Autumn 2025

DragonScience

Edited by Yolcy Zhang, Claire Sun, Yolco Mao (G12)

Robotic Research

Rehabilitation in Professional Football Players

Effort heuristic: How Environment Influences Art's Value

Is Time Travel Just a Theory?

Students use terrariums to identify fungus species

Ms. Kushner

Over the past two years, the GIN/ STEM Club developed and established small-scale terrariums to teach students about ecosystems, water, nutrient cycles and plant biology.

Students have observed how a controlled terrarium environment is ideal for growing plants that need high humidity, like mosses and ferns. They were also able to observe how these environments are self-sustaining and circulate moisture and air.

When studying these environments, very interesting fungi started appearing in the terrariums, which the students identified, and then observed their germination and spore production during their lifecycles. Most moulds that occur on potting soil do not pose a health risk. However, if the spores of these fungi accumulate in the room air, sensitive people may experience health problems, especially people with chronic or allergic respiratory diseases. (Bergman, 2022).

Figure 1: Cleave

This led to investigating what kinds of fungi are commonly found in soils in China, their uses, and which species should be avoided due to their toxicity.

Peat-free or peat-reduced potting soils consist of varying percentages of wood fibre, bark humus and green waste compost. These soils have naturally occurring fungal spores. High moisture levels combined with heat provide ideal conditions for fungal spores to germinate. (Bergman, 2022). Students successfully identified the "yellow flowerpot fungus", commonly known as the Flowerpot Parasol, scientifically named Leucocoprinus birnbaumii.

According to Li. et al, "Mushroom poisoning is a serious food safety problem in China. Since 2019, China CDC has conducted a series of investigations into mushroom poisoning outbreaks." (Li et al.) In a 2024 China CDC study, investigators identified 110 poisonous mushroom species. These species caused 7 distinct clinical disease types, including 8 species as newly documented as poisonous mushrooms in China. 599 mushroom poisoning incidents were identified across 28 provincial-level administrative divisions, affecting 1,486 patients and resulting in 13 deaths, with a case fatality rate of 0.87%. (Li et al.)

Students have become more aware of the necessity to identifiy new fungi species immediately and identify potential toxins. Effective control and treatment of mushroom poisoning in every schools involves comprehensive prevention through education, such as avoiding wild mushrooms and proper identification, and a coordinated emergency response plan. There are no reliable indicators for distinguishing edible from poisonous mushrooms, so the only safe approach is to avoid eating any wild mushroom. (Malinowska-Cieslik and van den Borne)

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The Neighbors in the Sky

Mr. Coolidge

Figure 1 Saturn through binoculars 22x60 (Credit: Surveyor 1, Cloudynights.com)

"Look around this Solar System of heavy elements… Here lies the body of a dead star." – Epitaph by Tracy Drain, Nasa-JPL systems engineer.

When humans first gazed at a dark sky sprayed with bright lights our imaginations compelled us to fill the sparkling void with stories and myths. Bright specks in the sky became linked with imaginary art of heroes, gods, and legends. Lifetimes later we can see beyond the myth into the void and find it full. Swirling clouds of gas, spinning torrents of matter, holes in space that not even light escapes, and an elusive lightless matter yet to be explained. Not every star in the night sky is an impossibly distant ball of burning gas, some of the brightest lights are our, comparatively calm, neighboring planets.

The planets of our solar system did not spontaneously come into being from the nothingness space. Every solar body (8 planets and 5 dwarf planets, sorry Pluto) is the dust collected from an exploding star 4.6 billion years ago. So big and near are the remnants of that explosion we can see them from our backyards.

Humans are driven by a romance of exploration, yearning always for the novelty of a new world, a new discovery, or any kind of change at all. Civilization has taken the earth we spin on and carved it with lines and borders that lay claim to the dirt. The fantasy of an unending horizon for the wild heart to march towards has been limited by permits and regulations. For those with pioneering dreams we must look further. Up and out of our planet's thin atmosphere (only 11 km thick) is our planetary neighborhood. Rocky balls of carbon and giant spheres of gas dance in a lazy circle around the nuclear fire of our solar system, and we have a front row seat.

Our neighboring planets are the frontier horizon of humanity's future. It is not over some distant horizon to be seen by the few and bold. If you look up tonight the future of humanity is within sight. The brave pioneer that will take mankind from dirt bound primates to interplanetary conquerors could be you.

So, what can I see when I look up?

Even beneath the urban blanket of light pollution that our city reflects off our sky, the brilliant images of planets shine through. For the next two months Saturn, the ringed giant, will be visible with the naked eye. Look just above the southern horizon after sunset to see its bright yellow reflection. Better yet, get a good pair of binoculars, stay up till it reaches its peak height in the sky (around 10:45 pm) and you may be able to see the lumpy shape of its rings or the bright dots of its largest moons.

Following Saturn's act will be Jupiter, the red gas giant. Its enormous size, 11 times wider than earth (NASA, 2025), and much closer than Saturn, make it easy to see with a pair of binoculars. With a medium sized DIY telescope you can even see the great red hurricane that blows at over 500 km/h.

Figure 2 Jupiter viewed through a camera lens (Credit: Stephen James O'Meara, Astronomy.com)

"Jupiter Facts." NASA, NASA, 21 Apr. 2025, science.nasa.gov/jupiter/jupiter-facts/#h-size-and-distance.
O'Meara, Stephen James. "Jupiter through Binoculars." Astronomy Magazine, 18 May 2023, www.astronomy.com/astronomy-for-beginners/jupiter-through-binoculars/.

TMU MedAspire: AI, Tech, and the Future of Medicine

Anna Lu - Grade 11

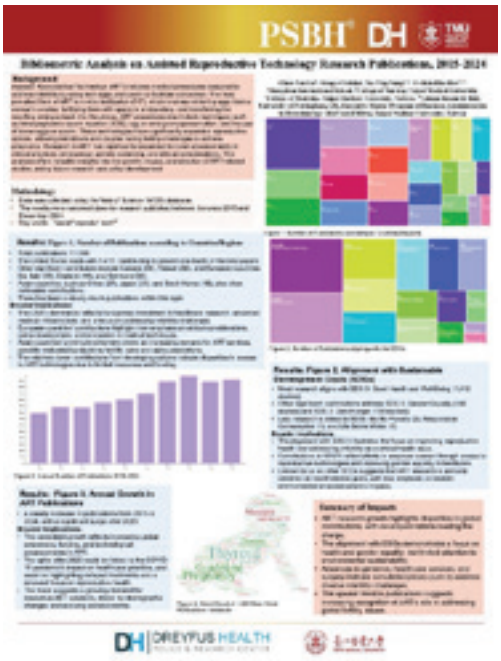
Over the summer, I had the great opportunity to participate in a two-week immersive program at Taipei Medical University (TMU). The experience deepened my knowledge and perspective on the future of medicine as I spent these weeks exploring the newest medical technologies, engaging in international conferences, and many more experiences. Among the many highlights, three aspects stood out the most to me: the role of AI in healthcare, the revolutionary Da Vinci surgical system, and learning practical clinical skills.

AI in Medicine: A Super Assistant or a Competition?

One of the most impactful moments of the program was the international conference on artificial intelligence in medicine. The discussions focused on AI advancements, including AI-powered mental health applications, diagnostic tools, and weight loss programs. I learned that AI is often referred to as a "super assistant," and has the potential to reduce human error, improve efficiency, and even revolutionize patient care.

However, the conference also highlighted the challenges AI brings. One issue is the lack of cultural understanding, and inherent biases in AI algorithms, which are often based on incomplete or skewed historical data. The concept of "AI hallucination" was especially concerning for me: how AI systems can sometimes generate false information with confidence. We see this often in AI in everyday life, for example, asking AI for book recommendations, and it made up completely non-existent books.

We also explored debatable ethical questions like "Who is accountable if AI makes a mistake?" and "Should patients or algorithms make decisions?". The conclusion was clear: "Doctors must lead AI—not follow it blindly." This emphasizes how doctors will not be replaced by AI, except maybe the fields of pathology and radiology, so… look out for that…



The Da Vinci Surgical System: The Future of Surgery

Another unforgettable experience was my hands-on interaction with the Da Vinci surgical system, a robotic assistant for minimally invasive surgeries. Watching a thoracic surgeon operate with precision on a video was impressive, but it didn't compare to the excitement of controlling the system myself.

The Da Vinci system combines human expertise with technological precision. It allows surgeons to do complex procedures with smaller incisions, which reduces recovery time and improves patient outcomes. This experience inspired me to consider a potential career in surgery, combining traditional medical skills with technological innovation.

bob the mannequin

"National Taiwan University Hospital Uses Single-Port Robotic System for Surgery | Taiwan News | Aug. 11, 2025 14:33." Taiwannews.com.tw, 11 Aug. 2025, www.taiwannews.com.tw/news/6176277. Accessed 3 Sept. 2025.
("National Taiwan University Hospital Uses Single-Port Robotic System for Surgery | Taiwan News | Aug. 11, 2025 14:33")

Bibliometric Analysis: The Power of Research

Another standout session during the program was on bibliometric analysis, a research method used to quantitatively analyze published academic literature. This process involves using statistical tools to evaluate the impact, trends, and influence of research within a specific field.

We learned how to use platforms like Web of Science (WOS) and VOSviewer to search for academic articles, analyze their relevance, and organize findings into visual tools like word clouds and impact charts. A practical exercise required us to select a research topic, search for relevant articles, and design an academic poster summarizing our findings, which was then entered into a gallery walk style evaluation of which the good ones were used by the university.

Learning Practical Clinical Skills

One of the most interactive and rewarding parts of the program was learning and practicing practical clinical skills. We had the opportunity to work on mannequins to perform essential procedures such as intravenous catheter insertion, airway management intubation, urinary catheter insertion, and nasogastric tube placement.

What I found most valuable was the realization that these seemingly complex procedures became manageable with guidance and repetition. Although practicing on mannequins was great, I understand that the real challenge is applying these skills to actual patients. It was a reminder that no amount of practice on simulations can fully prepare you for the emotional and technical demands of working with real people. In addition to learning procedures, we also practiced physical examinations, focusing on abdominal and neurological assessments. These sessions helped us develop both technical accuracy and patient communication skills.

The program culminated in an Objective Structured Clinical Examination (OSCE), a practical test designed to evaluate our clinical skills. The OSCE involved rotating through several stations, each testing a different skill or knowledge area, like history-taking, physical examination, and patient communication. This was stressful as it pushed me to apply everything I had learned throughout the program in a timed, structured environment. It also revealed how much goes on in those simple questions that the doctor asks you in the clinic.

Doing the OSCE was a valuable opportunity to practice working under realistic conditions. It also gave me insight into how medical students and professionals are assessed in real-world scenarios. This experience taught the importance of preparation, adaptability, and maintaining calm and professional under stress.

The Intersection of AI, Surgical Bots, and Research

Reflecting on these experiences, it became clear how interconnected these fields are. AI can streamline bibliometric analysis by processing massive datasets, while surgical robots like the Da Vinci system may one day incorporate AI to analyze patient data in real time and enhance precision. On the other hand, practical clinical skills remind us that human expertise and empathy will always remain at the core of medicine, no matter how advanced technology becomes.

As aspiring students who want to go into healthcare, it's our responsibility to lead these advancements, making sure they serve humanity in the best possible way. The message I took away from the program is that "Technology will never replace doctors; it will empower us to dream bigger, care deeper, and create a healthier world."

Acknowledgments: I would like to express my sincere gratitude to the incredible professors, doctors, and coordinators who made this such a meaningful and enriching experience.:

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Ms. Aline Weng

Four Weeks Inside the Brain at USC

Tonya Liu - Grade 11

Having no idea of what I wanted to do with my life, and taking an interest in the University of Southern California because I liked their colors and their women's volleyball team, I applied for their summer program in early 2025. I got to spend 4 weeks in LA, living in USC village with hundreds of students like myself. From the program "The Brain: Intro to Neuroscience", I took away mountains of knowledge and discovery about neurobiology, biology, chemistry, psychology, statistics, and myself. Little did I know, the summer of 2025 would not only be one of the best, but also the most impactful summers I've had.

The course was full of lectures and hands-on learning through labs, which meant I spent a lot of time writing lab reports (nine in total). At first, it felt like a lot of work, but I quickly realized how much it pushed me to think and write like an actual scientist. The labs themselves were also really fun: dissecting a pig brain, extracting my own DNA, and learning how to use a micropipette (a fancy pipette that can measure down to microliters) to run gel electrophoresis. In between, we covered the fundamentals of how neurons work, from ion channels and action potentials to how networks of neurons create memory, behavior, and disorders when things go wrong. We traced the different pathways in the brain that control how information travels, and I started to see how chemistry, biology, and psychology all overlap in neuroscience. We also got to visit some of the laboratories on campus and see all the research that was going on. The best part was our final project - a murder mystery case where we had to use everything we learned to present our findings. My team went above and beyond by creating a documentary-style short film on the case (let me know if you want the YouTube link).

A huge reason the course was so impactful was my professor. She had an endless energy for science, and not just neuroscience, but chemistry, biochemistry, microbiology, cancer research, physics, mental health disorders, radiology, advanced math… honestly everything. What stood out to me was how much she cared about our questions and the depth of which she'd explain things that we'd almost run out of time for the content. When I asked her what math class I should take for IB, she told me, "Take the one you're probably going to fail." So that's what I'm doing, since I'm going to have to face it sooner or later.

Of course, not everything was labs and lectures. We went on some really interesting field trips (for a neuroscience program), like indoor skydiving and bouldering. The Summer Program even brought us to Knott's Berry Farm, a super fun amusement park, and a Dodgers game on the Fourth of July. Living in USC village was another highlight all by itself. Imagine having Target, Sephora, Trader Joe's, every cuisine of food, and a gym all right downstairs. And better, Chipotle was only a 10-minute walk away. Beyond the convenience, the people and connections I made are sure to last for a long time. I met students from literally all over the world, and at the end, I felt like I'd known my roommates for years instead of a month.

I went to USC because I liked their colors and volleyball team. I left with a fascination for the brain, endless memories, and way too many Cava meals. Although the summer didn't give me all the answers for my future, it showed me the best way to find them is to keep exploring.

Sleep

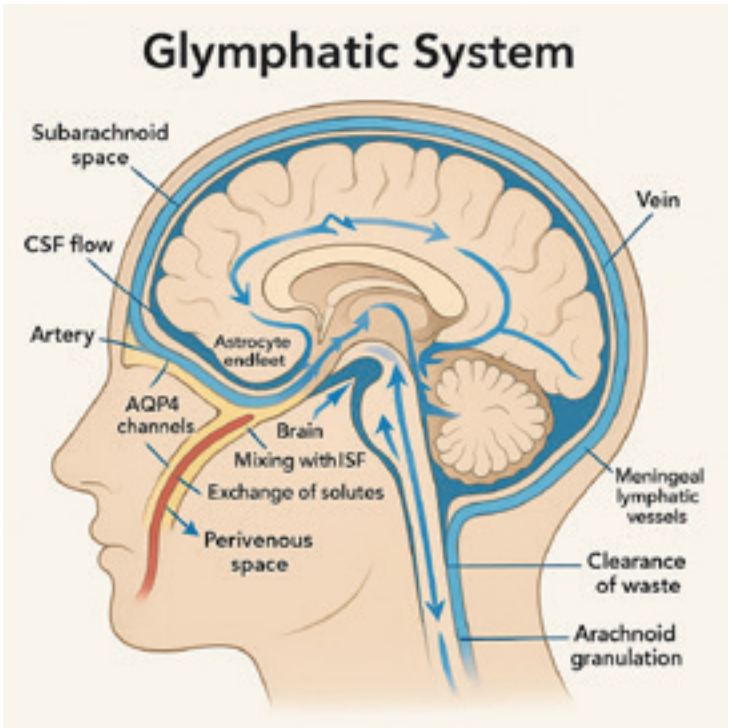
Kingsley Chen - Grade 8

We often think of sleep as wasted time. Eight hours lying still, not working, not studying, not doing anything productive. But neuroscience tells a very different story: your brain is never more active in one very specific way than when you are asleep. While you rest, your brain is busy performing a vital task — it washes itself clean.

For decades, scientists were puzzled. Every organ uses the lymphatic system to remove waste — except the brain. Since the brain produces an enormous amount of metabolic waste while fueling thought, memory, and emotion, researchers asked: how does it get rid of all that clutter?

In 2012, researchers at the University of Rochester discovered the answer: the glymphatic system. This network uses cerebrospinal fluid (the clear liquid that cushions the brain and spinal cord) to flush waste out of the brain. The name comes from "glia" (the brain's support cells) and "lymphatic," since the two systems work in similar ways.

Here's the astonishing part: this process only happens effectively when you're asleep. During deep sleep, brain cells shrink by about 60%, opening up more space between them. This allows cerebrospinal fluid to wash through the brain tissue like a tide, carrying away toxic by-products such as beta-amyloid and tau proteins — substances that, if left unchecked, can accumulate and damage neurons.



One of the wastes cleared during sleep, beta-amyloid, is the same sticky protein linked to Alzheimer's disease. When too much beta-amyloid builds up, it forms plaques that interfere with brain communication and eventually kill nerve cells. By sweeping it away nightly, the glymphatic system may be one of the brain's most important long-term protective mechanisms.

This also explains why sleep deprivation can feel so brutal. Without sleep, the nightly clean-up crew never comes. Waste lingers, neurotransmitters are thrown out of balance, and your brain fogs over. Students who try to pull all-nighters before exams aren't just tired — their brains are clogged with metabolic trash, making it harder to remember what they studied.

The implications go far beyond school performance. Chronic sleep deprivation has been linked to a higher risk of dementia, depression, obesity, and even cardiovascular disease. Researchers now suspect that impaired waste clearance may be a major reason. If the brain cannot remove toxins efficiently, damage builds up year after year, increasing vulnerability to disease.

Even one night of poor sleep can disrupt memory, reaction time, and emotional control. A study from the National Institutes of Health revealed that just a single night of sleep deprivation significantly increases beta-amyloid levels in the brain.

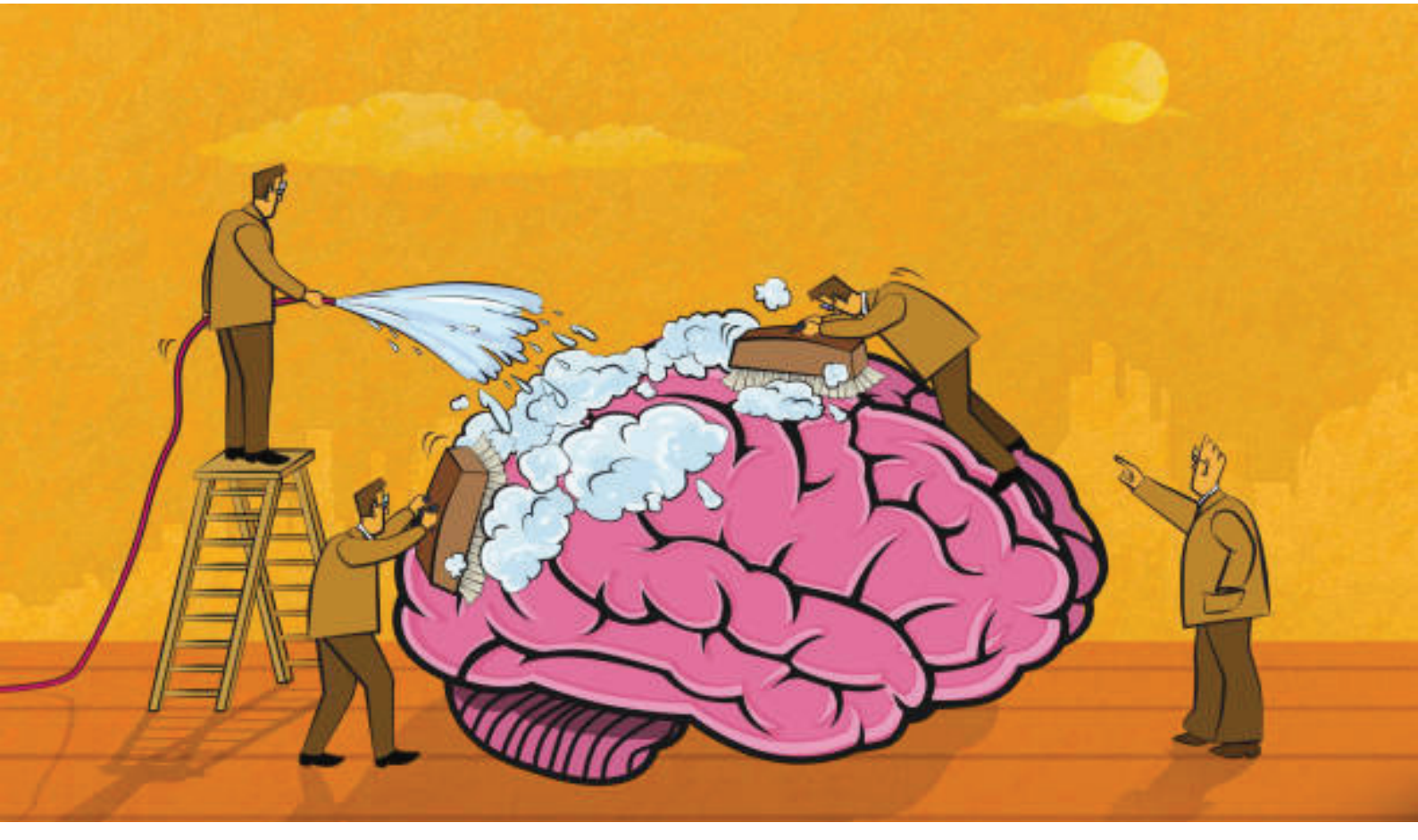
Not all sleep is equal. Light sleep, deep sleep, and REM sleep (dream sleep) all serve different functions. The glymphatic system is most active during deep, slow-wave sleep. This means that even if you sleep for eight hours but never reach deep sleep — perhaps because of late-night screen time, stress, or inconsistent schedules — your brain won't be fully cleaned.

The science is clear: you can maintain your brain's health by maintaining your sleep. Practical steps include:

1. Consistency: Go to bed and wake up at the same time each day, even on weekends.
2. Environment: Keep your room dark, quiet, and slightly cool.
3. Screen curfew: Avoid phones, computers, and TVs at least 30–60 minutes before bed, as blue light delays melatonin release.
4. Routine: Use calming rituals — reading, stretching, or listening to quiet music — to signal to your brain it's time to wind down.
5. Awareness: Recognise that "just one more hour" of studying late at night may cost you more than it gives back.

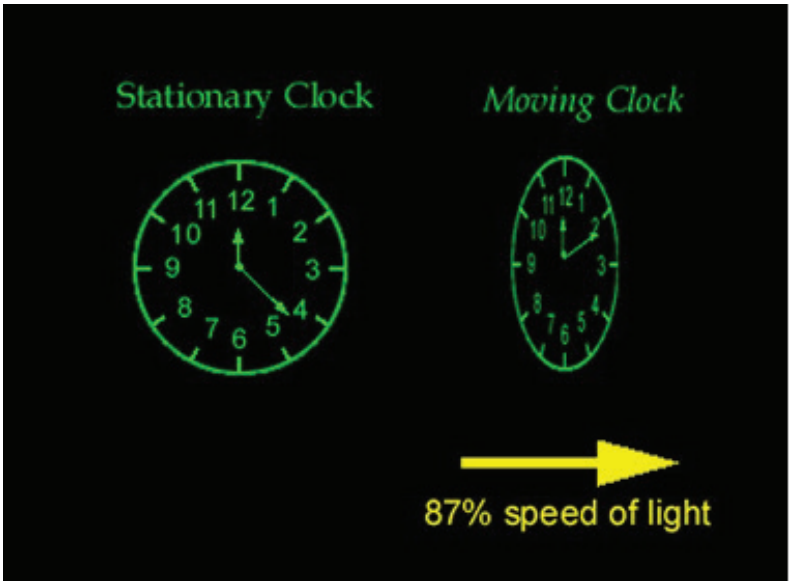
When you close your eyes tonight, remember that your brain is about to begin one of its most important jobs. As you drift into deep sleep, microscopic rivers of cerebrospinal fluid will sweep through your brain, clearing waste, preserving memory, and preparing you for tomorrow's challenges. Sleep is not laziness — it is maintenance.

So the next time you're tempted to sacrifice sleep for homework, gaming, or scrolling, remember: your brain's dishwasher can't run if you don't press "start."



Is Time Travel Just a Theory?

Spring Shi - Grade 10



Albert Einstein once suggested, "The distinction between past, present, and future is only a stubbornly persistent illusion." (AZ Quotes, 1). Time travel, a conceptually challenging idea of traveling between different points in time, both into the past or future, is unproven and currently may be considered "fictional," therefore not as simple as entering through a time machine; however, a phenomenon known as time dilation exists, according to Einstein's theory of relativity (NASA Space Place, 1). This consists of special relativity (1905), which states that the speed of light is constant for all observers, regardless of their motion, and general relativity (1915), which states that gravity is caused by the warping of space and time by mass (U.S. Department of Energy, 1).

Time is relative, not absolute. Time dilation occurs due to gravitational fields and relative velocity; time for an object in motion passes more slowly in relation to an observer at rest. Due to gravitational fields and relative velocity, objects with more mass generate a stronger gravitational field, warping space and time. Relative velocity measures an object's speed and direction relative to another object. The effects of relative velocity demonstrate that as objects travel through space with increased speed, approaching the speed of light, they travel through time more slowly (EBSCO, 1). The effects of gravitational fields cause time to slow down in stronger gravitational fields. For example, due to the Earth's gravitational field, a clock runs normally in stronger gravity and perceives another clock to run faster in another area with weaker gravity. In contrast, a clock in weak gravity runs normally and perceives the clock in strong gravity running slowly (Baird, 1). (Schirber, 1).

One experiment used to support the existence of time dilation includes studies on muon decay, carried out by Rossi and Hall in 1941, utilizing muons (elementary particles with short lifespans), created from cosmic rays during collision with Earth's atmosphere, demonstrating longer lifespans of muons moving at high momentum compared to muons with slow momentum due to special relativity. The Haefele-Keating experiment was performed in 1971 and explained the concepts of special and general relativity. Atomic clocks were flown around the world in an eastward direction, corresponding to Earth's rotation, and in a westward direction, opposite to Earth's rotation. The atomic clock going in the eastward direction had a faster speed due to the combined velocities of Earth's rotation and the plane through space, predicting a loss of time. By subtracting the Earth's rotation speed from the plane's speed, the atomic clock going in the westward direction traveled at a slower speed in space and gained time. Both atomic clocks were flying at high altitudes, causing both clocks to run faster than the clocks on Earth (Siegel, 1).

A consequence of time dilation is known as the "Twin Paradox", a thought experiment with one twin traveling in a high-velocity spaceship with an unstable reference frame by acceleration, while the other twin remains on Earth, and the traveling twin eventually returns to Earth younger than the other twin. An unsymmetrical effect occurs as the motion of the spaceship isn't constant in a straight line, causing the twins to age differently due to special relativity (May, 1). (The Physics of the Universe, 1).

In conclusion, the perception of time is different for individual observers and depends on their location and viewpoint. Time travel doesn't exactly signify time difference. Einstein's theory of relativity, divided into special relativity and general relativity, has proven time dilation, which occurs as a result of time and space being perceived differently due to different frames of reference (U.S. Department of Energy, 1). A few experiments have also been conducted to test the theory of relativity, including the Rossi and Hall experiment and the Haefele-Keating experiment. It might differ from what was originally imagined and expected, but time travel does exist.

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Robotic Research

Jia-chen Qu - Grade 12

Executive Summary

As humans explore the underwater world for its energy reserves, natural resources, and marine life, submerged infrastructure in oceans is expected to increase tenfold in the next 20 years. However, maintaining underwater assets is a costly and time-consuming challenge, as current underwater robots are inefficient and inflexible in underwater inspection operations. In the face of these challenges, a new robot—the EXRAY – aims to revolutionize subsea inspection and maintenance with its high-speed wireless communication, flexibility, and portability.

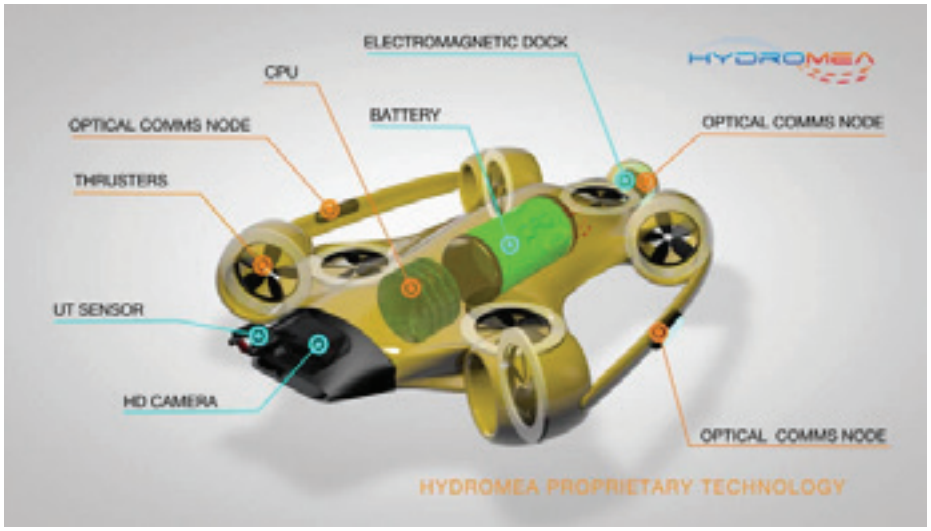

Figure 1. The EXRAY robot designed by Hydromea with its key components (Allen).

This paper examines Hydromea, the technology company founded in Switzerland responsible for developing and marketing EXRAY robots. The company is strategically positioned within the underwater market to capitalize on the growing need for a safe, efficient, and sustainable solution to underwater monitoring. This paper first covers the technical and historical background of the company to understand the development of its three core products: The LUMA, DISKDRIVE, and EXRAY. Afterwards, the market trends and demands for Hydromea's underwater inspection robots are quantitatively analyzed to determine the size and scope of the company's business opportunity. Considerations for threats and limitations to the company, including market competitors and geographical limitations, are also discussed.

With an evaluation of Hydromea's global positioning and key competitive offerings, recommendations for the future direction of the company are then suggested and justified. These include a hypothesis-driven market research plan using a Minimum Viable Product (MVP) to validate key assumptions, a word-of-mouth promotion and sales strategy to acquire clients, and a hybrid business model between subscription-based and direct sales to maximize revenue.

Problem Statement

As humans explore the underwater world for its energy reserves, natural resources, and marine life, submerged infrastructure in oceans is expected to increase tenfold in the next 20 years. However, maintaining underwater assets is a costly and time-consuming challenge, as current underwater robots are inefficient and inflexible in underwater inspection operations. In the face of these challenges, a new robot—the EXRAY – aims to revolutionize subsea inspection and maintenance with its high-speed wireless communication, flexibility, and portability.

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Value Proposition

In the face of these challenges, the company Hydromea offers a unique, innovative solution to achieve underwater monitoring. The company's key value proposition is to "cut the cord", proposing to offer the "EXRAY," a remote-controlled underwater robot that can communicate wirelessly with a human controller. This allows underwater maintenance to become much more efficient and flexible, allowing the robots to inspect narrow areas without the restraints of optical wires. The rate of information transfer is also much faster than acoustic systems despite being operated wirelessly.

Figure 2. Hydromea's LUMA-X Optical LED light transmission (WIPO).

Another value proposition of the company is to offer environmentally friendly approaches to underwater monitoring. The company aims to develop robots that have minimal environmental impact while also being more energy efficient than conventional methods of underwater monitoring. As a result, the company is working towards achieving the UN's Sustainable Development Goals of Objective 9: Industry, Innovation, and Infrastructure; Objective 13: Climate action; and Objective 14: Life Below water.

Lastly, Hydromea aims to offer a more cost-effective and cheaper approach to underwater monitoring and regulation. Through the EXRAY, the company founders aim to commercialize the underwater industry and make it more widely accessible to the general public, offering wide-reaching and flexible solutions to various underwater problems. Their products aim to achieve an 80% annual cost reduction to underwater maintenance costs when the robot system is fully operational. This is achieved through low-cost production and operation budgets, as well as energy-efficient communication devices compared to the acoustic transmission systems.

Mission Statement and Values

Hydromea's mission is to "enable cost-efficient, scalable, and sustainable asset monitoring by fusing autonomous systems with unique wireless communication solutions." Through their EXRAY products, LUMA optical modems, and DISKDRIVE thrusters, they hope to pioneer the industry of underwater monitoring, providing a remote-controlled vehicle that is more effective from both an economic and environmental perspective.

Hydromea's key values include a strong focus on sustainable development and environmental friendliness, as they want to facilitate greener marine operations that inflict less of an impact on the environment. Hydromea also puts strong focus on cost-efficient production, minimizing the cost of their products to improve their accessibility.

For full document go to this Google Doc link:
https://drive.google.com/file/d/1abBGFmJqnGLZAdU9c6MQ6i3-D66AYIUZ/view?usp=sharing

Rehabilitation in Professional Football Players

Yolcy Zhang - Grade 12

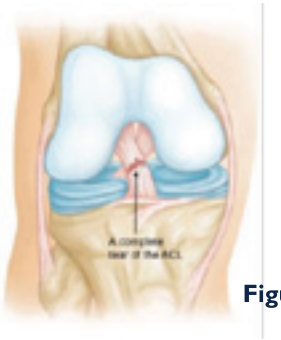

Figure 1: ACL rupture

Player #1: Virgil van Dijk
Injury: ACL (anterior cruciate ligament) rupture in right knee in 2020.

ACL is the ligament that connects the femur to the tibia, which provide the stability when moving knees (National University Hospital (NUH) Singapore).
On October 17, 2020, in the game against Everton, Liverpool's defender Virgil Van Dijk was tackled by Everton's goalkeeper Jordan Pickford, which led to a grade 3 ACL injury.

Figure 2: The grafting step

Symptoms of ACL rupture (Radswiki):
-Popping sensation followed by swelling.
-Inability to weight bear, which would improve in a short period.
-Knee feels to collapse (an involuntarily loss of strength), especially during pivoting movements.
-Hesitation when attempting to change direction.

Surgery (National University Hospital (NUH) Singapore):
The surgery removes the torn ACL and reconstructs the ruptured ACL, which is usually transplanted from the patient's own hamstring tendon. Tunnels will be created in the femur and the tibia, and the graft will be pulled up through the knee joint to the thigh bone.
The top part is fixed with a button, and the other end is fixed with a bioabsorbable screw. The graft will integrate into the bone tunnels.

Recovery (NHS website):
Soccer players who suffer ACL rupture typically return to play within 7-9 months after experiencing the injury. Van Dijk missed all the games in the 2020/2021 season.

After the operation, spend time in the hospital:
-Given medicines to reduce pain
-Can walk soon with assistance

Most patients can go home the same day they had the surger
-Regular exercises
-Regular physiotherapy
-Take out stitches or clips

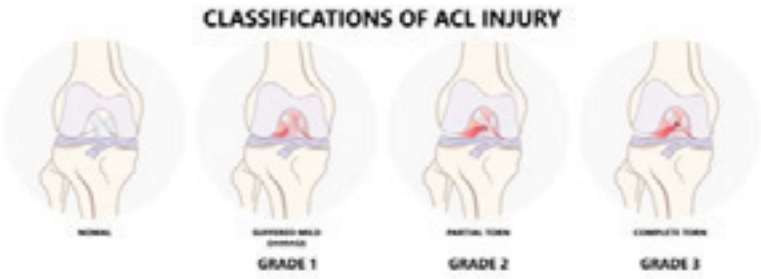

Figure 3: Severity of ACL rupture

Research shows that most athletes can returen to their pre-injury levels of performance, but usually takes 18 – 24 months (Brar). In an interview, Van Dijk states that "a knee injury is a mental blow for a footballer," highlighting the severity of injuries for athletes, and the fear of reinjury (kinesiophobia) and mental challenge of regaining confidence (Lee).

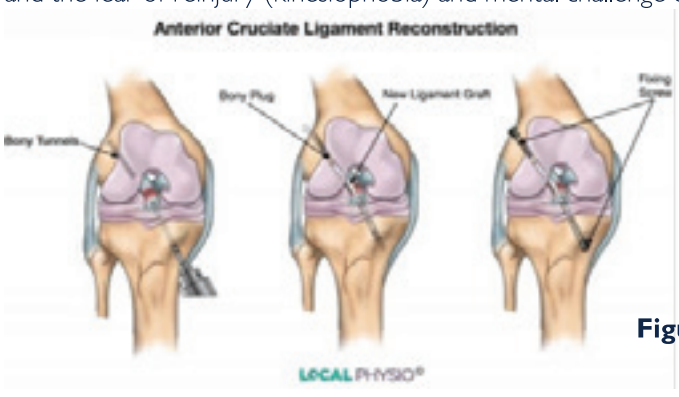

Figure 4: Surgery for ACL rupture

Player #2: Ronaldo Nazário
Injury: Patellar tendon rupture

ACL is the ligament that connects the femur to the tibia, which provide the stability when moving knees (National University Hospital (NUH) Singapore).

As one of the most well-known and successful soccer players, Ronaldo Nazário suffered knee injury during 1995/1996 season. After careful examine, doctor diagnosed him with Osgood-Schlatter disease, which refers to the swelling below the knee and over the shin bone (tibia), which caused by the quadriceps muscles pulling on the attachment point of the patellar tendon during exercises.

After successfully getting a surgery for his right knee, he returns to the field and scored 54 goals in 58 games. After several successful seasons, in 1998/1999 season, he had the knee injuries again. This time, knee specialist Professor Gerard Saillant advised that Ronaldo should not receive a surgery due to his irregular pain patterns. On November 21, 1999, during the game against Lecce, he twisted his knee when chasing the ball, tearing the kneecap tendon. Later he was diagnosed to have a partial tear of the patellar tendon, which also known as "jumper's knee," since it often occurs in sports that requires jumping (AlexandreG).

5 months after the surgery, Ronaldo returned to the pitch, but then completely ruptured the kneecap tendon after 7 minutes of playing. Ronaldo had to spend the next 2 years for rehabilitation, and he only came back until September 2001 (AlexandreG).

Ronaldo states that the injuries "transformed him personally and professionally," as he thinks that the injury helped him to grow, making him more responsible and disciplined. Eventually in 2002, he won the 2002 World Cup Golden Boot and the FIFA World Player of the Year award (AlexandreG).

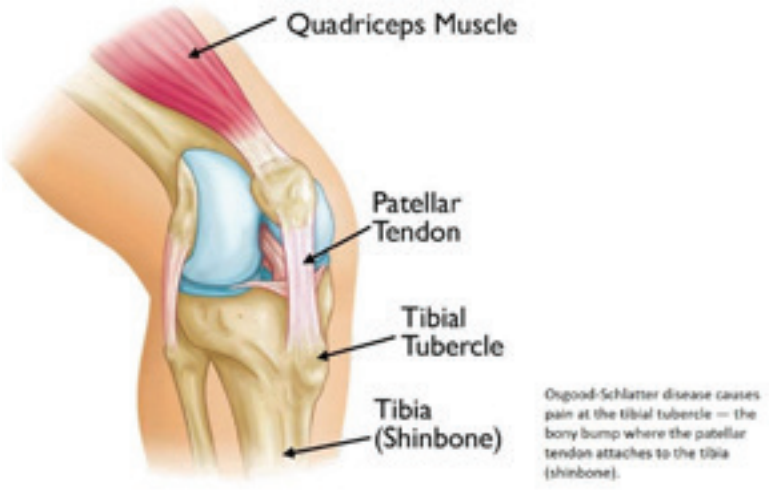

Figure 5: Patellar tendon rupture

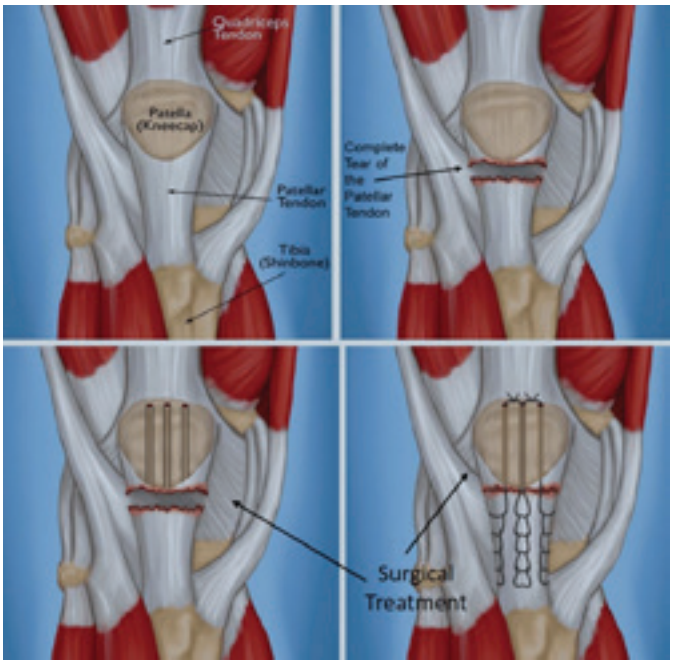

Figure 6: Surgical treatment for patellar tendon rupture

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How Soil pH Governs the Health of Moss

Claire Sun - Grade 12

In the intricate tapestry of a forest floor, mosses are more than just a green carpet.

Figure 1: DIcranum scoparium

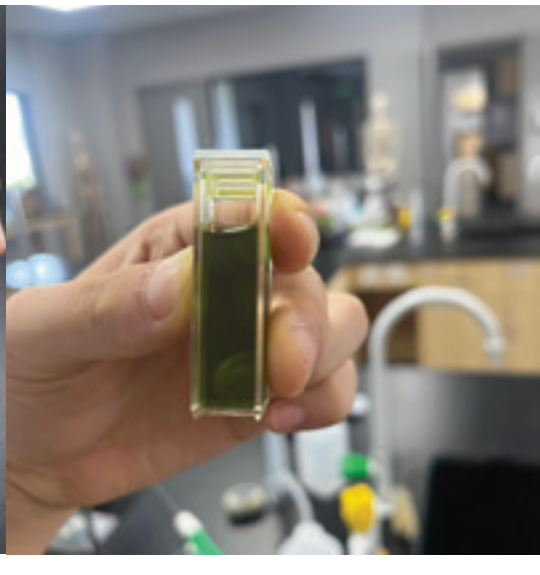
As one of the planet's most ancient land plants, bryophytes like Dicranum scoparium are foundational to ecosystem health, driving nutrient cycling and water retention. Their unique biology, lacking true roots and a protective waxy cuticle, forces them to absorb water and nutrients directly through their leaf surfaces. This very trait makes them exquisitely sensitive to their chemical environment, positioning them as potential bio-indicators for soil health. This investigation, conducted as a Biology Internal Assessment, sought to quantify this relationship by asking: To what extent does soil pH affect the chlorophyll concentration in Dicranum scoparium?

Chlorophyll, the green pigment central to photosynthesis, is a direct proxy for a plant's photosynthetic capacity and overall vitality. Background research indicated that chlorophyll is highly unstable in non-optimal pH conditions; in overly acidic environments, for instance, the central magnesium atom can be stripped from the chlorophyll molecule, causing degradation. Given that non-vascular plants like mosses exhibit a broad ideal pH range between 4.5 and 7.2, it was hypothesized that D. scoparium would display significantly lower chlorophyll concentrations in extremely basic conditions (pH 8.0-9.0), where protein denaturation and nutrient unavailability become critical factors.

Figure 2: Experiment Setup

To test this, a controlled laboratory experiment was designed. Samples of D. scoparium were cultivated in potting media with systematically manipulated pH levels—5.0, 6.0 (acidic), 7.0 (neutral), and 8.0, 9.0 (basic). These conditions were maintained over a four-week growth period through a standardized daily watering regimen using dilute solutions of HCl and NaOH.

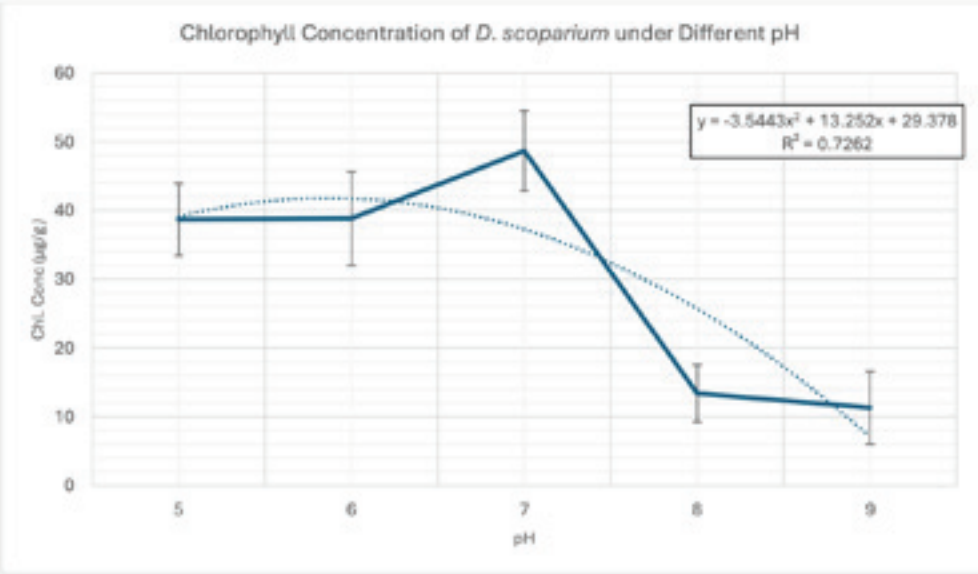
Following this cultivation, the chlorophyll was precisely extracted from the moss tissue using 80% acetone and a mortar and pestle. The concentration of chlorophyll a and b was then determined spectrophotometrically by measuring absorbance at 663 nm and 645 nm, with calculations performed using the established Arnon's equations.



The results were striking and statistically robust. Quantitative analysis revealed a clear optimal range for chlorophyll production. The highest mean chlorophyll concentration was observed at a neutral pH of 7.0 (48.65 µg/g), with healthy levels also present in the acidic groups. In stark contrast, a drastic decline occurred in basic conditions, with mean concentrations plummeting to 13.37 µg/g at pH 8.0 and 11.28 µg/g at pH 9.0. A one-way ANOVA test confirmed that these differences were statistically significant ($F(4,20) = 45.89$, $p < 0.0001$), allowing for the rejection of the null hypothesis.

Graph 1. The effect of hydrogen ion concentration on the chlorophyll concentration of D. Scoparium

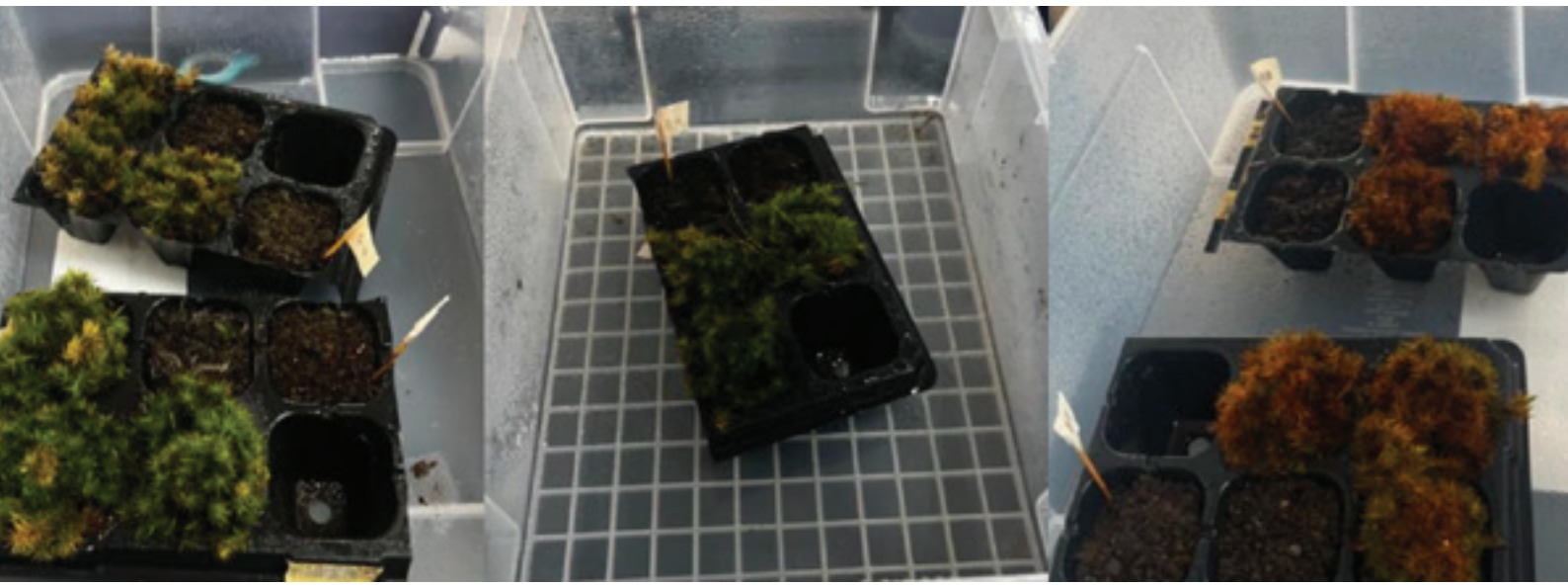
(Trendline is 2nd degree polynomial; error bar represents standard deviation, pearson's R, indicates relationship between variables and trendline)



These quantitative findings were corroborated by qualitative observations; mosses grown in pH 8 and 9 exhibited pronounced yellowing and a brittle texture, visual hallmarks of chlorophyll degradation and physiological stress. Conversely, samples from neutral and mildly acidic conditions remained green and turgid.

In conclusion, this investigation provides compelling evidence that soil pH exerts a profound influence on the chlorophyll concentration, and by extension, the photosynthetic health, of Dicranum scoparium. The species demonstrates a distinct preference for circumneutral to mildly acidic conditions and exhibits high sensitivity to basic environments. These findings strongly validate the potential of D. scoparium as a reliable, natural bio-indicator for soil pH. The visible color change from green to yellow in basic soils could serve as a valuable, low-tech tool for preliminary assessments in agricultural management or forest restoration projects, offering a silent but eloquent testimony to the condition of the earth beneath our feet.

Figure 3: Acidic-Neutral-Basic Group (left - right) after 1 week cultivation at the duration of experiment



Effort heuristic: How Environment Influences Art's Value

Yolco Mao - Grade 12

In psychology, the cognitive approach seeks to understand human behavior by studying mental processes like reasoning and memory. A key area of interest within this field is cognitive bias—the systematic, often irrational errors in judgment that arise from our limited information-processing capacity. These biases are frequently driven by heuristics, which are mental shortcuts that simplify decision-making. The Effort Heuristic, proposed by Justin Kruger and colleagues in 2004, is one such bias. It describes the tendency for individuals to judge a product or idea as being of higher quality if they believe more effort was invested in its creation, especially when the true value is difficult to assess.

A psychology IA was done as a replication and extension of Kruger's original experiment to deepen the understanding of this specific concept. While the 2004 study manipulated the perceived time spent on paintings, this new investigation aimed to determine if a harsh creative environment—specifically, being taken during wartime—could similarly act as a sign for effort and influence judgments of quality.

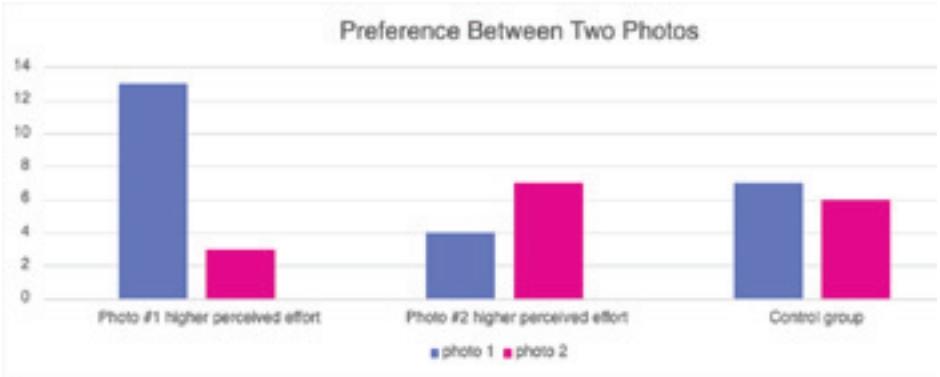


Figure 1: Preference of two photos (number of people)

The study employed an independent measures design with 42 international high school students in China, aged 15-19, who were selected using a random sampling technique. Participants were divided into three groups. In the two experimental groups, participants were told that one of two photographs—both black-and-white images of children taken by Henri Cartier-Bresson—was captured during a war. This was counterbalanced, meaning each photo was presented as the "wartime" image to different groups. A control group was told both photos were taken during peacetime. Participants then rated the photos on a scale of 1 to 5, estimated their monetary value, and stated their preference.

The results revealed a significant picture. When analyzing the preference and rating data, a paired sample t-test showed no statistically significant difference (p-value = 0.445) between subjects' rating on the pictures and the perceived effort. This part of the data supported the null hypothesis that there is no difference in perceived quality based on the environment.

Figure 2: Photograph used in the experiment by Henri Cartier Bresson

However, the monetary value estimations told a different story. Due to extreme outliers in the data, the researchers analyzed the median difference in value that each participant assigned to the two photos. The results showed that participants consistently assigned a higher monetary value to the photo they believed was taken in a war zone. A Wilcoxon signed-rank test confirmed this difference was statistically significant ($W = 131$, $p = 0.037$). Therefore, for monetary value, the alternative hypothesis was accepted.

Table 1. Descriptive Statistics of Average Rating (Likert Scale 1-5)

	Higher Perceived Effort in Pic A		Higher Perceived Effort in Pic B		Control	
	Pic A	Pic B	Pic A	Pic B	Pic A	Pic B
Mean (3 sig.fig)	4.06	3.94	3.00	3.67	3.57	3.57
Median	4.00	4.00	3.00	4.00	3.00	4.00
St.Dev (3 sig.fig)	0.781	0.429	0.817	0.850	0.912	0.850

The study had several strengths that increased its validity, including the counterbalanced design, which controlled for the inherent characteristics of the photos, and a control group that established a baseline for comparison. The use of standardized instructions and a distraction technique in the survey also helped reduce potential biases like the "screw you effect."

However, limitations were noted. The artificial school setting lacked ecological validity, and the self-report data may be unreliable. Furthermore, conducting sessions over multiple days risked participants sharing information. A key modification suggested for future research is to conduct the study in a more naturalistic setting, like an art gallery, and to provide a value range for monetary estimates to minimize erratic data.

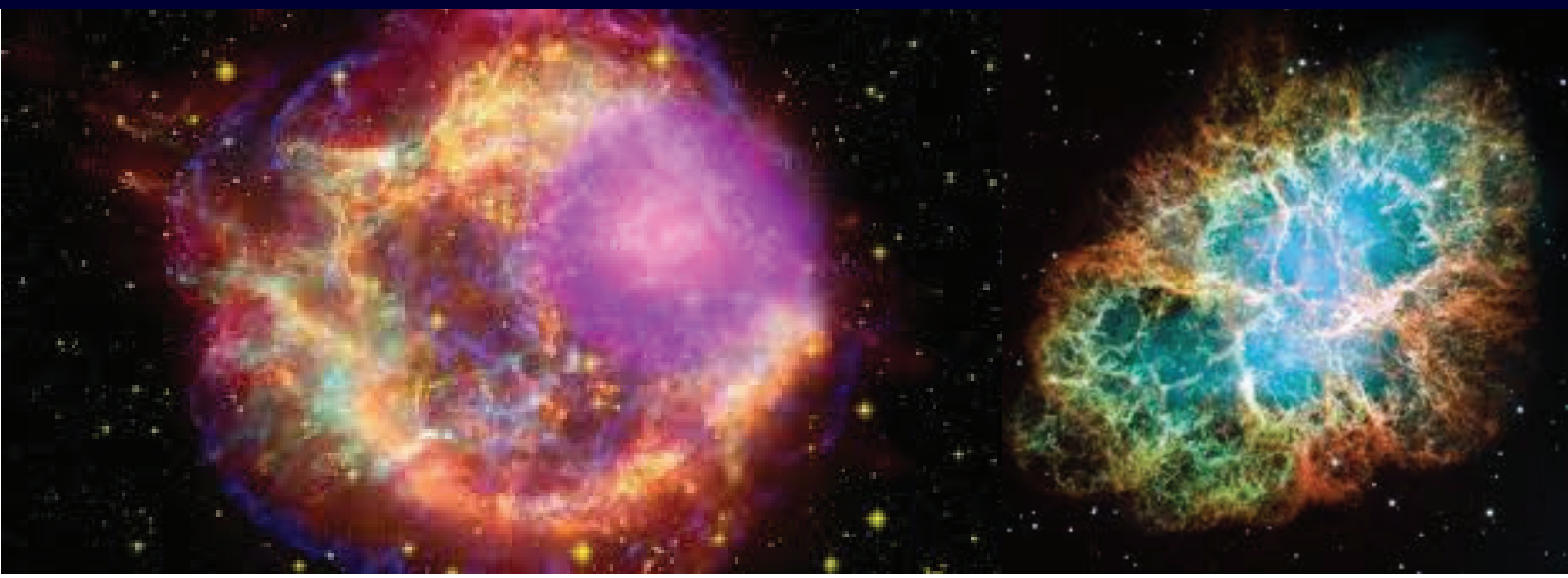
In conclusion, this replication provides partial support for the Effort Heuristic. The perceived effort of creating art in a harsh environment did not significantly affect how much people liked the work, but it did lead them to assign it a higher financial value. This suggests that the effort heuristic is a valid, though complex, cognitive bias. It demonstrates that the story behind a creation can shape our economic judgments, proving that even in art, perceived struggle can be conflated with worth.

Table 3. Result of Wilcoxon Signed-Rank Tests on Log-Transformed Monetary Valuations

Group	Number of Participants (N)	Median ln (Difference)	z value	p-value	Significance
Higher Perceived Effort in Pic A	14	0.18	54	> .05	F
Higher Perceived Effort in Pic B	12	-1.50	5	< .05	S
Control	11	-0.40	19.5	> .05	F

Note: ln(Diff) indicates = ln(Value_Pic_A) – ln(Value_Pic B). A positive median indicates higher valuation for picture A.
F = not significant; S = significant at .05 level.*

PROCEDURE



Supernova

Yessika Tiwari - Grade 11

When a star dies, it doesn't always fade quietly into the dark. Sometimes, it marks its death with a spectacular explosion called a supernova. This explosion releases so much energy in such a short time that even the sun could never produce that much in its entire lifetime. A supernova usually happens when a massive star runs out of fuel and collapses in on itself. This type is known as a Core Collapse Supernova.

In another case, when a white dwarf star gathers too much matter from another star, it causes a sudden nuclear reaction. This is called a Thermonuclear Supernova. What makes supernovae so fascinating is that they're the second biggest explosion after the Big Bang. They can stay visible for weeks, and the extreme heat and pressure create new elements like gold and iron. These elements are then spread across space, forming beautiful supernova remnants.

In our galaxy, supernovae are quite rare — they only happen about two or three times each century. Most of them can't be seen with the naked eye because the explosions are hidden by thick clouds of cosmic dust. However, there have been a few exceptions where humans were lucky enough to witness one. The first recorded supernova was SN 185, observed by Chinese astronomers in 185 AD. The most recent one, called SN 2021yfj, appeared in late August of this year and was detected by telescopes around the world.

Right now, there are no predictions for another star expected to go supernova soon. Still, scientists keep watching the skies, waiting for the next one to light up. Supernovae are important because they help spread elements needed to form new stars and planets. Without them, the universe would be missing many of the materials that make life possible. So even though a supernova marks the death of a star, it also creates the chance for new worlds to form — showing that every ending in space can also be a beginning.

Once a Dragon, Always a Dragon!

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