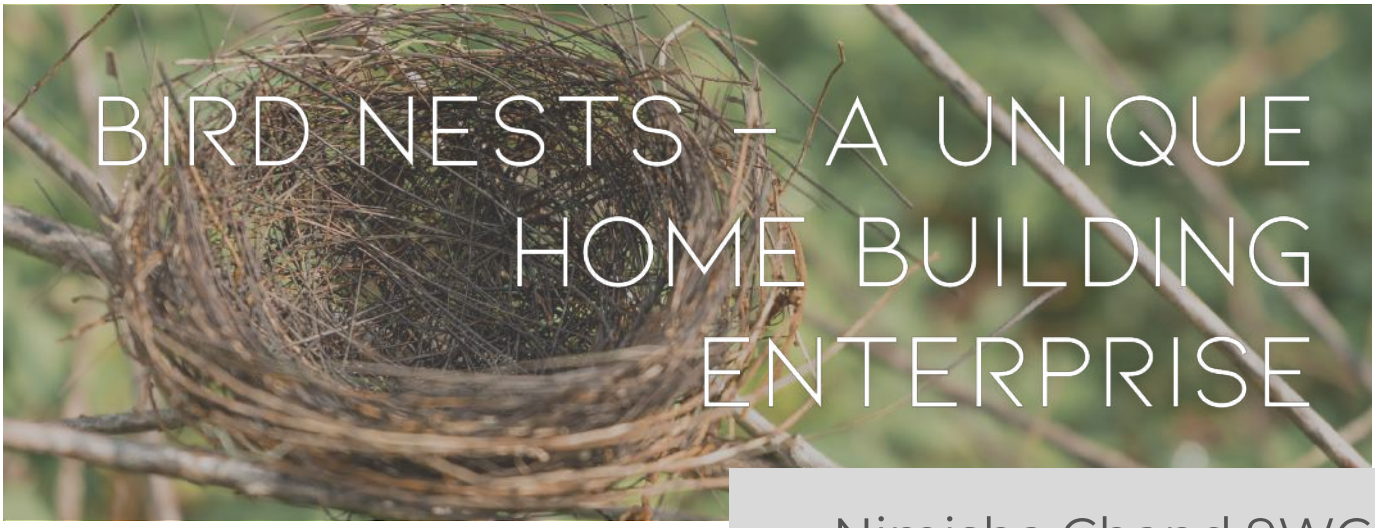

BIRD NESTS – A UNIQUE HOME BUILDING ENTERPRISE

Nimisha Chand 9WC

WHAT ARE BIRD NESTS?

Most organisms naturally find their homes in their environment, not having to make it themselves. Which is why, out of all the species in the animal kingdom, birds are the most creative creatures, building nests that are very complex and time-consuming. As well as unique, each bird has its special way to keep themselves from harm. The female sually does the construction of the nest, and the shape and size of these vary, as do the materials used. There are also many different places that birds build their nests, ranging from grounds, balconies, and treetops.

FUN FACT: Brood parasites are a species of birds which do not raise their own babies. Instead their eggs are similar eggs to that of other birds, so they can sneak it into the other bird's nest. The most common brood parasites are cuckoos, cowbirds, honeyguides, etc. (Croston, R. 2010)

WHY ARE NESTS IMPORTANT TO BIRDS?

A bird requires a nest for laying eggs and if it wants its babies to survive, also for them to be safe. The unborn babies have a risk of being captured by egg-eating animals, such as foxes, snakes, or even other larger birds (Atkins, 2023). Thus, nests are usually camouflaged within the foliage of trees, high up, so terrestrial animals and large birds of prey will struggle to reach and find their prey.

When the eggs hatch, the newborns don't have the ability to fly and have to stay in the nest for 1-2 weeks, still remaining safe. Although, this varies depending on what species. For example, a typical barn swallow would leave when it's about 3 weeks old.

The embryo inside the egg needs to stay warm and incubated, ideally ranging from 36-39°C, if exceeded to more than 41°C,

the body inside is not going to make it. Which is the reason birds sit over their eggs so that they don't get too cold. A nest helps regulate the temperature depending on where it's been built, in correlation to the environment.

HOW DO THE SURROUNDINGS AFFECT THE TYPE OF NEST?

The environment in which the bird lives in, can have different features such as rocks, high trees, bushes, etc. which they can use to their advantage. But it mainly depends on the objects around. Now let's take an eagle for example. They build platform nests, because their habitat is usually situated along water bodies and their nests are built on cliffsides, providing a steady surface. Platform nests are flatter versions of cup nests, comprising of sticks and twigs, with no soft inside. These nests can be made on surfaces such as trees, cliffsides, top of poles, or even on water. Herons, doves, raptors, egrets and pigeons are just some other examples of platform nest builders.

Most birds build their nests on trees, since wider or intersecting tree branches provide ideal building spots for nests, as well as not being too vulnerable. These nests are the most common ones, referred to as cup nests. Cup nests mostly inhabit the young of sparrows, warblers, eagles, hummingbirds, etc. As the name suggests, the nest looks and acts like a cup, consisting of twigs on the outside, and softer matter such as feathers, spider webs or moss on the inside, where the eggs are housed.

Aside from nests being perched on top of trees, they can also be found on branches. The type of nest depends on which part of the branch the nest is built on. Pendant nests usually hang from the end of tree branches, and are droplet shaped. Weaver birds, sunbirds, orioles etc. weave these from grass blades, hair or plant fibre. Baya weavers are widely known for the tubular entrances they build to pendant nests. They only contain a small opening, on the side or below the nest, protecting it from predators.

Now let's move lower to the bark of the tree, where cavity nests are placed. Cavity nests can be dug by their habitants, or can also be found naturally on a tree. It doesn't necessarily have to be in nature though, since holes or crevices in houses or buildings will also suffice. There's a small entrance, and a larger room inside. Woodpeckers, chickadees, barbets, all excavate their own cavities, and other birds can later try to steal territory after it has been used. (Textbook Travel, 2022)

HOW DO BIRDS' CHARACTERISTICS AFFECT THE NEST?

Nearly all birds build nests using their beak, carrying the materials and putting it together. Some birds also use their feet to pick up twigs and sticks. While beaks may seem like the core part of what material and type of nest the bird chooses to build, there hasn't been much evidence on that point. Instead, it is plausible that different types of nests have simply emerged through evolutionary processes, as the bird's ability to adapt to its environment becomes stronger. Eagle's nests are built high up on cliffs, and this is helpful because it works with the bird's sharp eyesight and vision, which they can use to spot prey or predators down below. (Bald Eagles: Nest Building, 2024). In contrast, kiwis have the worst eyesight among birds, and being flightless as well, they use their other senses, such as hearing or scent, to make their way around the environment. They

also have sharp talons and strong legs, which they use to dig out burrows, providing a place in the ground where they can lay their eggs (Kiwi Facts, 2021).

People might speculate that birds who have had more experience building nests, will be more skilled so they can build a safer and more sturdy nest. But actually, the quality of the nest will be the same no matter if the bird was making its first nest, or its last nest (Hall et al., 2015). Research says there are relations though, between brain size, and complexity of the nest. A simple scrape nest on the ground would indicate a smaller brain size, as compared to a cup nest builder. When this experiment was conducted, body mass was one of the factors that would also affect the brain size, thus it was also kept in mind that the body mass correlates with the brain size. Overall, the results showed that as the brain size increases, the more intricate the nest will be. In contrast, as the nest complexity increases, the body mass appears to decrease (Li et al., 2023).

CONCLUSION

In conclusion, different species of birds build different nests by using the best of their environment and picking the most suitable materials to build their nests. A place far away from predators and close to prey will make it easier for survival. Body mass and brain size play an important role in the type of nest. Why birds even know they have to build nests, or how to build it, is all because of instinct that they have gained through evolution.

Each bird uses what it has, to survive and thrive in its situation.

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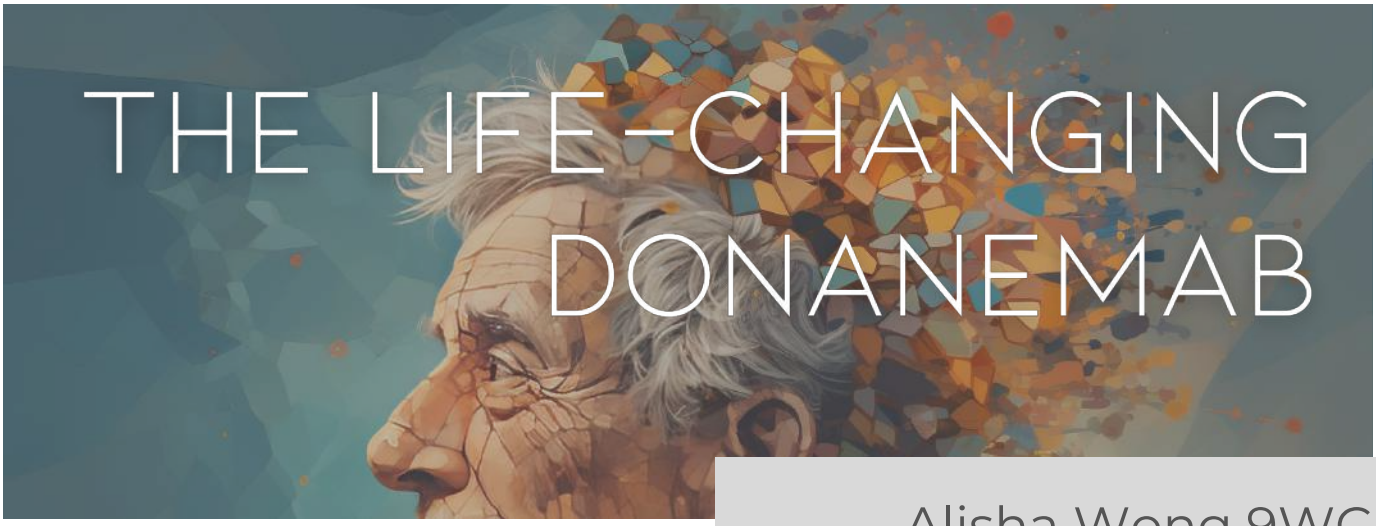


THE LIFE-CHANGING DONANEMAB

Alisha Wong 9WC

INTRODUCTION

Donanemab has shown significant slowing with Alzheimer's in its phase 3 trial. Has a cure been found for one of the deadliest diseases with 1 in 3 seniors dying with Alzheimer's or another type of dementia? (Alzheimer's Disease Facts and Figures, 2023)

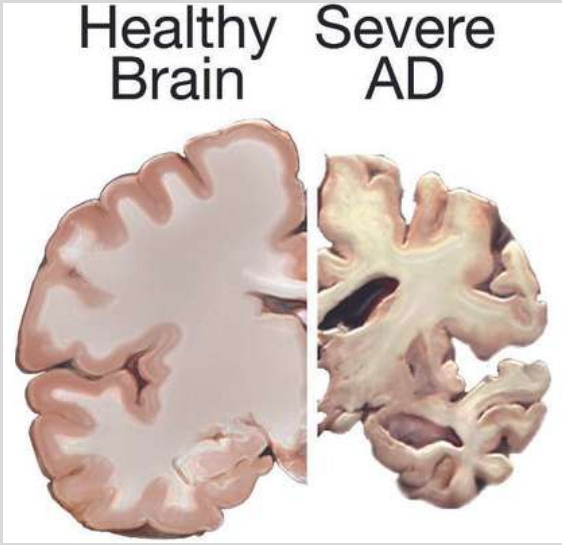
WHAT IS ALZHEIMER'S DISEASE?

In simple terms, Alzheimer's disease destroys your ability to carry out the easiest tasks, such as eating, communicating, etc, because it progressively ruins brain and memory abilities, and is the most common type of dementia.

HOW IS ALZHEIMER'S CAUSED?

This disease is caused by an abnormal protein build-up in and around our brain cells. In our brains, there is a type of protein called amyloid-beta, which comes from a larger protein breakdown, called amyloid precursor protein. (Brain Tour Part 2, 2024) (https://www.facebook.com/NIHAging, 2017)

When these proteins clump together, they form deposits called amyloid plaques. These amyloid plaques can grow in different parts of the brain over time. In the case of Alzheimer's, these plaques are usually found in the hippocampus, the part of the brain that stores your memory and cognitive abilities. Alzheimer's harms the brain through the loss of the connections between networks of neurons caused by the buildup of protein and the formation of these plaques It also causes the brain to shrink because the healthy neurons stop working. This causes the brain cells to eventually die. (How Alzheimer's Disease Changes the Brain, 2022) (https://www.facebook.com/NIHAging, 2017)



WHAT IS DONANEMAB?

Donanemab, by Eli Lilly, can slow cognitive decline in the early stages. This drug is designed to clear the "sticky gunk" that is the amyloid plaque. Donanemab is delivered through a drip bag, and into your vein, this is called an intravenously administered drug. This drug is a type of immunotherapy drug, which means you are using your immune system to recognize and destroy these dangerous cells. These kinds of immunotherapy drugs are also used in medicine to treat cancer. (What Is Donanemab?, 2023) By going through PET scans or testing, it can be shown in their spinal fluids if their amyloid buildup is in an active state and are in the early stages of Alzheimer's to be eligible for the Donaemab treatment.

THE RESEARCH:

To investigate the drug, a study of 1736 patients was conducted, all with early stages of Alzheimer's. Half were given a monthly infusion of Donanemab into their bloodstreams while the other half were given a placebo for 18 months. (Osborne, 2023)

A placebo group is a group of people who are getting inactive substances or treatments with no therapeutic effect. In this case, these patients received a substance that looks exactly like Donanemab but their treatment contains nothing as the active drug itself. Some common placebo examples are a saline injection or a sugar pill. (Health, 2015) The use of a placebo can trick your mind and body into a fake treatment. This effect is called "stimulated healing" which has already been around a millennial! (The Power of the Placebo Effect - Harvard Health, 2017)

THE OUTCOMES:

This inquiry concluded that after 76 weeks of treatment, Donanemab slowed down cognitive decline by 35.1% in people who are suffering in the early stages of Alzheimer's whose brain scans were showing low or medium levels of a protein named Tau. (Osborne, 2023) This drug works rapidly and can clear nearly 90% of the amyloid plaque from the brain. ((Sample, 2023). Donanemab teaches our immune cells to recognize and remove these amyloids. (What Is Donanemab?, 2023) Nearly half of the participants of the Donanemab group (49%) compared to 29% for the placebo, had no clinical progression of the disease worsening at 1 year.

In the research, it was discovered a small number of patients experienced some very significant adverse effects such as Cerebral Edema (swelling in the brain). There was one death in the placebo group and three in the Donanemab group that were deemed to be "treatment-related" in the meantime. (Osborne, 2023)

IS DONANEMAB A CURE?

Can this drug restore memories or any lost abilities from the brain? Donanemab has not proven that it can reverse or restore memory loss and cognitive function that is caused by Alzheimer's. Instead, people's brains would deteriorate more slowly, which indicates that before officially requiring care, they have more time to live independently. It is way better for Alzheimer's patients to have their disease slow down by a whopping ⅓, this can allow people to retain their daily tasks, such as making a meal and enjoying a hobby. (Roberts, 2023)

SIMILAR DRUGS

There is a similar drug out there named Lecanemab. Lecanemab and Donanemab are both immunotherapy, but they target different stages of amyloid buildup, although they are both targeting the same protein. Lecanemab targets amyloid that begins to form fibers, whereas Donanemab targets amyloid that has clumped together and formed as a larger build-up, or a plaque in the brain. (What Is Donanemab?, 2023) This drug is made by Eisai, a Japanese pharmaceutical company. It was proven that Donanemab is a better and safer drug due to the fact Donanemab was built to have different properties that obtain a lower risk of amyloid-related imaging abnormalities, (Sadowski, 2023) which are MRI discoveries of microhemorrhages and superficial siderosis. This drug was approved in the US in early 2023. (Roytman et al., 2023)

The second similar drug is called Aducanumab, but it was pulled back because of its costs and effectiveness, so this drug was rarely used. There were 39.9% of Donanemab treated and only 1.6% of Aducanumab patients that successfully had a decrease in their amyloid. (Salloway et al., 2023) This drug was approved by the FDA in 2021.

CONCLUSION

In conclusion, although Donanemab has some flaws of its own, and is not a cure for Alzheimer's, it can still drastically slow down the disease's progression. Perhaps, there will be a new life-changing cure for Alzheimer's in the future.

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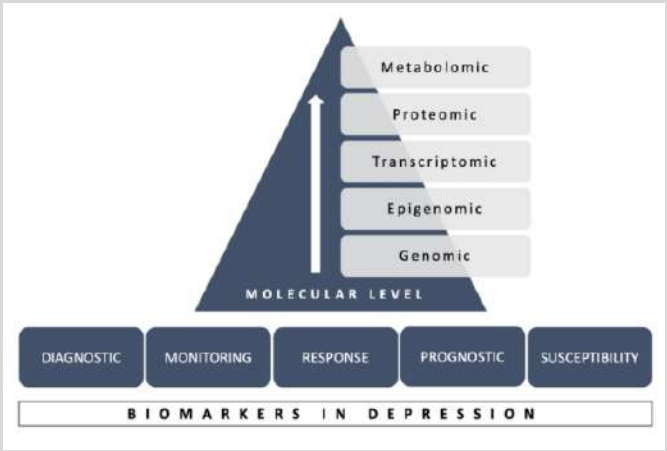
BIOMARKERS IN CHILD AND ADOLESCENT DEPRESSION

Ella Chan 10E



INTRODUCTION

Regardless of age, gender and occupation, depression is a serious health concern globally and is the top cause for disability. During adolescence, it is shown that about one in five teens suffer from depression. This is where biomarkers come into play – through the use of identifying biological processes relevant to depression, they are able to identify and provide relevant insights. This is highly beneficial to the prevention of long term consequences to adolescents' mental health and state of being. Thus, this article will focus on common biomarkers and how the research fares against traditional diagnostics.

COMMON BIOMARKERS

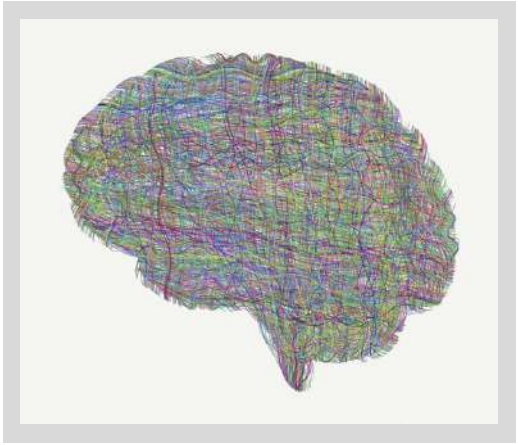
One of the most significant areas of study in the field of biomarkers is Interleukin-6 (IL-6). IL-6 is connected to particular symptoms of depression such as decreased appetite, sleep deprivation, and negative spirits. Additionally, it is considered one of the most promising biomarkers of depression, as findings show that people with depression tend to have higher levels of IL-6 than people without. In the context of children and adolescents, IL-6 levels play a part in determining how well they respond to antidepressant treatment, serving as a good indicator as it is the root for the change in serotonin levels and symptoms. In order to evaluate and implement IL-6's capability to serve as a biomarker, further research is required to solidify the link between depression and biological processes.

Another biomarker that researchers have expressed immense interest towards is the level of methylation in children and adolescents, females in particular. A collection of HPA-axis genes including CRHR1, CRH, CRHR2, and NR3C1 have been recognised as triggers for depression in adolescent girls.

Another biomarker is the brain-derived neurotrophic factor (BDNF). Associated with negative moods, sleep deprivation, little appetite, and other symptoms, abnormal BDNF levels may act as the kickoff for mood disorders. There is also a risk of a smaller prefrontal cortex and hippocampus in the brain. Current research suggests limited information about BDNF as a whole. However,

overexpression of BDNF during the adolescent period in animal models may act as a useful starting point to treating major depressive disorders in adolescents.

BIOMARKERS VS. TRADITIONAL DIAGNOSTICS



So, what sets biomarkers and traditional diagnostics towards depression apart? First, let us understand the components of traditional diagnostics. Traditional diagnostics usually include clinical assessments and medical tests, which are utilised in order to make an accurate diagnosis by ruling out other potential causes of the symptoms. Methods for the traditional approach include: clinical assessments, mental status examinations, laboratory tests (blood tests, thyroid-stimulating hormone, vitamin levels, etc.), Diagnostic and Statistical Manual of Mental Disorders (DSM-5), and last but not least Patient Health Questionnaire-9 (PHQ-9). DSM-5 in particular acts as a guideline to help determine whether the patient has depression as published by the APA. PHQ-9 is also a self-conductive questionnaire which helps aid the monitoring process for depression. As can be seen, biomarkers are more objective when determining whether a patient has depression and can monitor their progress in treatment accordingly, whilst traditional diagnostics focus on a more hands-on approach like clinical practice and research.

CONCLUSION

Biomarkers are sustainable in the long term due to the fact that they are convenient, efficient, and offer less invasive approaches to monitoring depression disorders. Despite their extraordinary potential, we have to keep in mind that this concept is still substantially new compared to clinical practices that already have a long history. Regardless of this, both approaches in combating the surge of depression are vital and both act as accurate, precise tools, with their own collective advantages and inconveniences. In order to further improve diagnosis, prognosis, and especially tailored treatment for children and adolescents that are suffering from depression, development of both traditional and digital biomarkers are required, which undoubtedly further contributes to medical advancements that are already in practice, as well as improving the lives of our existing and future generations.

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ORGAN TRANSPLANTS

Eunice Chan 10N

INTRODUCTION

An organ transplant involves removing an organ that might be damaged and replacing it with a healthy organ so that the body can function normally (healthdirect, 2023). They are needed to help people with terminal and irreversible organ failures and can extend and enhance the lives of the patients (Grinyó, 2013). Generally, organ transplants are only considered a last resort after other treatments have failed, as there are a lot of people who need a transplant and not many people who are willing to donate their organs. According to Hong Kong's Department of Health, in Hong Kong, the number of people waiting for a kidney transplant is 2438, and only 42 kidney transplants were done from January to September 2023 (Hospital Authority, 2023). Hong Kong's deceased organ donation rate is 4.7 per million people, among the lowest in the world (Legislative Council of Hong Kong, 2023).

HISTORY

People have thought about transferring different parts of the body in ancient legends all over the world, including Roman, Greek, Indian, Chinese, and Egyptian myths (Nordham & Ninokawa, 2021). The first documented mention of any form of transplantation was skin grafting in about 1550 BC, which was mentioned for treating burns (Nordham & Ninokawa, 2021). However, skin grafts have been the only successful transplant until the 1950s (Nordham & Ninokawa, 2021). In 1953, a person needed a kidney transplant and asked a surgeon named Joseph Murray, who had been investigating renal transplant techniques, for help (Powell, 2011). The person received a kidney from his identical twin after having been tested for the matching of the brothers by carrying out skin grafts, and he lived eight years after the transplant (Powell, 2011). Scientists began researching immunosuppression to research rejection in the 1960s and found out that some chemicals could suppress immune reactions from foreign organs, which led to the first successful transplant between unrelated patients using azathioprine and was also the first cadaveric transplant (Edinburgh Renal Unit, 2018). Thirteen xenotransplants were also done between chimpanzees and humans from 1963 to 1964, and one of the patients lived for nine months after the surgery (Cooper, 2012). Later in the same decade, pancreas, heart, and liver transplants were also done (Nordham & Ninokawa, 2021).

ORGAN TRANSPLANT

A lot of organs can be transplanted. The most common organs are the heart, lungs, liver, and kidney (Hospital Authority, 2023). There are two types of donors for organ transplants: living and cadaveric. Some organs can also be donated by living people, for example, kidneys, where people can donate one of their two kidneys, or livers, where people can donate a portion of their livers (Mayo Clinic, 2023). However, hearts cannot be donated by living people. Cadaveric organ

donation is an organ donation from someone dead. After an organ is removed from the body (both living and cadaveric organ donation), the cells and tissues will start to break down, as there is no oxygenated blood (LifeSource, 2022). They are stored in a preservation solution and are cooled down to keep the cells from breaking down (LifeSource, 2022). Each organ has a different time frame for how long the organs have to be transplanted after they are removed from the body. For example, the heart can only be out of the body for at most 4-6 hours, while kidneys can function for up to 36 hours (Donor Alliance, 2023). Sometimes, after an organ transplant, organ rejection may occur when the body's immune system attacks the organ because it is a foreign object. Even though tests before the transplant can reduce rejection, there is still a risk of rejection even a long time after the transplant. Immunosuppressive drugs are used to keep the body from rejecting a new organ, however, they make the person more likely to develop an infection as the immune system is suppressed (UVA Health, n.d.).

XENOTRANSPLANTATION

Xenotransplantation is different from allotransplantation, as while allotransplantation is within the same species (e.g. human to human), xenotransplantation is cross-species (e.g. pig to sheep) (Babb de Villiers, 2022) (Gallagher, 2022). As the number of people who need organ transplants is increasing and not enough people are willing to donate, scientists and doctors are investigating organ transplants between humans and non-humans. Although different organs have been used in xenotransplantation, pig organs are the most commonly used for transplant into humans since pig organs have a similar organ size as humans, can reproduce quickly, and humans have experience farming pigs (Babb de Villiers, 2022). While organ rejections also happen in allotransplantation, xenotransplantations trigger a more fierce defence system (called hyperacute rejection) from the person's immune system as the body recognises that the tissue is not human (BIO, n.d.). CRISPR gene editing technology can help scientists alter genes to remove antigens, reducing the chances of rejection (Babb de Villiers, 2022). Scientists have also tried to put human genes into the pig's genome (Babb de Villiers, 2022). There are also concerns about the chances of infections from animal organs, from diseases such as porcine endogenous retroviruses, which are in the genes of all pigs, and some of them can transfer to human cells (Denner, 2021). To prevent this, different methods have been developed, for example, selective breeding, post-transcriptional gene silencing, antiviral drugs, vaccinations, and genome editing (Denner, 2021). The pigs are also grown under specific conditions to prevent exogenous infections (Denner, 2021). In addition, there are ethical issues surrounding xenotransplantations, such as finding the fairest system to allocate organs, animal ethics about the care of the animals (as they will be kept in laboratory conditions), religion, and more (Rollin, 2020).

3D BIOPRINTING

Since the largest risk of organ transplant is organ rejection, scientists are working on growing an organ from cells in the patient's body so that the body will not reject the organ without taking immunosuppressive drugs (ClevaLab, 2021). Scientists are doing this by using 3D bioprinting, which is similar to a normal 3D printer, printed layer by layer, except that it uses bioink (made from cells, hydrogels, and chemicals) instead of plastic (Jones, 2019). Even though scientists cannot print complex organs at the moment, they can already print simpler tissues, for example, blood vessels (Jones, 2019). Cells in bioink can come from an organ and be replicated in a lab (BBC, 2022). There are different methods of bioprinting, extrusion-based bioprinting, droplet-based bioprinting, and energy-based bioprinting (Hello World HD, 2021). The prints are printed onto a flat surface or into support bath material, which will help hold the material so that it does not collapse. The print is also incubated as cells proliferate and change over time (Hello World HD, 2021). As mentioned before, cells from bioink can come from an organ, but it might be difficult to take healthy cells from an organ that is damaged. This is why stem cells are used. Stem cells are cells that can turn into different types of cells in the body (MedlinePlus, 2016). The 2

major types of stem cells are embryonic and adult. Embryonic stem cells can turn into any type of cell but can only be found in the embryo, while adult stem cells can only turn into a specific type of cell (ClevaLab, 2021). Skin cells, which are easy to access, can become induced pluripotent stem cells to make other types of cells when they are cultured with specific growth factors for bioink (Cleva Lab, 2021). One challenge for 3D bioprinting complex organs is keeping the cells alive, as cells can be damaged or die easily (Becher, 2023).

XENOTRANSPLANTATION

Xenotransplantation is different from allotransplantation, as while allotransplantation is within the same species (e.g. human to human), xenotransplantation is cross-species (e.g. pig to sheep) (Babb de Villiers, 2022) (Gallagher, 2022). As the number of people who need organ transplants is increasing and not enough people are willing to donate, scientists and doctors are investigating organ transplants between humans and non-humans. Although different organs have been used in xenotransplantation, pig organs are the most commonly used for transplant into humans since pig organs have a similar organ size as humans, can reproduce quickly, and humans have experience farming pigs (Babb de Villiers, 2022). While organ rejections also happen in allotransplantation, xenotransplantations trigger a more fierce defence system (called hyperacute rejection) from the person's immune system as the body recognises that the tissue is not human (BIO, n.d.). CRISPR gene editing technology can help scientists alter genes to remove antigens, reducing the chances of rejection (Babb de Villiers, 2022). Scientists have also tried to put human genes into the pig's genome (Babb de Villiers, 2022). There are also concerns about the chances of infections from animal organs, from diseases such as porcine endogenous retroviruses, which are in the genes of all pigs, and some of them can transfer to human cells (Denner, 2021). To prevent this, different methods have been developed, for example, selective breeding, post-transcriptional gene silencing, antiviral drugs, vaccinations, and genome editing (Denner, 2021). The pigs are also grown under specific conditions to prevent exogenous infections (Denner, 2021). In addition, there are ethical issues surrounding xenotransplantations, such as finding the fairest system to allocate organs, animal ethics about the care of the animals (as they will be kept in laboratory conditions), religion, and more (Rollin, 2020).

CONCLUSION

To conclude, an organ transplant can be used to help patients with terminal and irreversible organ failures by replacing the organ. The most common organs that can be transplanted are the heart, lungs, liver, and kidney, and they can come from both living or dead bodies. There is a risk of organ rejection after the transplant, where the immune system attacks the transplant. Xenotransplantation, which is transplanting organs between different species, is used as there are not enough organ donors. While scientists cannot use 3D bioprinting to print complex organs yet, there is hope that 3D bioprinting can print complex organs for transplantation to save more people in the future.

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AN INTRODUCTION TO THE PSYCHOLOGY BEHIND SERIAL KILLERS

Anson Chiu 10N

INTRODUCTION

As humans, our interests are often piqued by dangerous topics given our nature to find relief in having a deeper understanding of our fears. An example of this would be our fascination with serial killers, a topic that many criminologists try to find the root cause of. This article will serve as an introduction to exploring the psychology behind serial killers.

WHAT ARE SERIAL KILLERS?

Serial killers are generally defined by law to be murders of 3 or more people in a time period longer than a month with “cooling off periods” in between (Philip Jenkins, 2024). There are four main types of serial killers, categorised by their dominating motive being power and control, psychotic breaks (visionary), self indulgent pleasure (hedonistic) and the elimination of a certain group of people (mission-oriented). With this said, there are always exceptions, with some serial killers’ motives being cravings like fame, fortune and lust (A. Bonn, 2019).

EARLY DEVELOPMENT AND SOCIAL FACTORS

Studies have shown that approximately 74% of serial killers had trauma stemming from their childhood experiences (EduBirdie, 2022). Elements of child abuse, either physically, sexually or psychologically, were evident in a large majority of the individuals questionned, allowing researchers to speculate whether the exposure to such violent behaviour took part in cultivating the aggressive mindset of a serial killer. According to the NHS, a behaviour sequence analysis carried out in 2020 showed that those who had experienced physical and sexual abuse as a child had evidence of overkill on the victim (exessive physical damage) and tended to commit crimes of the same type on others (Jean Marono et al., 2020).

Serial killers are often reported to have mental illnesses as well. It’s important to note that having one doesn’t immediately cause murderous tendencies. However, schizophrenia and antisocial personality disorder 2 have been highly prevalent in serial killers (Maghsoodloo et al., 2012). An article published by the NLM states that a study carried out on patients with schizophrenia in the 1990s revealed that it increased the chance of violent actions by around 8 times (Richard-Devantoy et al., 2009). Antisocial personality disorder was also frequently observed in offenders, with it increasing the risk of becoming a serial killer 10 times in men and 50 times in women (Richard-Devantoy et al., 2009). These effects are enhanced by other factors, such as drugs, alcoholic substances and low income.

1 Schizophrenia is a rare major mental disorder that causes people to hallucinate and think in a disorderly manner, disturbing their view of reality.

2 Antisocial personality disorder (ASPD) is a condition categorised by the difficulty for someone to feel empathy to other individuals, as well as separate right from wrong.

BRAIN CHEMISTRY AND GENETIC FACTORS

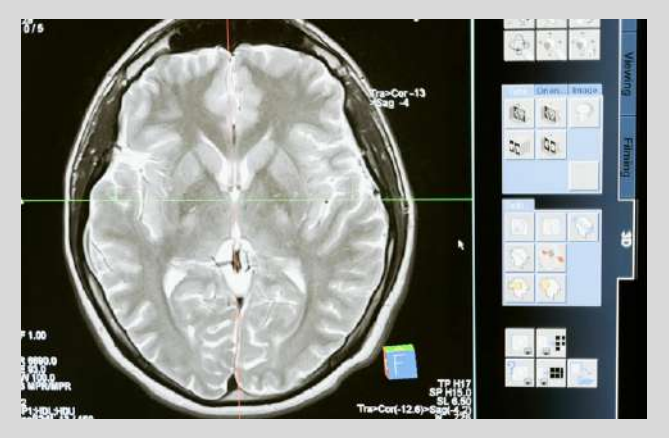

Fig 1: Example of a brain scan image

On the other hand, abnormalities in brain structure, especially in the prefrontal core, affect the probability of someone becoming a serial killer too. One prominent difference is that they have less glucose metabolism in parietal areas and the corpus callosum compared to average (StudySmarter, 2019). Another difference is asymmetrical activity in the amygdala1 , thalamus2 and medial temporal lobe (Raine et al., 1997). Additionally, their deficiency in levels of dopamine and serotonin, two neurotransmitters needed for mood regulation, has also been associated by doctors with impulsive aggression and symptoms of depression (Seo et al., 2008). As to how these anomalies were formed, there are two main options: brain trauma and genetic influence.

An investigation on brain trauma in serial killers carried out by Michael H. Stone in 2009 claimed that approximately ¼ of the serial killers they interviewed had suffered either a major injury to the brain or malady, e.g. meningitis (Sharma, 2018). The latter reason for their behaviour mainly concerns the deficiencies of the gene CDH13 (cadherin 13) and genotype MAO-A (monoamine oxidase A), whose absences are linked to not only decreased dopamine turnover rates, increased risk of substance abuse and ADHD, but also violent actions against living organisms (Tiihonen et al., 2014). It's not a certainty, although this feature has been present in a majority of serial killers' genetic make-up leading researchers to suggest that the lack of CDH13 and MAO-A could be one of the factors in the creation of a serial killer due to these genes' important function of moderating impulsive and violent urges.

1 An important part of one's emotional processing.
2 A structure in the middle of the brain that acts like a relay of signals.

CONCLUSION

Given all this information, one can conclude that the psychology behind serial killers is a complex topic that provides no definite answer to the question of why they act this way due to the fluctuations and differences in each person's behaviour, although genetics and experiences during their childhood have been proven to play a major role in causing their behaviour. But hopefully, with all the dedication and effort put in by researchers, recognising behavioural patterns in serial killers will allow experts to analyse the causes of criminal activity and a step will be taken in finding a way to prevent future tragedies from happening.

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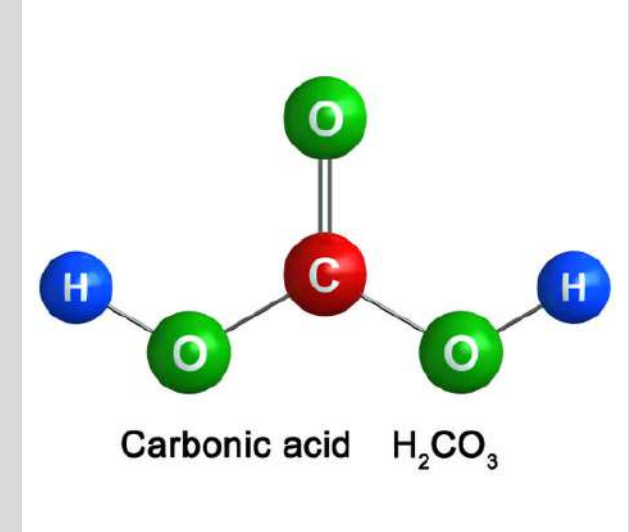
THE EVOLUTION OF SOUR TASTE

Eugenie Kim 10N



INTRODUCTION

Sour taste is one of five tastes that we can recognise (Hannah E. R. Frank, Katie Amato, Michelle Trautwein, Paula Maia, Emily R. Liman, Lauren M. Nichols, Kurt Schwenk, Paul A. S. Breslin and Robert R. Dunn, 2022). You might be familiar with sweet, bitter, salty and umami. We have incorporated sour taste globally, for thousands of years. From fermented kimchi from 4000 years ago to pickles from ancient Mesopotamia, we have been using microbes to take advantage of our sour taste (PBS Eons, 2022).

Despite this, we have little understanding of the evolutionary aspect of sour taste. We know the origins behind other tastes, and why our ancestors had to evolve them to survive (Hannah E. R. Frank, Katie Amato, Michelle Trautwein, Paula Maia, Emily R. Liman, Lauren M. Nichols, Kurt Schwenk, Paul A. S. Breslin and Robert R. Dunn, 2022).

For example, we used bitter taste to warn of potentially toxic compounds in our food, while sweet is used to detect foods high in energy that contain the valuable sugars that we need for processes such as respiration (Hantzidiamantis, 2022). We needed a taste for salt in order to identify sodium and minerals, and umami taste to identify protein-rich foods (Joosse, 2022).

Sour, on the other hand, sticks out as an anomaly. The reason as to why this is because sour foods don't typically contain vital nutrients that vertebrates require, or contain toxic compounds that we might need to potentially avoid (PBS Eons, 2022). Sour taste, unlike all the pre-existing tastes, has not been lost by vertebrates over the changes of evolution. For example, we expected dolphins, vertebrates that appeared to have only salty taste receptors, to not be able to detect acidity in the food that they eat. So was the case for cats, vertebrates that don't have sweet taste receptors. Instead, we found that not only did all tested species retain the ability to taste sour, but that they enjoyed eating sour foods (Joosse, 2022).

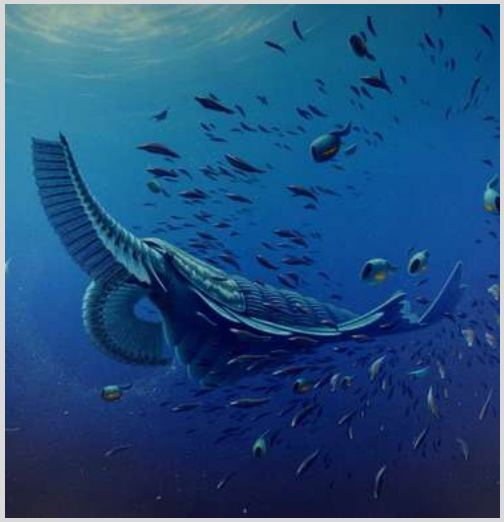
DEEP DIVE - WHY MIGHT WE NEED IT?

Surprisingly, scientists, upon studying the genes of vertebrates, have found that no vertebrates

have lost the ability to taste sour over time. From this, researchers were able to deduce that the ability to taste sour must have originated from our common ancestors - backboned fish (PBS Eons, 2022). They hypothesised that this was important for the ancient fish, most likely because of the need to taste the acidity of the aquatic environment. Ocean acidification, which is when carbon dioxide dissolves into seawater, can be dangerous for living organisms, making the ability to sense the ocean's acidity important for our ancestors (Hannah E. R. Frank, Katie Amato, Michelle Trautwein, Paula Maia, Emily R. Liman, Lauren M. Nichols, Kurt Schwenk, Paul A. S. Breslin and Robert R. Dunn, 2022).

But why does the ability to taste sourness stick to us even as far as now? Our fish ancestors were actually filter-feeders, meaning that they simply sucked other smaller organisms. They soon evolved and started to access their food choices, like how we do today (like what you'll eat for lunch) (Hannah E. R. Frank, Katie Amato, Michelle Trautwein, Paula Maia, Emily R. Liman, Lauren M. Nichols, Kurt Schwenk, Paul A. S. Breslin and Robert R. Dunn, 2022). The ability of sour taste soon shifted from a sense to check the environment's acidity to an important tool to detect and avoid acidic foods. For example, an animal that would need to avoid acidic foods is the sheep. This is because eating high concentrations of acidic foods can lead to damage to their gut-microbiome, since they heavily rely on bacteria in their gut to digest their food (PBS Eons, 2022).

However, some species enjoy sour foods, including us. Researchers believe that our taste for sourness has shifted over the course of our evolution as apes. We lost our ability to produce our own vitamin C millions of years ago, when a gene responsible for producing the vitamin mutated (Hannah E. R. Frank, Katie Amato, Michelle Trautwein, Paula Maia, Emily R. Liman, Lauren M. Nichols, Kurt Schwenk, Paul A. S. Breslin and Robert R. Dunn, 2022). Ever since, we have been in need of finding our own sources of it so that we don't suffer from deficiencies like scurvy. Vitamin C, also known as L-ascorbic acid, has a strong acidic, sour flavour. You can find vitamin C in a variety of citrus, fruits and fermented foods, which you eat everyday (at least I hope) (PBS Eons, 2022).



CONCLUSION

However, despite our current knowledge about how animals evolved our sense of sour taste, things remain yet wishy-washy. We will never know for sure based on the data that exists in the present, how our ability to detect this taste was able to stand against time and remain withstanding to this day. Perhaps someday we shall discover the definite truth and reason why vertebrates have kept this ability throughout the course of evolution, but for now, we are left to speculate using what information that we have in our current time.

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DWARF PLANETS

Bernice Yu 10N

INTRODUCTION

You may have heard of the dwarf planet Pluto. It is the most famous dwarf planet and it used to be the ninth planet. Aside from size, what makes dwarf planets different from normal planets? In 2006, the IAU (International Astronomical Union) defined something as a planet through three requirements. This consists of orbiting its host star, having a mostly round shape and being large enough so that its gravity is able to clear away anything with a similar size near its orbit around the host star (Pluto & Dwarf Planets - NASA Science, n.d.). All requirements apply to dwarf planets except for the last one. Dwarf planets are not able to clear away their orbit of debris, which normal planets are able to do through their larger size (Pluto & Dwarf Planets - NASA Science, n.d.).

DISCOVERED DWARF PLANETS

Currently, there are five recognised dwarf planets, and they are Pluto, Ceres, Makemake, Haumea and Eris (Society, 2023). However, astronomers think that there may be many more dwarf planets, having discovered more such as Quaoar, Sedna and Orcus, with much more possible candidates. All the five recognised dwarf planets are located in the Kuiper Belt except for Ceres, which is located in the main asteroid belt between Mars and Jupiter. A lot of dwarf planets have very cold temperatures, ranging from negative 100-200 degrees celsius, making it unsuitable for lifeforms. Many dwarf planet discoveries have provided us with useful information, giving us knowledge about other planets in our solar system. One example of this is the study of the orbital paths of Pluto and Neptune, which shows the two bodies interlocked in orbital resonance (Wendel & Wendel, 2022). When Neptune orbits the sun three times, Pluto has done two orbits, meaning that the

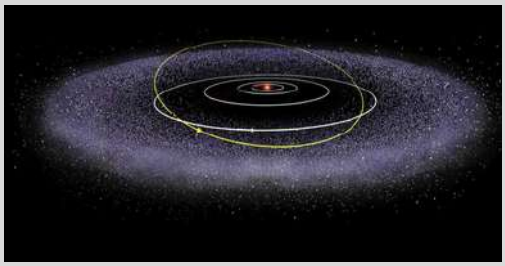
formation of both planets have taken place closer to the sun, but migrated out later over time (Wendel & Wendel, 2022).

Dwarf planet Pluto was discovered in the year 1930 and was a planet until 2006, where it was categorised instead as a dwarf planet. It has a radius of 1,185 kilometres, and compared to Earth, Pluto is about one-sixth of Earth's total width (Pluto & Dwarf Planets - NASA Science, n.d.). Similar to normal planets, Pluto also has moons, having five of them. Charon is Pluto's largest moon, notably being about half the size of the dwarf planet itself. On the 14th of July, NASA's New Horizons spacecraft flew to Pluto and began a closer discovery, revealing a heart-shaped area of ice containing icy mountains (Dooling, 2024). Additionally, it also found some reddish material covering Charon's north pole that seems to have come from Pluto's atmosphere (Dooling, 2024).

As mentioned previously, unlike other dwarf planets, Ceres is located in the main asteroid belt. In 1801, it was discovered by astronomer Giuseppe Piazzi and explored by NASA's Dawn spacecraft in 2015 (Pluto & Dwarf Planets - NASA Science, n.d.). It is considered as one of the smaller dwarf planets in our solar system, estimating about 1/13 of Earth's width (Pluto & Dwarf Planets - NASA Science, n.d.). Makemake is a reddish-brown dwarf planet and is smaller than Pluto but larger than Ceres, with a diameter of about 1,426 kilometres. It gets its name from the Rapanui god of fertility. In March 2005, it was first observed by M.E. Brown, C.A. Trujillo and D.L. Rabinowitz at the Palomar Observatory (Pluto & Dwarf Planets - NASA Science, n.d.).

Haumea has a unique shape compared to most dwarf planets. Its oval shape comes from its fast rotation speed, making a full rotation in 4 hours. Across its longest axis, it measures about 2,322 kilometres (Society, 2023). Its name comes from the Hawaiian goddess of fertility. It also has two moons named Namaka and Hi'iaka. Eris is a larger dwarf planet, with a similar size to Pluto, having a radius of 1,163 kilometres (Pluto & Dwarf Planets - NASA Science, n.d.). Discovered in 2005, this dwarf planet gets its name from the Greek goddess of discord and strife (Pluto & Dwarf Planets - NASA Science, n.d.). It has one moon named Dysnomia. Similar to Haumea, this is named after Eris' mythological daughter.

THE KUIPER BELT



Home to many dwarf planets, the Kuiper Belt is located beyond Neptune's orbit, consisting of small icy objects. Known to be one of the largest regions of space in the solar system, it was named after Dutch American astronomer Gerard P. Kuiper, because of his publication of a scientific paper in 1951 that speculates about objects beyond dwarf planet Pluto. These objects are assumed to be leftovers during the formation of the outer planets in the solar system, which is similar to the formation of the main asteroid belt. (Kuiper Belt | Definition, Location, Size, & Facts, 2023). For now, there are more than 2,000 objects that have been catalogued by observers, but this is only a small amount compared to the total number of objects astronomers think there are (10 Things to Know About the Kuiper Belt - NASA Science, n.d.).

CONCLUSION

To conclude, a dwarf planet is defined through its ability to orbit around its host star, being mostly round and able to clear away objects near its orbit using gravity. The IAU has five recognised dwarf planets, which are Pluto, Ceres, Makemake, Haumea and Eris, with many more dwarf planets out there in the universe. As scientists and astronomers continue to discover more dwarf planets over time, this gives us a better understanding of how the universe works and its history, shaping our view of the world we live in.

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Avery Yau 10R

INTRODUCTION

The mind is the ultimate powerhouse of human nature. It has sculpted many into renowned innovators as well as notorious killers. For centuries, scientists have been astounded by the duplicity of mankind - are psychopaths birthed similarly to erudites? Are their motifs genuinely innate, or are they simply products of unrelenting trauma? Ultimately: what makes a criminal, criminal?

WHAT GOES ON IN A CRIMINAL'S MIND?

According to the US Department of Justice, impulsiveness is the most significant and notable trait present among offenders. This is often accompanied by [greater hostility] as well as [negativism] (Buikhuisen et al., 1984). Neurologically, these traits stem from a part of the brain called the amygdala. Located in the medial temporal lobe, this component acts as a major processor for emotions and memories (Clinic, 2023). Results from a study conducted by Dustin Pardini, Ph.D., show that men (the assessed population only included men) with lower amygdala volumes are more likely to be belligerent than men of the same age but with higher volumes of amygdala (Pardini et al., 2014). This shows that the amygdala can differ in size depending on different emotional circumstances. Another study led by psychologist Meagen E. Beckerson produced results that proved a correlation between amygdala size and psychotic tendencies; i.e. persons who showcase psychotic behavior tend to have smaller amygdala sizes (Beckerson et al., 2023).

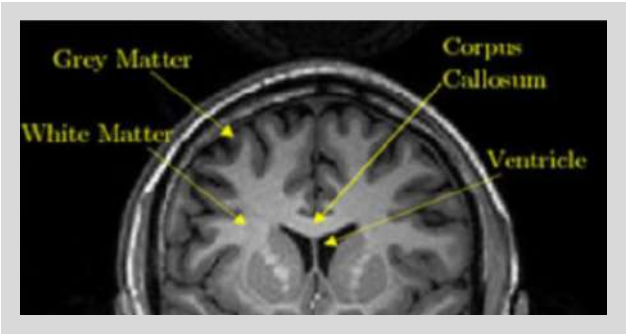
Criminal behavior, however, can be sourced from other underlying conditions. In the case of a middle-aged school teacher developing interests in child pornography, MRI scans reveal the presence of an orbitofrontal (area of the prefrontal cortex that's located above the orbits) tumour; neurologists believe this to be the main source of the patient's sexual deviancy. Sources later claim that once the tumour was removed, the teacher's interests reverted to normal. Additionally, Russel Swerdlow, the leading neurologist of the case stated that [the tumour likely interrupted connections between the orbitofrontal lobe and the amygdala]; this likely affected the man's impulse control and thus his unprecedented behaviour (Burns & Swerdlow, 2003). According to several sources, most cases of rape and sexual assault are results of diminished impulse control; meaning that most unplanned crimes are acted out wantonly and intuitively, on impulse (Marneros, 2007). Most of these offenders also show no remorse or empathy after committing these crimes; their acts were simply fearless*.

*In an experiment led by postdoctoral research associate Yu Gao from UPenn, several three-year-olds were examined for fear conditioning in set conditions. The report states, "The researchers put electrodes on the children's fingers while repeatedly playing two tones". One of the tones

as played followed by an unpleasant, cacophonous sound; another was played alone without accompanying tones. After twenty years of observation, the results showed that some of the participants had committed crimes (the degree of violence was not clear). These participants were revealed to be the ones who failed to display fear through the sets of experiments. In other words, these children were unsuccessful in perceiving danger and thus showed no signs of having awareness. This trait is often the result of a dysfunctioning amygdala, meaning that they fail to properly process strands of information; not properly identifying what is 'safe' and what is not (Gao et al., 2010).

Another common trait among most psychopaths is their seeming lack of contrition (Ramsland, 2017). This image compares the amount of grey matter in the minds of murderers to other offenders; grey matter is involved with the processing of information which can be used for feelings of empathy and remorse. They have a reduced amount of this matter. According to scholars from the University of Chicago, they believe that there is a strong correlation between the amount of grey matter present in the brain and the chances of committing aggravated crimes (Turner & Koenigs, 2019).

SO ARE THESE TRAITS GENETICALLY PROPELLED?



According to the twin studies (epidemiological studies designed to measure the influence of genetics on a given trait), genetic effects explain 56% of the variance in gray matter volume (Alex et al., 2023). Another study also revealed a strong relationship between childhood trauma and the volume of gray matter present in the brain. This research, conducted by Marieke J.H. Begemann involved participants who were diagnosed with bipolar disorder and schizophrenia, as well as healthy individuals. All participants were obliged to fill out a Childhood Trauma Survey and also underwent neuroimaging through numerous scans. Results show a [pattern of more pronounced frontal grey matter reduction] in participants who reported histories of childhood trauma (Begemann et al., 2021). A child's upbringing is also extremely integral to adulthood development and thus their susceptibility to crime. As mentioned previously, the amygdala functions as the center of 'information processing'; the smaller the size, the more likely a child is to develop psychotic tendencies (Pardini et al., 2014). Research also shows that the volume of the amygdala can be affected by certain anxiety disorders; especially when paired with depression (De Bellis et al., 2000) (Pezawas et al., 2005) (Zahn-Waxler et al., 2008) (van Elst et al., 2000). Next, reports show that a majority of the population diagnosed with Alzheimer's disease tends to be quite small (Jacobs, 2023). They further reveal that most cases of AD are not 'transmitted' through inheritance (National Institute on Aging, 2023).

An experiment conducted at the University of Cambridge in 2020 provided evidence that youth with higher trauma scores had a smaller amygdala volume (Peverill et al., 2023). Additionally, among all cases of trauma, sexual and physical abuse has been shown to have the most impact on amygdala subregions (Nogovitsyn et al., 2020). Furthermore, high levels of stress may cause initial expansion of the amygdala yet present adverse effects (size reduction) later on (Hanson & Nacewicz, 2021).

However, in certain scenarios, amygdala size can also be inherited. Meta-analyses suggest that the possibility of a child inheriting anti-social behavioral sets is approximately 40-60% (Ferguson, 2010). An examination of the influence of common DNA variation [in a sample of neurologically healthy adults] (led by members of the Queensland Brain Institute), strongly emphasized that

genes were highly expressed in the human amygdala (D Stjepanovic et al., 2013).

CONCLUSION

After collecting a myriad of credulous data, I believe that criminality can be both inherited and/or nurtured through the early years of childhood. Nonetheless, we can say that there is little likelihood (among case reports) that deviant traits are inherited/innate; acute cases are exempted as they are most likely products of both genetics and childhood trauma. Instead, most criminologists believe that they are more likely to be developed as a result of trauma (about most non-violent to semi-violent cases). Although it is scientifically proven that inheritance is fully possible, starting in the fetus, it is more likely for traumatic events to occur during the stages of childhood into adulthood. Events like sexual assault and/or physical abuse can be adversaries to one's mental health; victims are usually more prone to mental disorders post-trauma. Various data sources reveal that there's a significant association between sexual abuse and a permanent (lifetime) diagnosis of anxiety disorders. It is incredibly important to emphasize that children and teenagers are extremely prone to assault and abuse, even in the modern age. Statistically, one in nine girls and one in twenty boys under the age of 18 experienced sexual abuse or assault (to, 2014). This beats the odds of one inheriting so-called criminal traits.

While criminal behavior can sometimes be driven by natural occurrences such as tumors and an innately small amygdala, negative childhood experiences pose a further risk of criminal activity. Furthermore, schools, social services, and most importantly parents should appropriately identify behavioral signs displayed in children that raise concern; e.g. antagonism, low levels of awareness, morbid fascinations, etc. Governments should also enhance municipal services and facilities to suit certain groups of people that are more likely to experience or exert trauma; e.g. low-income households or families with criminal records.

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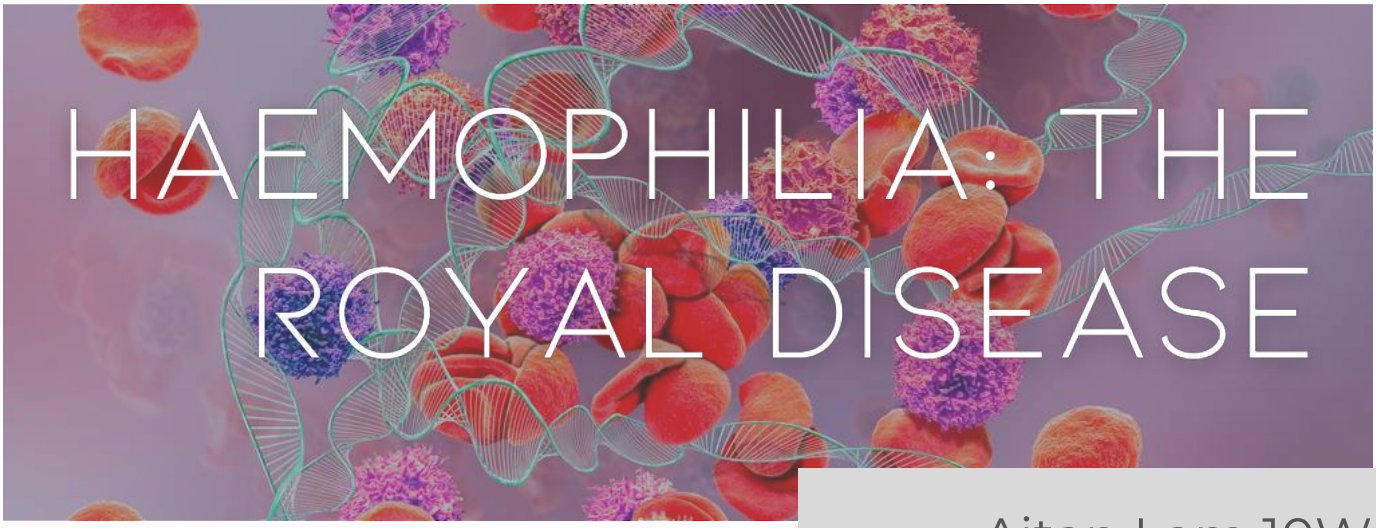

HAEMOPHILIA: THE ROYAL DISEASE

Aitan Lam 10W

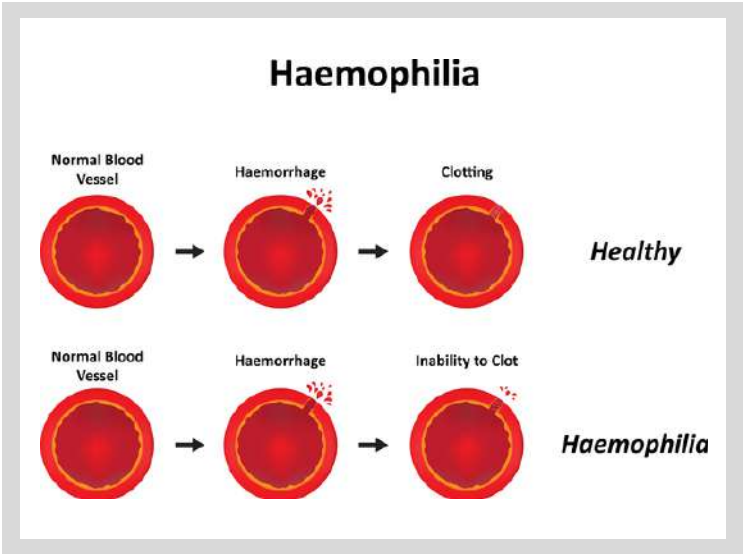

Fig. 1: Clotting in healthy RBCs versus those with haemophilia.

Haemophilia is a sporadic hereditary condition that causes significant impairments to the body's natural blood clotting systems. Because Queen Victoria of England inherited haemophilia, it has been referred to as the "royal disease" by the medical profession for centuries. Haemophilia is caused by mutations in the genes that create factors VIII and IX, two proteins required for blood clotting. The two most prevalent types of haemophilia are hereditary and are known as haemophilia A and haemophilia B.

Haemophiliacs either have low quantities of these clotting factors or lack them completely, which increases their propensity to bleed heavily or even uncontrollably after wounds and procedures. Thus, even little incisions or internal haemorrhages into muscles and joints can quickly become life-threatening. Before the development of clotting factor replacement therapy, the majority of people with severe haemophilia died from heavy bleeding before they reached adulthood, which is depicted in Fig. 1.

Haemophilia is a complex and prolonged diagnosis of various diagnostic procedures (blood tests, imaging tests, and other diagnostic done to measure the levels of clotting factors VIII and IX. Absence or abnormality of factor VIII or IX levels indicates haemophilia A or B, respectively. The ratings are used to determine severity and are classified as mild, moderate, or severe based on the percentage of normal coagulation factor activity.

The physician can also review the patient's medical records and inquire about abnormal

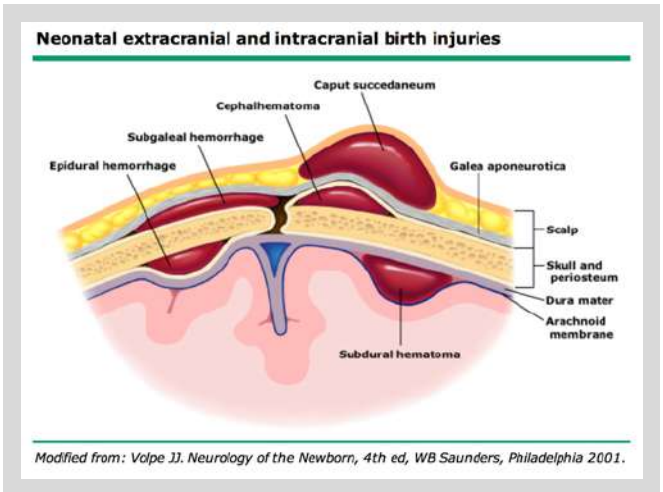

Fig. 2: A diagram of a cephalohematoma, an accumulation of blood under the scalp.

or delayed bleeding in the medical history. Medical history plays an important role in diagnosis because a history of joint bleeding, birth injury, frequent nosebleeds, delayed bleeding from cuts, and bleeding in the womb can be a sign of bleeding disorders. A family history of bleeding is also important, as haemophilia is a genetic condition.

A physical examination can also be performed to detect signs of bleeding in the joints or muscles. The physician will assess the area of limb motion and tenderness, noting any unusual sweelling, pain, or heat in the joint. Unexplained lesions or bleeding on the skull (cephalohematoma) in infants may indicate bleeding, so they are also checked during physical examinations.

After analysing all the test results, the physician can determine whether the patient has haemophilia or not. The tests also provide crucial information to shape treatment planning and symptom management immediately from the initial diagnosis. Ongoing testing and monitoring are also needed to ensure therapy remains safe and effective, especially for those on clotting factor replacement or prophylaxis (preventative treatment). Early diagnosis, especially in babies and children, helps prevent complications from delayed or missed treatment.

Haemophilia mainly affects men because of mutated genes on the X chromosome Meanwhile, women usually carry the mutations and can pass them on to their offspring. The severity of haemophilia in individuals can vary from mild to severe depending on one’s immune response. Fortunately, with appropriate treatment and injury prevention, hypertensive patients can generally live normal lives, although their life expectancy may be slightly reduced.

A CURSE ON THE CROWN: HAEMOPHILIA IN THE LINE OF SUCCESSION

The close link between haemophilia and European royalty can be traced to none other than Queen Victoria of the United Kingdom, widely regarded as the first person known to carry the haemophilia gene in royal blood. The Queen passed on the genes to her three children: her daughters Alice and Beatrice, and her youngest son Leopold.

Leopold, Duke of Albany, suffered from haemophilia and faced many challenges throughout his life as a result of his condition. Sadly, he died at the age of 30 from a cerebral haemorrhage possibly related to his fall.. Leopold's sisters Alice and Beatrice carried the gene and passed it on to their children.

(Fig. 3: Alexei Nikolaevich, Tsarevich of Russia.)

As a result of this genetic inheritance, haemophilia spread dramatically in many European royal families, including those of Russia, Spain, and Germany. Alexei, the son of Tsar Nicholas II and Czarina Alexandra — the granddaughter of Queen Victoria — had inherited the “Royal disease.” The collapse of the Russian aristocracy was heavily by influenced Alexei's haemophilia, ultimately leading to the Russian Revolution. The young prince's health was so dire that Grigori Rasputin, a self-proclaimed saint, had to temporarily set aside Alexei's bleeding affair and the increasing political and social discontent in Russia. Rasputin's influence on the royal family, his role in the fall of the Romanov dynasty, and the rise of the Bolsheviks were underway.

A BREAKTHROUGH IN CLOTTING: HAEMOPHILIA MEDICATIONS AND PROCEDURES

There are several efficacious treatments for haemophilia, the most common of which include the following:

- Clotting factor replacements: Administering missing clotting factors intravenously (typically factors VIII or IX) to restore blood clotting. It treats acute bleeding episodes and prevents bleeding before surgeries or physical activity. Factors can be derived from blood plasma donations or synthesised using recombinant DNA technology.
- Prophylaxis: Regular infusions of clotting factor concentrates prevent bleeding in severe haemophilia cases. Prophylactic factor replacement started early can help avoid joint injury and other effects of recurrent bleeding episodes.
- Pain management: Clotting factors and pain medication alleviate acute bleeding pain. Painkillers may be required for persistent joint pain from repetitive bleeding.
- Physical therapy: Joint bleeding, commonly experienced by haemophiliacs, can cause a loss of strength, flexibility, and mobility. Physical therapy and targeted activities help to mitigate the effects.
- Orthopaedic surgery: Severe and untreated haemophilia causes repeated bleeding and therefore joint damage. Orthopaedic procedures like joint replacement and synovectomy (removal of the synovial lining of the joint,) address chronic pain or disability caused by haemophilia.

The care provided to those with haemophilia has been revolutionised by these medicines. People with haemophilia can now control acute bleeding episodes and stop them altogether because of the development of clotting factor replacements. Prophylactic factor replacement therapy, in particular, has reduced the frequency of joint injury and other effects of recurrent bleeding. With a variety of drugs available to deal with both acute and chronic pain problems, pain management has also advanced tremendously.

Physical therapy is becoming a vital part of haemophilia care as it lowers the risk of joint injury, enhances overall quality of life, and helps patients retain joint flexibility and strength. When necessary, orthopaedic surgery is also an immensely effective treatment for haemophilia-related problems.

CONCLUSION

Haemophilia is a long-lasting condition that requires cautious treatment. Luckily, medical advancements have led to the emergence of compelling, accessible, and effective medication to treat the disease. With appropriate consideration of available treatments, people with haemophilia can nowadays lead ordinary and satisfying lives, liberated from the incapacitating impacts of this complicated condition.

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