PRINCETON HIGH SCHOOL

THE CACTUS

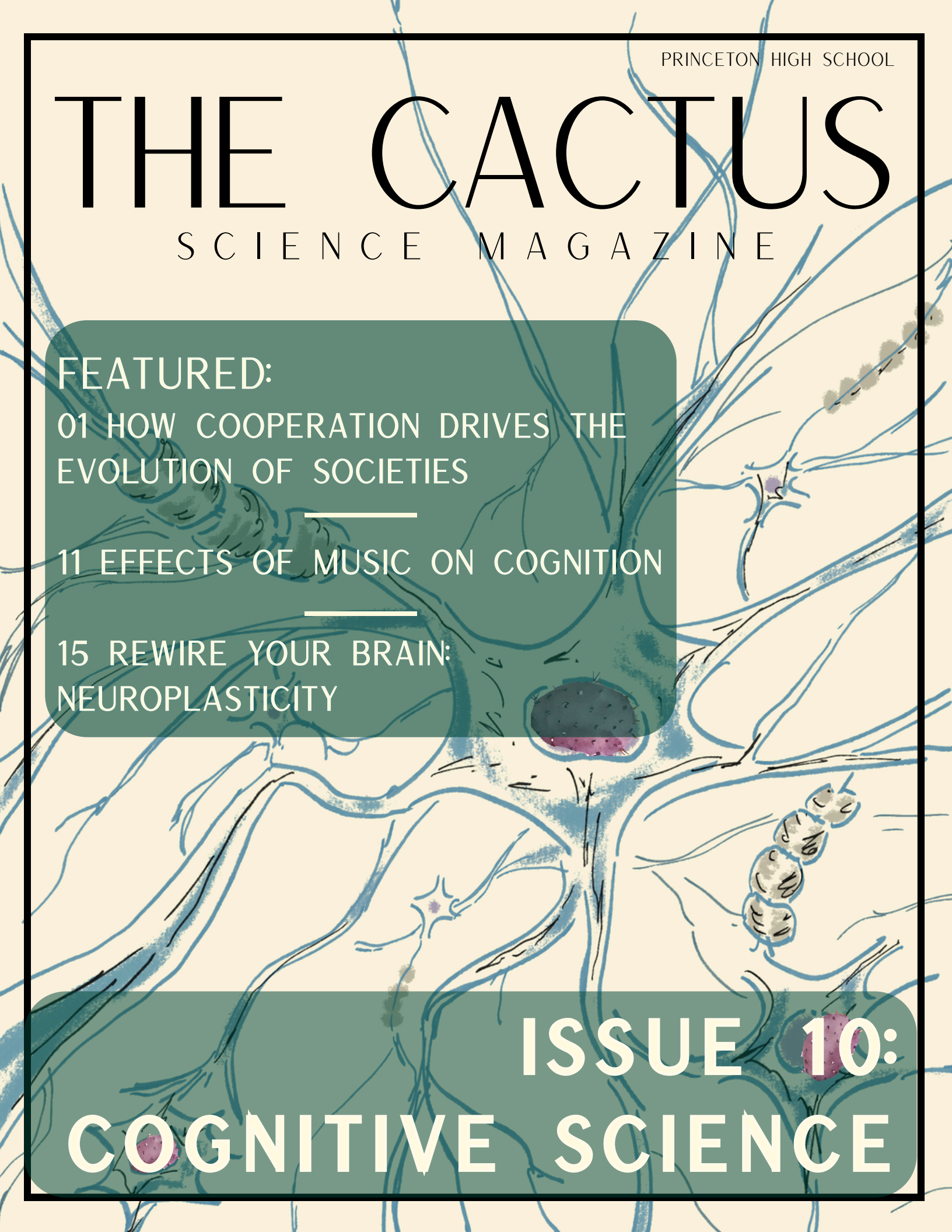
SCIENCE MAGAZINE

FEATURED:

01 HOW COOPERATION DRIVES THE EVOLUTION OF SOCIETIES

11 EFFECTS OF MUSIC ON COGNITION

15 REWIRE YOUR BRAIN: NEUROPLASTICITY



ISSUE 10: COGNITIVE SCIENCE

EDITORS' LETTER

Famous psychologist Jean Piaget who laid the foundations of cognitive and developmental psychology once said,

"The principal goal of education in the schools should be creating men and women who are capable of doing new things, not simply repeating what other generations have done; men and women who are creative, inventive and discoverers, who can be critical and verify, and not accept, everything they are offered."

Back in 2023, the Cactus Science Magazine was created with the intention of providing Princeton High School students with a platform to explore their creativity, push the bounds of curiosity, and inspire others to challenge the world around us. Of all the scientific fields of study, cognitive science is one of the most open ended, interdisciplinary, and widely applicable – broadly defined as the intersection of psychology and philosophy.

As we begin to study human intelligence, and with it, what drives our thoughts and interactions with each other, cognitive science lends us a framework through which we can study all aspects of the human experience. And unsurprisingly, we've found that traditional methods of explaining how human intelligence and behavior are represented through solely neuroscience or just anthropology aren't able to fully account for all that we want to explain. As we live in an increasingly connected world, the quicker we realize that phenomena rarely can trace their causes to a single event, the better we'll create policies, guidelines, and rethink how we treat each other.

This issue on cognitive science strives to discuss just that; we dive into how game theory drives the cooperation of societies, wrestle with the complexities of the development of mental health issues, and report on the creation of new technologies meant to aid our cognitive abilities. We've discovered that using multiple lenses to explore the overarching theme of human intelligence results in unexpected, new findings, which we hope you'll also enjoy reading about. Creativity drives novelty. We expect that the continued exploration of new interdisciplinary fields like cognitive science, the surprising combination of seemingly unrelated domains, will create the next generations of informed scientists, thinkers, and pioneers.

THE CACTUS

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THE EVOLUTION OF COOPERATION IN LARGE SOCIETIES

BY NIKOLAI MOROZOV

Imagine a society without division of labor. The marksman would have no use for his talent in shooting and capturing game, and the scholar would not be able to pursue his intellectual interests. In allowing each and every person to do their best work, division of labor benefits all [1]. However, in order for this division of labor to exist, work must yield some reward. If a certain occupation does not allow for a person to make a living, that occupation will have no appeal, and few will be willing to do it when presented with alternatives, thereby robbing society of the benefit that it would bring. An acute case of this was the Great Depression. As a result of this sudden and steep economic downturn, manufacturing and production rates went down almost 72% in 1930 and 1931, and unemployment skyrocketed. The trust that one may always find a niche or position for oneself to prosper in one's own craft is fundamental to society. However, upon delving deeper, it almost seems paradoxical. If an employer can promise a worker pay, then rob them of it, the employer has gained at no cost. Therefore, in all cases, it is the rational decision for the employer to deny their employees pay.

Here, we come across our first problem which can be solved using the field of game theory. In order to solve this first problem, let us consider another. This simple, illustrative, and general example is often used as an anchor point for introductory game theory. Let's say we seat two people across from one another. There is a total of $10,000 between them. Each player can either split the money, or steal it for themselves. Now, let's formalize. Player one's set of choices to comprise set A, and player two's to be set B. Therefore, set A= {Split, Steal} and, equivalently, set B = {Split, Steal}. Then, let S=AB. This is the "Cartesian product" of A and B, and returns a set which contains every single possible combination of the elements of sets A and B. Therefore, S= ({Split, Split}, {Split, Steal}, {Steal, Split}, {Steal, Steal}). S is known as the set of strategy profiles [3].

		Player A	
	Player B	*Split*	*Steal*
	Split	*Split, Split*	*Steal, Split*
	Steal	*Split, Steal*	*Steal, Steal*

Fig. 1 – The two players' set of outcomes. Image: ***Nikolai Morozov***

In this case, each strategy profile bears different consequences. When both players split, each receives $5,000. When one steals and the other splits, the stealer gets all $10,000. Finally, when both steal, neither gets any money. When A goes up to the plate, they have two options: steal, and get either $10,000 or none, or split, and get either $5,000 or none. The choice seems obvious for player A – steal every time!

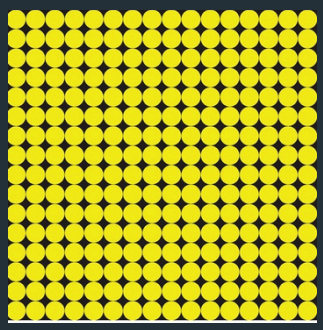
This, of course, is not how we run society. If everyone defected constantly and never cooperated, our modern society would crumble in an instant. Still, if both players are rational and competent, then defection seems like the most logical choice. The reason why this crumbles is because of a hidden assumption. In saying that each player wants the money purely for themselves, we assume that they are minimally benevolent and maximally shortsighted. Over the long run, cooperators beat out defectors by playing each other, even if they lose money to defectors most of the time—the only reason why this one-time case is inaccurate is that it is a single moment. When a cooperator plays a cooperator, each interaction is a guaranteed $5,000, whereas a defector's opponent catches on quickly and defects in turn, resulting in no gain for either one. Therefore, society stands upon the mutual understanding that defection leaves progress stagnant. Now, coming back to our original problem, we see why the employer doesn't exploit his employees. If an employer defects by robbing his workers of their pay, except in extreme circumstances, few will be willing to work for him anymore. Eventually, with no workers, he's out of a job. This is known as reciprocity, where all societally relevant actions cause an equivalent societal reaction [4].

However, because of the scale of human society, why we should cooperate still remains obscure. After all, nations have millions of inhabitants who may share different motives and beliefs, where some groups may appreciate different things than others. For example, in the community of employers, those who turn the best profit are lauded, whereas in the community of employees, it's those who do the least work and yet earn the same wage. The objectives of these two highly interdependent groups are contradictory. One way to explain this is to turn to species which cooperate similarly to us. Social insects such as bees, for example, are able to create beehives, which are complicated, organized societies [5]. At first, these species' altruism was believed to accord with kin selection theory. This theory rests on inclusive fitness, which is the sum of the fitness one organism gains, and the fitness gain to the other organism it interacts with, scaled by relatedness, in an interaction. Thus, increasing the fitness of a highly related organism to oneself effectively increases one's own fitness. This theory then posits that this is the origin of cooperation [6]. This result is expressed by equation (1), where if one organism is sufficiently related to another, it is favorable for them to choose to cooperate.

(1) R > c/b, where R is relatedness, c is cost, and b is benefit, as formalized by W.D. Hamilton in 1964.

An interesting facet of this is haplodiploid theory, which states that the clade hymenopterans (which includes bees, ants, etc.) is more likely to exhibit eusociality due to its mating habits and the principle stated above. In a colony of this clade, all males are haploid, since they are born through the unfertilized meiosis of females. Therefore, they share half of their DNA with their mothers, and none with their siblings. However, when these haploid males mate with diploid females, the resulting children both have all of their father's genetic information, and half of their mothers'. Therefore, they are guaranteed to share half of their genomes, derived from their fathers, and on average share a quarter of their genomes deriving from their mothers. Hence, sisters typically share ¾ of their genetic information with each other, while only sharing half of it with their mothers, meaning they are more highly related to their siblings than their parents, promoting eusociality. However, by the 1990s, this hypothesis had all but been abandoned. As new species exhibiting eusociality were found, the correlation between haplodiploid reproduction and cooperation dipped below statistical significance. Unfortunately, it had too many assumptions to ever be realistic. It assumes that all interactions are pairwise and additive, and hence excludes many synergistic, complex games which are closer to simulations of real human interaction. Though there has been some debate on the validity of kin selection theory [7], this is the widely adopted conclusion. When the fitness (its so-called inclusive fitness) an individual gains is simply seen as the additive sum of the fitness it gains and the fitness its partner gains times their relatedness, larger-scale, more involved interactions cannot be modeled.

(a)



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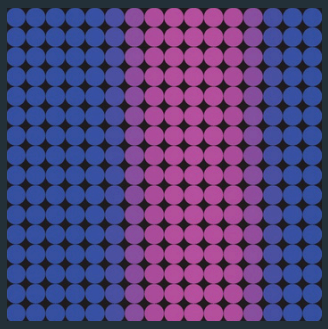

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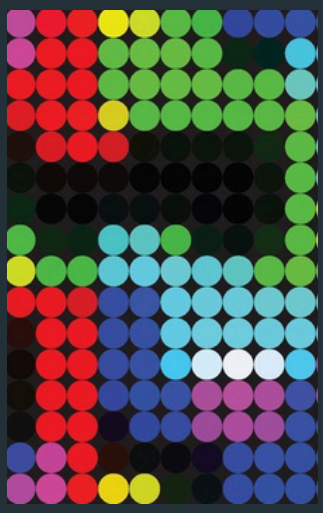


Instead of it being because of kin being close to kin, the unity of certain groups may instead be caused by common cultural background. To see why, suppose that we have a large group of people, and that they intermix and move around rather slowly, all while picking up local cultural traits rather quickly. Say they span two environments. Through rapid local adaptation, those living in one particular environment will develop a culture centering around the maximization of fitness. Thus, they will initiate cultural selection, where both groups quickly become distinct due to the systematic passing down of knowledge from generation to generation. Every single subsequent generation will take what the last one left behind, tweaking and improving it, leaving just a slightly better final product behind. Take, for example, Northern Alaska, where the kayak is crucial for the whaling of its indigenous tribes, and yet no single human intellect could come up with the perfect kayak through pure power of reasoning because of its enormous spatial complexity. Over centuries of tinkering, however, where the best "adaptation" to the kayak is the one that lasts, the kayak at least approaches its ideal form through its own form of selection. As Charles Darwin said in his book The Descent of Man, "...if some one man in a tribe, more sagacious than the others, invented a new snare or weapon, or other means of attack or defense, the plainest self-interest, without the assistance of much reasoning power, would prompt the other members to imitate him; and all would thus profit" [8]. As such, cultures can evolve and separate themselves from one another, leading to many small groups. This is shown in Figure 2.

In these groups, any behavior can be kept stable. For example, if one improves the current design of kayak, their reputation benefits. If they steal, it worsens. Thus, any behavior can be kept stable when employing the three Rs: reciprocation, reputation, and retribution. 'Good' acts come back through reciprocity and retribution, and improve reputation, all the while 'bad' acts decrease reputation, thus causing negative reciprocation as the result of retribution. Depending on a group's set of values, cooperation may be favored more or less. Finally, the mechanism by which cooperation evolved in human cultures becomes clear. More cooperative groups tend to outlive less cooperative ones: after all, a society may live long if a soldier is willing to sacrifice themselves for their peers and their country.

Fig. 2 - The above images show (a) a group where local cultural adaptation is much slower than mixing; (b) shows a group where migration rates are somewhat slower than mixing (2m = s); and (c) shows where selection is much faster than mixing (10m = s). In the last image, we see different groups emerge. Image: Boyd et al., Robert et al. (2009). https://pmc.ncbi.nlm.nih.gov/articles/PMC2781880/

The Mystery Behind Deja Vu

BY HANNAH CHANG

You take a step, and are thrust into a fragment of memory you can't quite remember. The world seems to spin in an uncannily familiar way, and you're sure this has happened before. The people are exactly where you recall them to be —their conversations exactly as you would predict. Then, just as quickly as the feeling comes, it vanishes in a fleeting moment despite your attempts to grasp it.

Around 60-70% of the population experiences the spontaneous sensation of déjà vu, meaning "already seen" in French, during their lifetime [1]. It has been observed to be most prevalent in ages of 15-25, with the feeling becoming less common with aging. Ultimately, déjà vu is caused by miscommunication between the different parts of the brain, specifically the temporal lobe and hippocampus: the brain structure responsible for processing new information. This miscommunication, which can result from certain triggers or interactions with the environment, can render one unable to identify the border between a memory and new experience [2].

Because of déjà vu's unique characteristic of vanishing almost spontaneously, it is still a relatively undiscovered area of cognitive science and a mystery to the neurology community[4]. However, some suggest that certain individuals, such as those who have higher levels of education, are frequent travelers, regularly remember dreams, or undergo higher amounts of stress and tiredness, may be more susceptible to déjà vu [1,2].

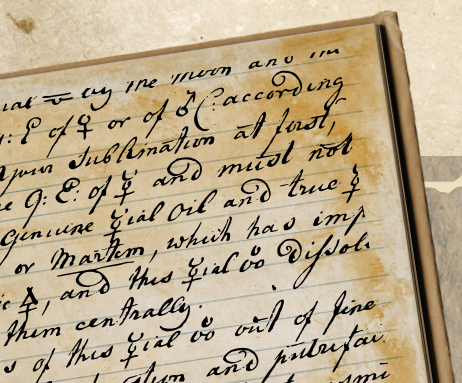
Researchers have speculated multiple theories that may contribute to déjà vu, one being "dual processing" or "split perception theory" [1, 5]. This theory describes the confusion the brain faces when absorbing information, and categorizing it as old or new knowledge. An individual may receive a quick stimulus when they are distracted or in a state of unclear mind, resulting in an incorrect or weak perception of reality. Upon receiving that stimulus again, the mind may recognize it as familiar, but not fully recall or register experiencing it before [5].

On the other hand, the "Glitch Theory" suggests that déjà vu is a result of neurons sending unintentional electrical impulses throughout the body after witnessing a certain stimulus. Researchers have even compared this to the involuntary jerks which occur when someone is sleeping, known as hypnagogic jerks. Both are similar in relation to neurons creating signals that do not align with what the body is truly experiencing [5]. Another common theory for déjà vu is the "Electrical Malfunction Theory". This theory suggests that brain signals called synapses are slightly mistimed and mismatched, occasionally causing brief confusion in what is being seen [5]. This can lead to the sensation known as déjà vu. Lastly, some experts theorize that the brain has two consciences, with one focusing on the activities going on in the world outside, and another prioritizing inner mental processes. Thus, when one is tired or deprived of proper rest, the brain may confuse these two consciousnesses, leading to déjà vu [1].

To test the connection between memory and déjà vu, researchers developed virtual reality scenes and played them before a group of individuals. When those individuals were later brought to areas with similar surroundings, many noted having a vague sense of déjà vu. The results of this test support the idea that environmental triggers contribute to déjà vu.

It's important to note that the occasional occurrence of déjà vu is not a matter of concern, but in rare circumstances, it can be a sign of neurological disorders. While déjà vu has been noted to persistently happen to those with dementia [2, 4], individuals who suffer epilepsy or have temporal lobe seizures may also experience it more frequently [1]. This is due to the fact that people with temporal lobe seizures often experience déjà vu before the seizures start. Since seizures result from excessive bursts of abnormal electrical energy, some researchers believe déjà vu might merely be a small, electrical mistake in the body [3]. It's also been proposed that recurrent anxiety can lead to déjà vu, as both take place in the hippocampal formation, although further evidence is needed to support this theory. Ultimately, although déjà vu is safe in most cases, when it is accompanied by confusion, headaches, weakness, shaking, or loss of awareness, it is wise to seek medical attention [2].

The abundance of theories regarding déjà vu shows how much is yet to be discovered about the human brain. So, the next time that strange haze of familiarity washes over you, stop and wonder about that little mystery in your great, complex, brain.



How Psychedelics Are Reshaping the Treatment Mental Disorders

The information provided in this article is for educational purposes only. Neither the authors nor The Cactus Science Magazine endorse drug use, and this article is not to be substituted for professional medical advice about the usage of psychedelics or other forms of addictive drugs. Consult medical professionals with further questions about the usage of said drugs.

BY GAVIN JOSH MACATANGAY AND JOSH HUANG

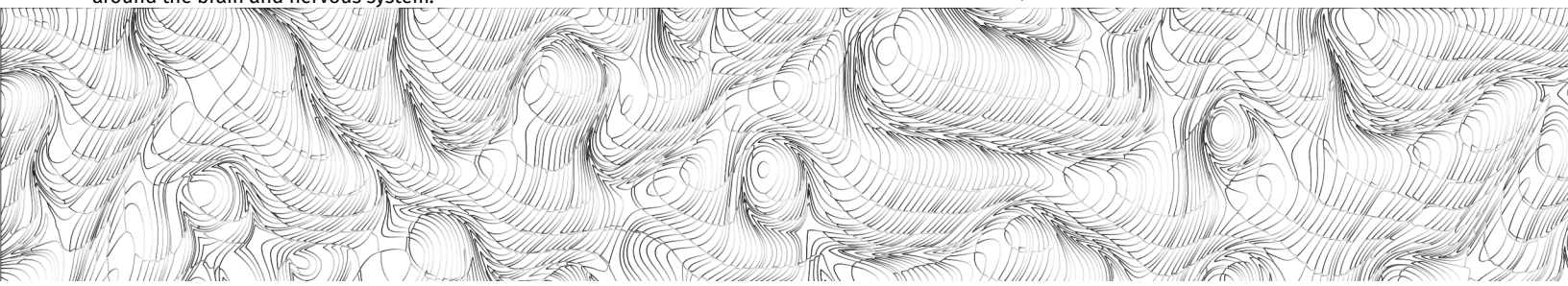
When many think of psychedelics, they imagine mind-bending visual and auditory hallucinations that are vivid with colors and sounds. However, scientists are beginning to look at these classes of drugs in a new light. Although research isn't widely developed yet, studies indicate that psychedelics could to help individuals with anxiety disorders through microdosing, a technique where individuals take small, nearly unperceivable doses of drugs—most commonly, psychedelics—to improve mood and focus without experiencing the actual hallucinatory effects of the drug [1].

Broadly, drugs are classified as chemical substances that alter one's body by producing a biological effect when administered [2]. Importantly, the effect of each drug depends on the substance and the dosage utilized—higher dosages often result in more exaggerated effects. Many drug mechanisms are centered around the brain and nervous system.

The nervous system works through a series of cells known as neurons that have two main functions: reception and transmission. Reception is the process of receiving signals either electrically or chemically, through neurotransmitters, which are a group of signaling molecules that serve as the messenger of cells. Transmission is the second half of the process, where these signals are then passed down through a unique gap called the synapse. By changing the level of neurotransmitters, drugs can cause signals to get amplified or reduced. For example, alcohol can amplify signaling for the release of dopamine and serotonin in the brain, such as sweating and an increase of blood pressure [3].

Psychedelics, a subclass of drugs that change perception, mood, and cognitive processes, act similarly, but most chemical mechanisms have yet to be identified by researchers [4].

However, one of the mechanisms that researchers have been able to identify is that of lysergic acid diethylamide (LSD), which they linked to selective serotonin reuptake inhibitors (SSRIs) [5]. These drugs work by blocking the reuptake of serotonin, a neurotransmitter associated with emotions of happiness. By blocking reuptake, SSRIs force more serotonin to stay within the organism's body, resulting in lengthened feelings of happiness. This is used to explain how LSD and other psychedelics are able to induce feelings of euphoria within its users. Other mechanisms, namely the hallucinatory aspect of psychedelics, have yet to receive a widely accepted explanation. Researchers have been able to figure out the general way psychedelics induce hallucinations, as these drugs are able to rewire the brain by changing when neurons fire, but the mechanism used to select these aforementioned neurons still elude scientists in the field [5].



That said, there is new research looking into the possibility of microdosing psychedelics to treat patients with anxiety disorders [8]. A recent study done in 2023 examined the efficacy of 9 different trials in which patients with a variety of anxiety disorders were treated with various types of psychedelics, where efficacy was denoted as the change in the quality of life of the patients before and after being microdosed with the drug. They discovered that, aside from the drug ayahuasca, the other psychedelics were found to statistically lower anxiety and were well tolerated by the patients. The only side effects present were elevated blood pressure, vomiting, dissociation, and anxiety, which were effectively mitigated by the researchers, establishing the first study to scientifically conclude that psychedelics have a potential use case in medical contexts.

On the other hand, the side effects related to the consumption of psychedelics have been extensively studied. Notably, the most prominent side effect is causing hallucinations [4]. These hallucinations depend both on the user's environment and their mental state. If in a bad mental state (i.e. experiencing intense negative emotions or thoughts), the hallucinations caused by a given psychedelic are usually unpleasant, which is commonly known as a "bad trip" [6]. However, recreational usage of psychedelics is never good for one's health, as long-term side effects of using psychedelics include a variety of emotional issues and higher rates of depression, anxiety, and addiction [7].

However, there are some limitations to microdosing with psychedelics because of numerous prerequisites for safe practice. Notably, the microdosing of psychedelics must be performed in a controlled environment with medical professionals at hand. If these drugs truly became a mainstream and widespread treatment to certain mental ailments, it would be difficult to have professional oversight over these drugs at all times. Rather, it is more likely that patients would have to take these drugs as a prescription. This could lead to a situation much like one of benzodiazepines, a medication used for anxiety. These drugs were abused by many when given as a prescription due to their addictive nature, which could be the same for psychedelics as they can give euphoric effects.

These drawbacks can be fixed with the right regulations and processes, showing how there is potential for using psychedelics in a medical manner. If this proves successful, these drugs could be a supplementary tool to help those suffering from anxiety disorders and open up an alternative pathway for treating these conditions.

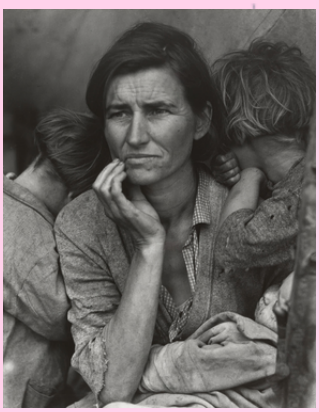
How Art Impacts Perception

BY: NAOMI CARROLL

"Image: Ossawa, H. (1905). Abraham's Oak [Painting]. Smithsonian American Art Museum, Washington, DC, United States. https://americanart.si.edu/artwork/abrahams-oak-23636"

Dorothea Lange

Lange worked as a photographer to raise public awareness of and provide aid to struggling farmers, using photography to confront the urgent circumstances around her and effect social change.
She most famously documented hardships of migrant farmers driven west by the Great Depression and the Dust Bowl and photographed images critiquing Japanese Internment in World War II [1].



"Image: Lange, D. (1936). Migrant Mother. The Museum of Modern Art, New York City, NY, United States.https://www.blackmountaincollege.org/between-form-content-digital-resources/"

Artistic communities foster social transformation, advocate for empathy, and bridge gaps among diverse populations. Art can also provide insight into the mind and feelings of other people, facilitating both theraputic insight and community bonding [2].

External Perception

Artistic appreciation and exposure can lead to prosocial attitudes, openmindedness, greater attention to detail, empathetic concern and feelings of care and responsibility towards others. Diverse expression in the arts promotes greater understanding and compassion for diverse perspectives, tolerance, and unity [2].

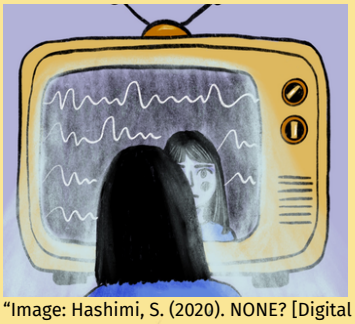
Jacob Lawrence

"Image: Lawrence, J. (1946). Steel Workers. Black Mountain College Museum, Asheville, NC, United States. https://www.blackmountaincollege.org/between-form-content-digital-resources/"

Lawrence used expressive collage cubism to convey the powerful messages, documenting stories of everyday life in Harlem, segregation in the South, and stories of liberation, resistance and resilience [3]. His bold colors and an expressive figurative style created a visual narration broadly understood by a broad audience, challenging biases and celebrating Black culture and identity [4].

"Image: van Gogh, V. (1889). The starry night [Painting]. Museum of Modern Art, New York City, NY, United States. https://www.moma.org/collection/works/79802"

Internal Perception and Impact



"Image: Hashimi, S. (2020). NONE? [Digital Art]. The McGill Dailey. https://www.mcgilldaily.com/2020/10/on-the-limits-of-representation/"

Art facilitates a form of experiential learning and emotions that disrupt preconceived notions. It can heighten empathy, sympathy, self-reflection, emotional developement, resilience, and creativity. Creating and interacting with art can also be calming and relaxing, helping people center themselves and experience a safe and expressive outlet for exploring and confronting complex emotions [2].

"Image: Last name, First and middle initials. (Year). Image title [Animation]. Site Name or Museum, Location. URL

Pictured above is a still from Disney's *The Little Mermaid* (1989) depicting Ariel with humanly impossible proportions exaggerating her thinness.

Artistic and aesthetic experiences provide an internal cultural identity and a framework of perception that influences how other art is understood. Exposure to only a certain style of art for example, can create a bias towards that art style in the future. The same can be said about what the art is portraying. Exposure to art depicting mainly white people can similarly promote internal biases against seeing any other groups of people in art and even real life. Art in the media plays an essential role in determining people's schemas of the real world, assumptions about cultural ideals, and perceptions of body image and gender [5].

"Image: Last name, First and middle initials. (Year). Image title [Animation]. Site Name or Museum, Location. URL

Pictured above is a still from Disney's *Aladdin* (1992) depicting a conglomerate culture with Arab Bellydancing, South Asian Bindi, and a Moroccan Fez hat.

Disney Princesses

Children are very vulnerable to messages portrayed through art. Disney princesses often embody beauty through their unrealistic thinness, youth and largely Eurocentric features while also mainly representing Western cultures and Westernized interpretations of other cultures causing many children to idealize these traits and cultural ideas [6].

THE SCIENCE OF FORGETTING

BY: LILY CAO & ELIZABETH WONG

From recalling important deadlines to remembering meaningful conversations, memory shapes nearly every aspect of daily life. It allows people to learn from the past, function in the present, and prepare for the future. Despite how reliable memory may seem, it is more fragile than most realize. Even small changes in physical or mental well-being can influence how information is stored and later received. While it is a natural cognitive process to forget, several factors can accelerate the rate at which it occurs. Many people are familiar with medical conditions that are associated with memory loss, like dementia and Alzheimer's disease. However, memory can also be impaired by less commonly discussed causes, including psychological trauma and sleep deprivation.

Most people have trouble recalling memories during the first few years of their lives due to a phenomenon known as childhood amnesia. Memory formation relies on the hippocampus, a structure located in the brain's temporal lobe that is connected to episodic, or personal, memories [1,2]. However, the hippocampus doesn't fully develop until at least the age of seven, meaning memories formed before then can be difficult to recall later in life [1].

As people grow older, the memories that form and remain can be categorized into three main categories: explicit memories, implicit memories, and short-term working memory. Explicit memories concern general information or daily events, and mainly involve the hippocampus. On the other hand, implicit memories, concerning motor memories, rely on the cerebellum and the basal ganglia. Lastly, short term memories are created in the prefrontal cortex [2]. In all of these parts of the brain, specific groups of neurons create connections between each other called synapses. These circuits of connections can be made stronger or weaker depending on when and how many times they've been activated in the past. Memories are formed based on reactivation of certain combinations of neurons. Additionally, in adults, new neurons can be created through a process called neurogenesis, which can improve the formation of new memories. Frequent activation of certain neurons can strengthen the bond between them, solidifying those memories, but less consistent activation weakens the connections, which can lead to memory loss [2].

Sleep is an active process that stabilises memories. So a lack thereof would mean memories are not stored in the brain effectively. Sleep supports memory consolidation by allowing the hippocampus to "replay" new experiences and transfer them to the cortex, where long term storage occurs. Without sleep, this process breaks down, and new information is unable to be stabilised [5]. Additionally, different stages of sleep are important for active communication to occur between different brain regions. This process can be disrupted when there is a lack of sleep, which means the new information learned never moves into stable long term storage, making the brain more prone to forgetting what it learns. [6] Further, when the brain is deprived of sleep, the orexin system becomes overstimulated, interfering with the production of new neurons in the hippocampus. Since neurogenesis is vital for forming new memories, the inhibition of doing so weakens the brain's capacity to learn and store information. It was found that sleep deprivation leads to increased expression of certain chemicals and processes like orexin-A and PLCβ1 and ERK1/2 phosphorylation. This alters signalling pathways in the brain, ultimately creating a hostile environment for new neuron growth. [7]

Memory loss can be grouped into passive and active forgetting. Active forgetting is a mechanism that intentionally weakens memories. It can happen due to new information that is prioritized over old memories , acceleration of memory decay, voluntary suppression of unpleasant memories, or the recalling of one part of a memory to suppress another. A new concept, intrinsic forgetting, removes old or "irrelevant" memories by creating specific forgetting cells to actively degrade memory to increase brain efficiency and adapt to new information. On the other hand, passive forgetting occurs due to more "natural" causes, such as a loss in context cues, confusion with similar memories, or natural decay over time [3]. The cognitive process of the brain usually peaks during one's 20s. Afterwards, it is normal for one's processing speed to slow down with age and for the amount of content in the working memory to diminish [4].

Trauma also has a huge impact on memory loss. Physical traumas, like strokes or concussions, can impact the function of memories, especially if they affect brain regions crucial for memory processing, like the hippocampus. In the US, it is estimated that around 3.8 million concussions occur each year in the US. [8]. Memory loss is a common concussion symptom, usually lasting a few weeks proceeding the concussion. However, if the memory loss lasts longer, it becomes a sign of post-concussion syndrome (PCS). While it is not known what causes PCS, some factors that put people at risk for PCS include age, anxiety, and prior headaches or brain injury[9]. These traumatic brain injuries can result in short-term memory decline, challenges in remembering tasks, or memory loss based on the severance of the injury incident [10].

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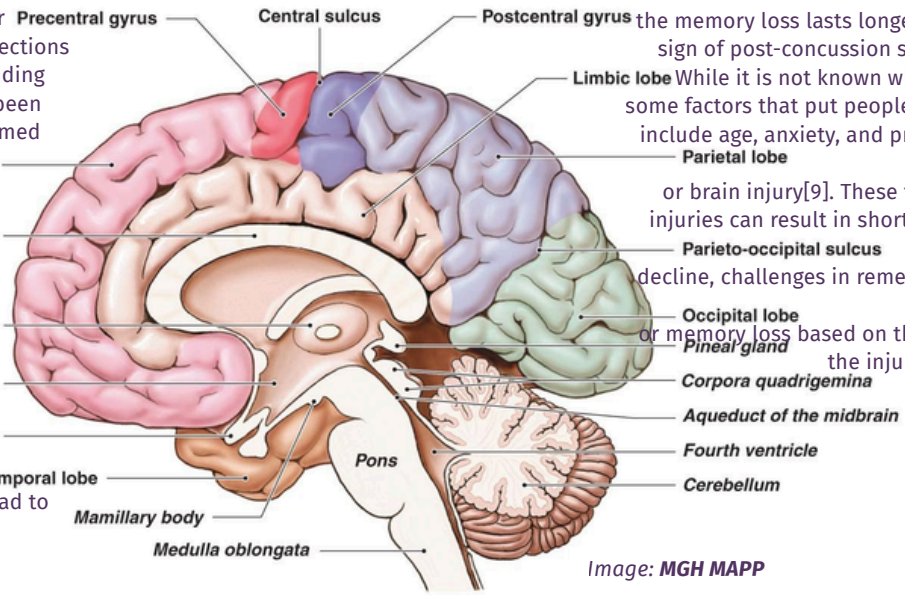
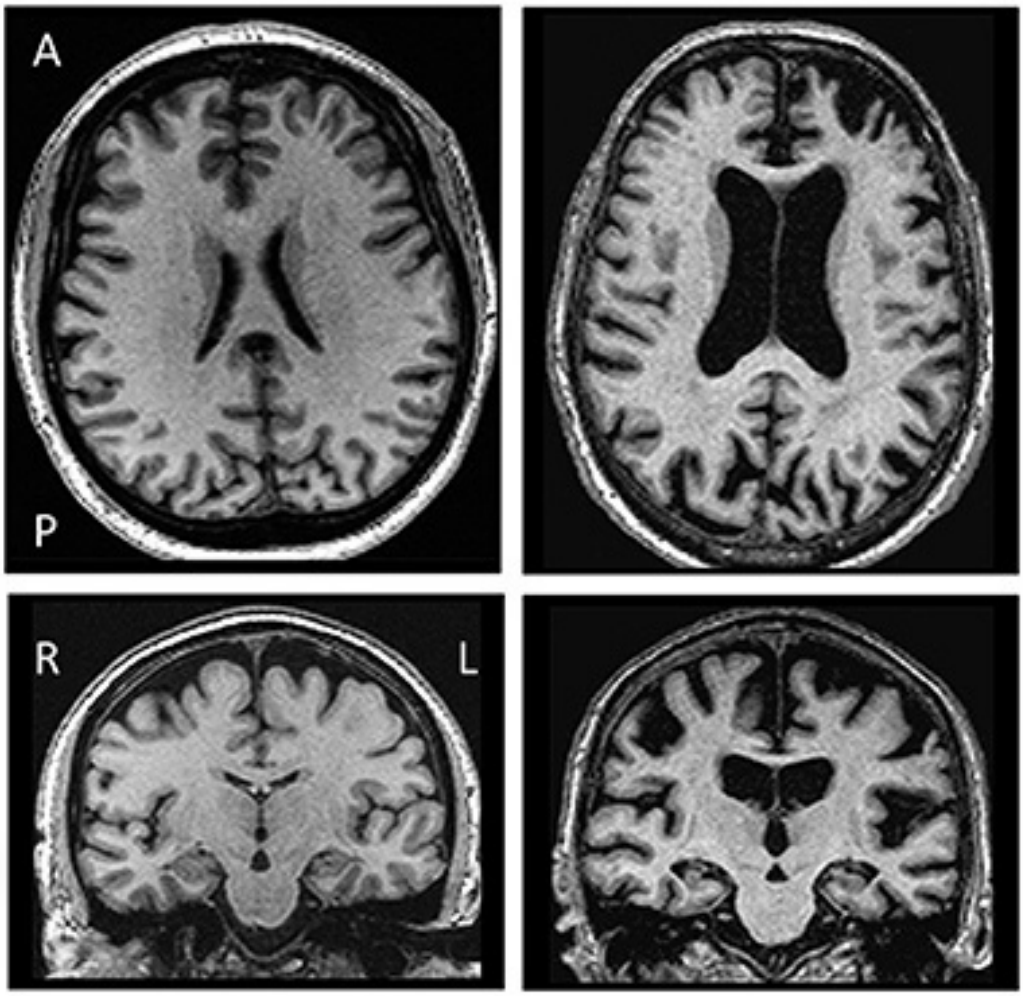


Image: ***MGH MAPP***

Apart from physical traumas, emotional or psychological traumas can also affect one's memory. Dissociative amnesia is a defense mechanism when one's brain purposely blocks out information, creating "gaps" in their memory due to distressing or traumatic experiences. In most cases, the memories still exist but are inaccessible. There are two types of amnesia: Retrograde, which affects finding old memories, and anterograde, which blocks out the formation or storage of new memories [11]. Post-traumatic stress disorder (PTSD) is a mental health condition that is caused from traumatic events, like a war. The symptoms—varying from intrusive memories, avoidance, depressive thoughts, and an increase in emotional and physical reactions— can appear within a few months after the event, or sometimes don't occur until years later. Intrusive memories can appear in forms of flashbacks, dreams, and more, bringing back the traumatic memories from the event [12].

Dementia is classified as a disease that affects memory, thinking, and the ability to perform daily activities. It can be caused by a multitude of factors that destroy nerve cells and damage the brain. For example, smoking, depression, and having high blood pressure can all damage nerve cells, and lead to deterioration in cognitive function [13]. Dementia can be caused by many diseases, the most common being Alzheimer's disease. Alzheimer's occurs when there is a build up of amyloid and tau, which are substances in the brain that can cause misfolds in tissues around it. When there is a build up of these substances, they clump up and form structures called plaques and tangles, which makes it harder for the brain to work properly [14].



Healthy brain

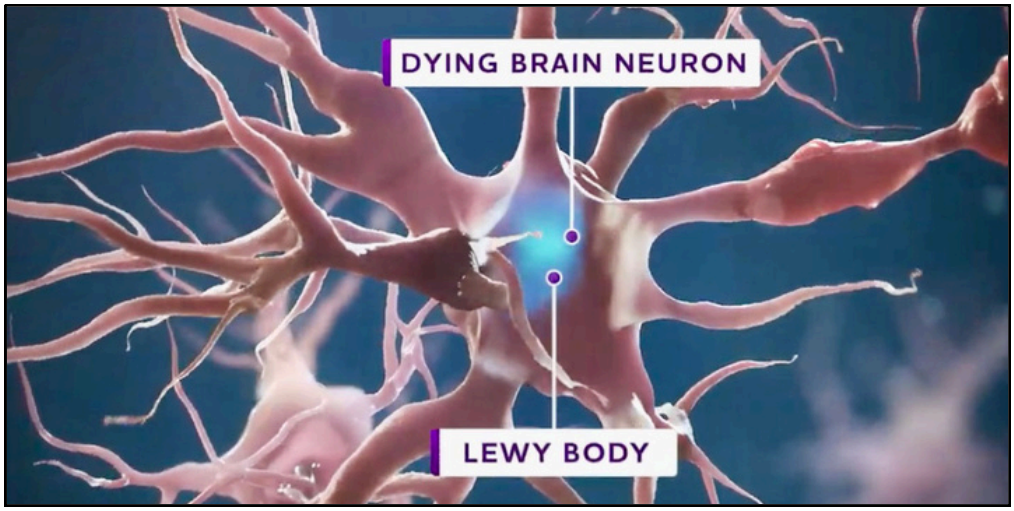
Typical Alzheimer's disease brain

Image: ***myALZ Team***

Another form of dementia is Lewy body dementia (LBD). LBD is a progressive disease, meaning symptoms start slowly and get worse over time. LBD is caused when alpha synuclein, a protein that plays an important role at the synapses, forms into clumps in the neurons. This causes neurons to work less effectively and eventually die. LBD affects many of the brain regions, including the cerebral cortex, limbic cortex, hippocampus, and brainstem. By affecting these areas, this also affects the functions of these parts of the brain. This includes information processing, perception, emotions, forming memories, and regulating sleep [15].

Currently, researchers, like the team from Case Western Reserve University, University Hospitals (UH) and the Louis Stokes Cleveland VA Medical Center, are working to find ways to revert the supposedly irreversible damages to memory loss caused by diseases. This specific team has recently discovered a possible way to reach a full neurological recovery from Alzheimer's disease by maintaining normal levels of a central cellular energy molecule, NAD+ [17]. Studies similar to theirs are being conducted all over the world, working to one day create a world where everyone can live their entire lives with an abundance of memories to look back to.

Image: ***Alzheimer's Association***



BREAKING NEWS

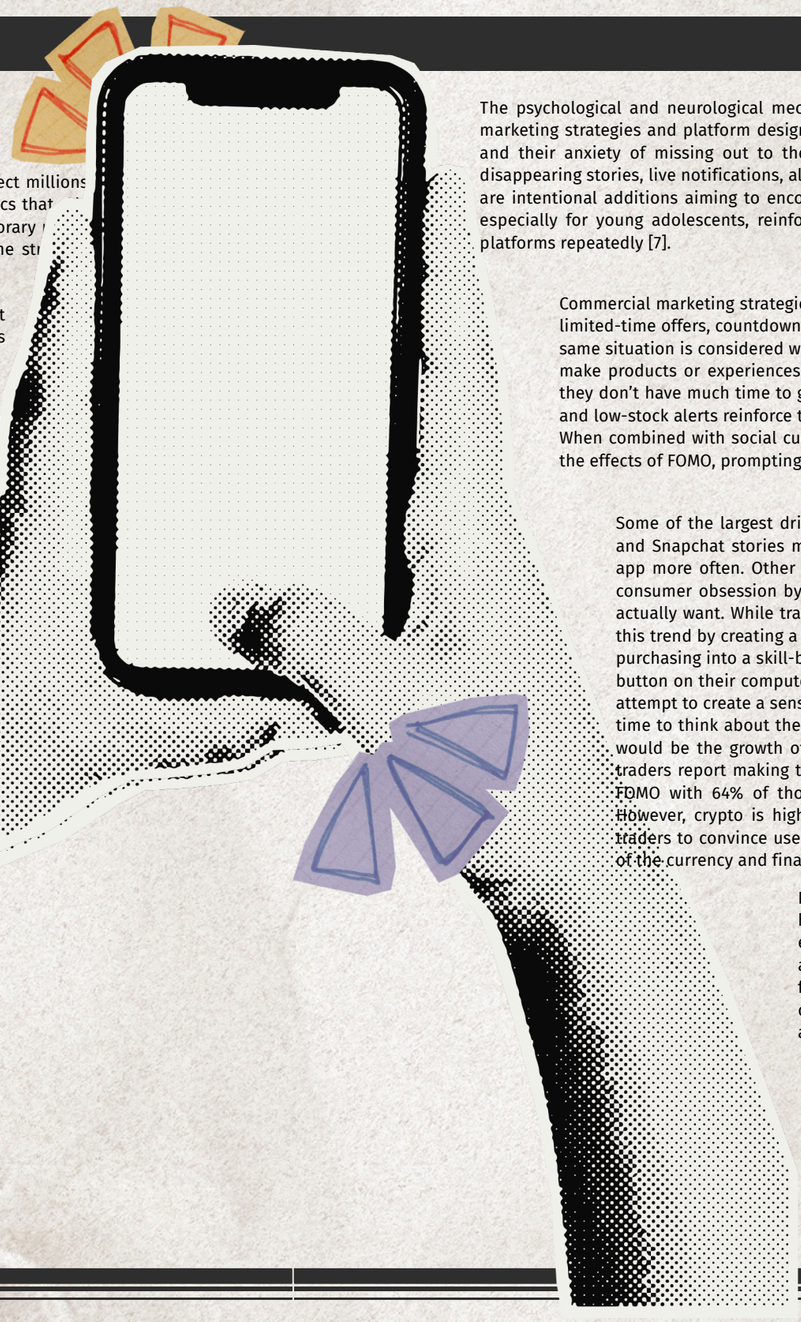
Breaking News

WON'T WANT TO MISS!

MISSING!

FOMO, The Digital Trend Capturing Millions of Minds

BY DANIEL GU & DEREK HU



In today's digital world, the accessibility of social media makes it incredibly difficult to resist. While often said to connect millions around the globe, internet sites like Instagram, X, Snapchat, and many others employ manipulative and entrapping tactics that on the comparison between self and others encouraged by digital connection to attract and maintain users. From temporary such as Instagram or Snapchat stories, to limited-time sales and offers, platforms across the internet utilize the same st FOMO, or the "fear of missing out".

Simply put, FOMO refers to the anxiety that others may be experiencing something rewarding from which one is absent (hence "missing out"), typically felt when observing those with seemingly more adventurous and successful lives [1]. This feeling is also characterized by a desire to stay continually connected with what others are doing [2].

Psychologically, FOMO is rooted in the basic human need for a sense of belonging and social connection. It is strongl associated with unmet psychological needs for autonomy, competence, and relatedness—the three core needs of Self Determination Theory, or SDT, a framework for motivational psychology [2]. SDT proposes that these three needs ar essential for well-being. When one is frustrated, whether by feeling powerless, ineffective, or excluded, they become mor sensitive to what others are doing: the fear of missing out. This makes people pay more attention to their interactions, leading people to frequently check social media to reassure themselves that they are not missi anything socially rewarding [3].

Neuroscientific research supports SDT's proposals. Studies have found that individuals who experience strong fears of exclusion display differences in the precuneus, a brain region involved with social comparison and thinking about oneself, suggesting that they process social information through a perspective of self-referential social comparison [4]. Because of both this increase sensitivity and motivational deficits such as those suggested by SDT, individuals find themsel stuck in a loop in which perceived social gaps elicit anxiety, leading to digital engagement attempt to restore a sense of connection and control, which once again leads to anxiety. O this cycle can cause problematic social media use (PSMU).

FOMO can be highly detrimental to students, particularly those who frequently experience it when studying or working. Studies have shown in teenagers, greater sensitivity to perceived losing out is associated with higher PSMU, or a greater tendency to use more social media apps [5]. These feelings are also associated with negative outcomes both daily and over the course of a semester, including sleep deprivation, stress, fatigue, and physical weaknesses [6]. Additionally, research has shown that users worried about being excluded are more likely to constantly check social media applications to be aware of messages and statuses. In the real world, this occurs through individuals repeatedly checking their mobile devices, even when engaged with friends in social environments, in a process also known as "phubbing" [7]. Coined by the McCann Australia agency, phubbing refers to the 21st-century trend of ignoring another individually physically present in favor of your phone [8]. In other words, adolescents anxious of being left out are more likely to overuse digital devices, leading them to phub their offline, real-world interaction partners [9].

The psychological and neurological mechanisms of FOMO also make individuals, especially teenagers, a prime target for marketing strategies and platform design. Social media platforms and marketers exploit users' desire for social connection and their anxiety of missing out to their advantage, leveraging it to increase engagement and sales. Features such as disappearing stories, live notifications, algorithm-based curated feeds, and trending hashtags are not just added for fun; they are intentional additions aiming to encourage frequent use and constant attention. Continued exposure to these features, especially for young adolescents, reinforces a sense of both missing out and falling behind, keeping users returning to platforms repeatedly [7].

Commercial marketing strategies utilize similar principles by creating a feeling of scarcity and urgency. Flash sales, limited-time offers, countdown timers, and low-stock alerts capitalize on the human bias of loss aversion, when the same situation is considered worse if it is framed as loss rather than a gain [10]. Flash sales and limited-time offers make products or experiences feel fleeting: when one feels that something may soon be unobtainable and that they don't have much time to get it, they fear missing out and are more inclined to purchase it. Countdown timers and low-stock alerts reinforce this feeling, serving as reminders of the scarcity and creating a sense of competition. When combined with social cues, such as indications of what others are purchasing, these tactics further amplify the effects of FOMO, prompting users to act quickly to avoid missing out, relying on impulse rather than reason.

Some of the largest drivers of FOMO have been social media cultures and trends. For instance, Instagram and Snapchat stories may use limited time appearances to encourage users to actively check in with the app more often. Other more impactful trends include drop culture, in which large companies manipulate consumer obsession by deliberately creating a sense of scarcity to raise demand for objects buyers don't actually want. While traditional sales are based on selling as many units as possible, drop culture reverses this trend by creating a competitive environment with supplies at limited availability, turning the process of purchasing into a skill-based game and subsequently leading to users waking up at 3AM to spam the refresh button on their computer [11]. This is similar to aforementioned flash sales and low-stock alerts, which also attempt to create a sense of urgency and scarcity to convince buyers to rapidly buy before they have enough time to think about their decision. Some FOMO trends can even be predatory and detrimental. An example would be the growth of crypto and other digital currencies. Surveys have found that over 80% of crypto traders report making their decisions, such as which cryptos to purchase and invest in, strongly based on FOMO with 64% of those surveyed believing they have already missed out on large crypto gains [12]. However, crypto is highly susceptible to scams, such as rug pulls, which play off of the fears of crypto traders to convince users to invest before rapidly selling all currency, leading to the immediate value drop of the currency and financial ruin of investors.

In conclusion, FOMO's pervasive nature demonstrates not only the complexity of human psychology and nature but also the tendency of digital environments to exploit said complexity. Rooted in human desires for social connection, autonomy, and competence, this sense of exclusion drives compulsive behavior such as frequent social media use and phubbing, which often have negative consequences on many parts of life. Platforms and marketers use these tendencies to their advantage, employing certain features to obtain engagement and sales.

Despite such negative trends, there are reasons to be optimistic: trends like the joy of missing out (JOMO) are a direct result of widescale FOMO trends. JOMO is a direct, positive, and intentional counterpart to FOMO that encourages healthy lifestyles and stepping away from the constant noise of social media. By turning off the notifications and choosing to join JOMO, one can learn to restore oneself, leading to improvements in mental health, focus, and personal relationships.

Your Brain on the Beat

BY: SUNNY CUI

MUSIC

"What an odd thing it is to see an entire species—billions of people—playing with, listening to, meaningless tonal patterns, occupied and preoccupied for much of their time by what they call 'music'"

This remark began Musicophilia: Tales of Music and the Brain, a book written by Oliver Sacks, the British born neurologist renowned for transforming clinical case studies into humanistic literature [1].

Odd indeed that we ubiquitously drift away in the flow of music alone in our room and surrounded by strangers. Odd that music originated over 40,000 years ago. Odd that the history of music is as ancient as humanity itself.

Why are we so oddly and continuously drawn to music?

We derive our answer from modern neuroscience: music is not just simply a form of art and a source of pleasure but also a cognitively powerful tool. The human brain is widely considered to be a "prediction machine" that constantly anticipates future events by generating and updating a mental "model" based on past experience [2]. By anticipating future sounds and musical events, the brain reduces uncertainty and minimizes the energy to process every detail of the environment.

This predictive drive is exactly what music exploits. Through the lens of music theory, music is built by three fundamental components: melody, harmony, and rhythm [3]. These components are all built from patterns, and our "prediction machine" loves patterns, from which it can learn, update, and enhance future performance.

Our brain doesn't wait passively for the following notes but forms expectations: the next beat, phrase ending, and harmonic resolution. When the music confirms our prediction, we feel satisfied, the brain's reward system is triggered to release dopamine, a "feel-good" hormone. This is a pathway to our increasing affection toward music [4].

What about actively listening to music when performing cognitive tasks such as studying? Is it actually disruptive?

In the 1990s, a group of researchers claimed that after listening to Mozart's Sonata for Two Pianos (K488) for 10 minutes, spatial-temporal reasoning and intelligence were boosted significantly, and this became known as the Mozart effect [6]. The arousal-mood hypothesis was developed to explain the Mozart effect by suggesting that external stimuli such as music improve cognitive performance not directly, but by increasing arousal (one's mental energy and intensity) and creating a positive mood [7].

However, a recent review article published in 2022 shows that the answer to whether background music is disruptive during study is rather complicated [8]. Their findings showed a broadly negative effect: background music generally impaired memory and language related tasks, with lyrical music proving more disruptive than instrumental. Only limited positive effects were identified. Nonetheless, the full picture still remains elusive and requires more controlled research.

You may be wondering why. The "storage" of facts and music rely on different memory systems [10]. Facts often depend on declarative memory, especially the hippocampus and medial temporal lobes systems that support new episodic and semantic learning, while music is supported by procedural, emotional, auditory, and motor networks that usually stay relatively intact even when declarative memory is badly damaged [11]. In other words, music is distributed and not stored in a single place like facts. Music is tied to rhythm, melody, motor habits, emotion, and autobiographical associations.

The interesting effects of music on our cognition doesn't stop with memory. There are so many unexpected and unsolved cases in Sacks' book: a man struck by lightning suddenly developed an intense passion for piano music, specific music triggering seizures, and the broad spectrum of musical talent—from extreme sensitivity to nearly total absence [1].

> **"The brain's prediction system is naturally inclined to replay catchy, recently heard musical patterns."**

No matter what, Sacks writes that "this propensity to music—this 'musicophilia'—shows itself in infancy, is manifest and central in every culture, and probably goes back to the very beginning of our species" [1].

And sometimes, this affection goes too far. The music you love or a random excerpt just keeps on playing in your head—colloquially called an earworm—hijacking attention during a test. This experience is often known as involuntary musical imagery, or "a conscious mental experience of music that occurs without deliberate efforts to initiate or sustain it" [5]. This happens, again, because the brain's prediction system is naturally inclined to replay catchy, recently heard musical patterns.

Memory is perhaps the most striking and crucial cognitive domain where music leaves its mark. Sacks describes Clive Wearing, a musician with severe herpes encephalitis-induced amnesia. This syndrome caused his memory to reset every few seconds and destroyed his episodic memory, or memories of specific past, everyday events and contextual details associated with them [9]. However, his musical abilities (including playing and reading music) and emotional attachment to his wife remained intact. Music and love, in this case, outlasted mundane facts [1].

BCIS: CONNECTING MIND TO MACHINE

BY: IZZY GUSTUS & GRACE CHEN

As the fields of medicine and bioengineering continue to expand, many disabilities and conditions such as epilepsy now have treatments using devices with brain-computer interfaces. These systems previously used only for medical purposes have led to the creation of user-friendly devices available to audiences beyond just those with special medical needs. Now, cognitive devices such as Nike Mind slides and Neurable MW75 headphones are being released to the public to help improve calm and focus.

The beginnings of most user-friendly medical devices trace back to complex systems called brain-computer interfaces (BCIs). BCIs are input-output systems that connect brain signals to hardware. The current most common purpose for BCIs is to help with neuromuscular disabilities, which cause trouble with executing actions due to a mishap in signaling between the brain and muscles. Devices that have been created to assist with this include prosthetics, specialized wheelchairs, and even neurological computer cursors that allow individuals to control on-screen activity through signals from their thoughts [1].

To start, intracortical signals are derived from the primary motor cortex of the brain via miniscule, implanted electrodes that live close to the neurons themselves. These electrodes track the activity of muscles based on their location, as well as speed, acceleration, force, and muscle preparation and activation. Instruction cues and movement patterns can also be encoded [2]. Based on this information, the electrodes can choose to further stimulate the motor cortex to strengthen signals and increase muscle movement or power. Intracortical BCIs can be used to help with muscle exhaustion, numbness and returning sensation to previously blunted external stimuli due to central nervous system trauma [5, 6].

In addition, electrocorticographic (ECoG) signals use the cerebral cortex to determine somatosensory-evoked potentials (SEPs), which are signals triggered by peripheral nerves and sent to the brain. These signals are converted into electric signals for the electrodes, which are attached to the scalp and spinal cord, to input into data collection devices. This data is commonly used to determine if a patient is able to care for themselves or if medical assistance such as the aforementioned intracortical electrodes is required [3].

Lastly, electroencephalographic (EEG) signals are used on a larger variety of output devices and on multiple parts of the brain. This is because EEG electrodes are cheaper, yet lower in resolution and data quality compared to the other BCI types. This can be an advantage, as devices using EEG signals are more accessible, but the method is also less used in research [7]. Like ECoG electrodes, EEG electrodes are attached to the scalp. They record electrical activity in specific areas of the brain based upon the type of device being used. For example, prosthetic limbs, specifically arms, use these frequencies from the motor cortex to apply movement. EEG signals can also be used to study brain activity in order to diagnose brain conditions such as epilepsy [4].

Although many advancements in BCIs have been geared towards medical disabilities, the Neurable MW75 headphones represent an example of a BCI designed for a wider audience. This device functions as a normal set of headphones, but is specifically designed for improving focus, cognitive speed, and calmness in working on PC and mobile devices. Developed during the COVID-19 pandemic, these headphones aimed to improve time management for remote workers whose average productivity time had dropped by three hours [8]. The hardware includes 12 fabric sensors that use EEG tracking to log what the company calls 'biofeedback,' or vitals tracking, in neural reports in its Neurable app [9]. The app includes information about the user's concentration and efficiency based on these vitals; the raw information is transformed into these reports via AI systems built into the app [10]. When using the product, two of three users reported having improved focus with the average user experiencing a 33% improvement. Nonetheless, the confounding variable of sound cancellation provided with the device, which is not taken into account in the reports, could also be at play in improving focus [9].

Neurable headphones differ from seemingly similar competitors who also produce vitals tracking devices such as the Oura ring, Apple watches, FitBits, and other smart watches. This is because the headphones use vitals from the brain rather than just a normal pulse, and they can thus give better information on focus. However, Neurable headphones lack the sleep tracking abilities that other devices have, as that is not their intended purpose and they are unconventional for sleeping.

While devices like the Neurable headphones work to improve cognitive performance, other companies are also applying neuroscience to consumer products relating to physical performance. In January of 2026, Nike released the Nike Mind 001 and 002 shoes, which are sensorimotor neuroscience–based recovery footwear. These shoes were designed to improve sensory awareness, and are said to increase focus and decrease distracting thoughts. The target audience of this product is athletes, with a goal of increasing the feeling of being "present" pre-workout or post-workout [12, 13].

To reach an athlete's mind, these shoes take advantage of the foot's thousands of nerve endings, which make it one of the body's most sensitive areas [14]. The slide is designed to stimulate these nerve endings with 22 independent foam nodes on the footbed. Each node moves in a "piston-like rhythm" that engages the sensory area of the brain through the mechanoreceptors of the feet [13]. According to Nike, side effects of the shoe include, "clearing your mind, acting on instinct, and a complete lapse in hesitation" [12].

During development, Nike neuroscientists used mechanical sensors, electrical signals, and brain rhythms to test the impact of the slides, before concluding that the stimulation from the shoes increased athlete alertness and stability [13]. Some reviewers claimed that the shoes make their feet "feel awake" and allow them to "feel the texture of the surface they're walking on", which causes them to feel more grounded [14, 15]. While more studies are necessary to establish these connections, the new connection between footwear and neuroscience is an exciting premise.

BCIs are a rapidly growing facet in the field of neuroscience and represent significant potential growth in quality of life for those struggling with neurological disorders.These BCIs vary in system and have been implemented in devices like cochlear implants or robotic arms to restore or enhance bodily functions. New products are also being developed to help consumers improve health and focus, as well as to make BCIs more integrated and accessible in daily life.

Formatters: ***Lia Schlessinger and Claire Menapace***

Procrastination: The Student's Silent Saboteur

BY: YATHARTH MAKWANA

Stress rocketing, grades obliterated, and utter agony followed by instant remorse and self reproach: This scenario is only too familiar to the average student. With ~86% of high school students pushing back everyday assignments and mundane tasks [1], procrastination has become increasingly pervasive.

Procrastination is a constant battle between the limbic system (emotional, instant-gratification aspect) and the prefrontal cortex (logical, rational aspect) of the brain. When faced with an unwanted task, the limbic system causes a "fight, flight, or freeze" response, prioritizing instant mood relief over long term goals. This overrides the prefrontal cortex, leading to Dopamine release [2].

Attempts to escape this never-ending cycle are often futile without proper strategies. Hence, this article will attempt to bring light to patterns of procrastination and its effects, and present effective strategies through an accessible and practical approach for the aspiring student.

Patterns of Procrastination

Temporal Discounting: Procrastination's Trump Card

Temporal Discounting is the concept that explains the reason behind why long-term gains are eclipsed by short-term rewards, leading to the true objective being eluded. For example, the gain of completing a long-term project is overshadowed by the immediate gratification of watching a funny video [3]. Research using fMRI scans has shown that the prefrontal cortex is active when decisions pertaining to long-term, delayed, rewards are made. In comparison, when immediate gain is involved, the limbic system takes precedence [2]. When the limbic system is activated, it overrides the prefrontal cortex leading to a decision prioritizing immediate gain, and thus, leading to procrastination.

Perfectionism and Procrastination

Counterintuitively, perfectionism and procrastination are correlated , with the former being a direct factor to the latter for many people [4]. The limbic system of many perfectionists is triggered because the fear of defying expectations and criticization increases, leading to apprehension when starting a task. Similarly, overanalysis also leads to disrupted action. Additionally, perfectionists avoid starting a task because they believe that the task at hand is only worth doing if it is important. "Unimportant" tasks are not started because they are believed to be unworthy [5].

Likewise, procrastination can also reinforce perfectionism because failing at a task leads to further apprehension and lack of feedback for a task, leading to even more poor results, ending in an endless cycle.

Effects of Chronic Procrastination

Procrastination reduces productivity and is also capable of altering and reducing the efficacy of the brain long-term. In addition to students being engulfed, 1 in 5 (20%) of all adults regularly procrastinate, highlighting the pervasiveness of procrastination [6]. Procrastination strengthens the neural pathways of the brain which are associated with avoidance. Similarly, it weakens the pathways associated with discipline, leading to it being increasingly difficult to focus [2]. This leads to poorer results and procrastination becoming a habit. One habitual, procrastination is extremely difficult to combat and has detrimental effects on work pace and attention span, and snowballs into greater disarray.

Additionally, procrastination decreases the gray matter in the prefrontal cortex, leading to decreased decision making and impulse control . This leads to less control over rational decisions, compromising everyday critical thinking in class, or for any other task.

Procrastination also increases cortisol (stress hormone) levels, the excess of which leads to impaired memory, decreased focus, and compromise of mental health [2]. This leads to less productivity and cognitive function, leading to a less efficient work or school life.

Formatter: ***Aleena Zhang***

Secrets to Success

Self-Forgiveness

Scientists have found that forgiving oneself leads to decreased procrastination in the future, restricting the limbic system . A study conducted involved measuring participants' (students') emotional/mental state after each test, to observe the correlation between self-forgiveness and test results. Unpredictably, the results of this study found that, generally, procrastination is reduced when students were not as harsh on themselves because forgiveness recognizes the wrong in their doing while allowing a growth mindset [7].

It is important, as students, to forgive the self about earlier mistakes and to move on, allowing for a more successful academic career.

Establishing Accountability

Individual accountability is a highly effective method to overcome procrastination. Sharing and announcing one's objectives socially to another study partner or family member proved to be extremely effective in reducing fatigue and finishing tasks. Alternatively, to-do lists are also known to be effective in holding oneself accountable.

A study showed that students who announced themselves accountable for a task, were much more likely to finish the task as compared to students who did not. Out of a cohort of 276 students divided into control and variable groups, with each student being assigned the same tasks as other students, students that held themselves accountable through an online accountability platform performed better in class and did better on assignments and tests. The enhanced performance on assignments, including time management, show that accountability to a task makes it more likely to be finished [9].

The Pomodoro Technique

The Pomodoro technique to reduce procrastination and fatigue is highly recommended. The technique involves productive work in short bursts, usually 25 minutes, with intermittent 5 minute breaks. After completing a few cycles, a longer break is taken. The short breaks offer a periodic, built-in reward which satisfies the limbic system and the brain's craving for dopamine.

A study found that participants who use the Pomodoro method were able to complete tasks for a given day more efficiently than those who did not use the technique. The study allowed medical students to take routine surveys which then mapped them on the Irrational Procrastination Scale (way to quantify procrastination) [8].

However, this technique, though effective to reduce procrastination, may not be effective for students that like to "go with the flow" as they work because it causes them to halt their mental flow. For example, when engaged in creative tasks such as writing a story, it is unhelpful to have frequent breaks because they cause a disruption in focus and interrupt the "flow" of creativity. However, in tasks which require extensive logical thinking, the Pomodoro Technique is a great way to stagger work and finish the task efficiently without getting distracted [8].

Procrastination follows very defined outlines and patterns, and knowing these in addition to techniques to mitigate them provide an academic boost to students, allowing for a better and more successful academic performance. While each of the strategies – Self-forgiveness, Pomodoro, and Accountability – are extremely useful, some may benefit the individual better than others, depending on different mindsets, academic abilities, and various other factors such as the task at hand. For example, the Pomodoro technique is better suitable for logical thinking tasks, while the self-forgiveness method is more suitable for holistic academic growth. Ultimately, the "best" strategy is discernible by the individual, though all three discussed strategies are useful in different cases. These strategies can be applied to have a more successful academic performance as students, and a greater school experience in general.

Formatter: ***Aleena Zhang***

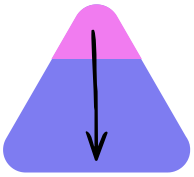
Rewired
How Social Media Hijacks Human Focus

BY: CLAIRE HUA

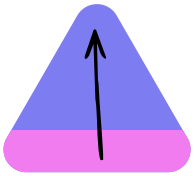
Types of Attention [1]

Top-down: Goal Driven

- voluntary
- controlled by internal goals and knowledge



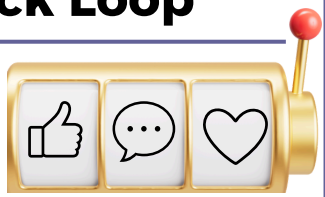
Bottom up: Stimulus Driven



- involuntary
- reactive
- triggered by external stimuli

Feedback Loop

Brain scans show that the **anticipation** of a **notification** releases more **dopamine** than the actual content of the message.



Notification → action → reward

Myth or Fact?

Human attention span: 8 seconds

vs.

Goldfish attention span: 9 seconds

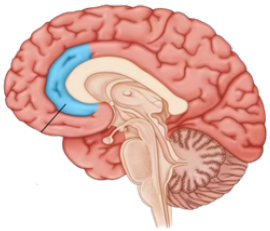
Myth!

Attention is task dependent, not a fixed timer.

The Hardware Change

Anterior Cingulate Cortex (ACC) :

- activates during tasks requiring focused attention
- **helps say "no"** to an impulse. [2]



Heavy scrolling can "thin out" the brain tissue in this area.

Our mental brakes are **physically** wearing down making it much harder to **stop** scrolling

Research shows that trying to do **two things at once** (like working while scrolling) **cuts** your brain's **efficiency** by

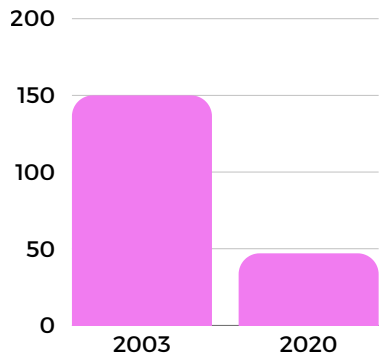
40%. [3]

Human attention isn't shrinking in capacity; it is suffering from **attentional fragmentation**. [4]

the constant **splitting** of **focus** caused by multitasking, notifications, and rapid task switching

We have the ability to focus for hours, but we have been conditioned to "switch" once a task becomes low stimulation.

Average time (seconds) spent on a **single** screen task [5]



Rewire Your Brain: Understanding the Power of Neuroplasticity

BY: EILEEN CHEONG

Imagine your brain as a living house that constantly remodels itself. Its four rooms–the lobes–are constantly changed based on how you live in it. These lobes handle everything from planning and memory to senses and sight. The frontal lobe acts as a planning office for decision making; the parietal lobe is the sensory room of information and awareness; the temporal lobe acts as a library that stores memories; and finally, the occipital lobe is the theatre projecting your vision.

All these lobes in the cerebrum of your brain are affected by a process called neuroplasticity. The magic of neuroplasticity is that if one of the lobes is damaged or needs upgrading, the brain can shift its architecture to recover or add on to them, proving that the brain is not in a fixed state, but designed to change based on experiences.

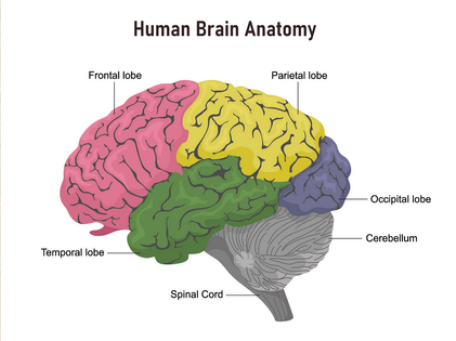


Image: Johns Hopkins Medicine

Neuroplasticity is the brain's ability to reorganize and rewire its neural connections, enabling it to adapt and function in ways that differ from its prior state. Much like plastic, the brain is highly malleable in response to learning new skills, experiencing environmental changes, recovering from injuries, and adapting to sensory and cognitive deficits [1]. This dynamic process occurs on a cellular level through synaptic plasticity–the strengthening or weakening of connections between neurons from damage or recovery–and neurogenesis, the process by which new neurons are formed in the brain for regulation [2,3]. Neuroplasticity is often categorized into two types: structural and functional.

Structural Plasticity

Structural plasticity physically changes the brain structure, occurring when more neurons and synaptic connections are formed through learning, memory, and experience [4]. The creation of more neurons happens through a process called neurogenesis. New neurons developed during this process enable the adult brain to rewire itself, especially in the hippocampus. The Hippocampus acts as the brain's processing center, controlling memory, learning, navigation, perception, and emotions [5]. The hippocampus experiences rapid growth in neurons and synaptic connections specifically during infancy and childhood as a result of heightened learning, experience, and memory development. This is an example of structural plasticity, as the brain's anatomy is physically altered in size and complexity through growth and development [4].

Structural plasticity can be imagined as pathways that extend the brain's map: When a new skill is learned, synaptic plasticity strengthens the communication between neurons, triggering them to sprout new physical neural pathways called dendrites. These neural pathways then rearrange themselves, physically remodeling the brain's structure to store in the new skill [6]. An example of this is learning how to walk as a baby. As infants learn how to take their first steps, the brain creates new neural pathways that extend its informational map in which the new adaptation is stored. Through this learning process, it is the structural flexibility that physically alters the brain structure.

Formatter: ***Aleena Zhang***

Functional Plasticity

Functional plasticity is the synaptic remodeling following brain dysfunction or injury, where already existing neurons propagate and form new synaptic connections [4]. This remodeling takes place when the brain adapts parts of its functions to compensate for malfunction or damage of neurons in another part of the brain. This takes place in the cerebral cortex and amygdala [4]. The amygdala is heavily involved in emotional regulation and response [7]. Similar to the hippocampus region, the amygdala is especially active during childhood [4]. Early experiences of stress and trauma are proven to increase the rate of cognitive decline because the dendrites of neurons in the prefrontal cortex and hippocampus shrink in response to it. And those who are in a chronically stressful environment or state have larger amounts of gray matter volume in their amygdala–the brain's processing center for emotions and perception– indicating higher levels of emotional response and reaction [8,9]. Experiences like this at an early age cause the brain to have tendencies of "protecting" itself by altering neural connections, and therefore altering emotional responses in future experiences. Since functional plasticity is reorganizable, however, it can also be used to heal trauma. By intentionally retraining neural responses, the brain can reshape established patterns and connections when faced with familiar situations or triggers [4].

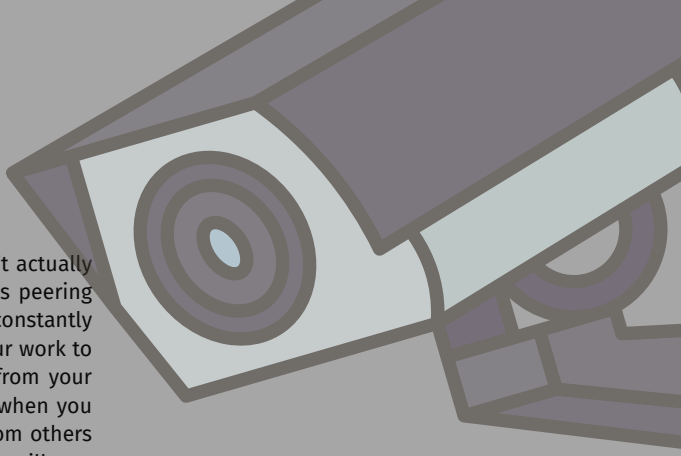
On the other hand, the cerebral cortex is responsible for the higher-level processes of the human brain: conscious thought, memory, language, reasoning, decision-making, emotions, intelligence, and personality. Functional plasticity allows the cerebral cortex to reorganize its structure and function from physical damage in the brain [10]. In the same way structural plasticity builds new pathways, the brain can "re-route" its map after an injury. This is from the undamaged areas sprouting new dendritic branches to create stronger synaptic connections, allowing the undamaged tissues of the brain to quickly adapt and take over the functions of the damaged parts. For example, cases show that stroke victims could temporarily or even permanently lose their basic motor or speech skills. However, functional plasticity can help the victim regain these skills, where the healthy brain tissues around the damaged area will try to aid recovery by reorganizing neural circuits and compensating for the damaged areas often through therapy and repetitive practice [11]. Beyond just reorganizing existing circuits, the brain initiates a regenerative response from neurogenesis. Following a stroke, neural stem cells in specialized regions are triggered to multiply and produce new neuroblasts [2]. These newborn cells migrate towards the damaged area to replace potentially replace lost neurons and release growth factors to keep surviving cells alive. This perspective suggests that the brain doesn't just rewire; it makes a biological attempt to replace lost tissue by creating new neurons. Through this cellular process, functional plasticity gives the brain the flexibility that allows individuals to potentially regain lost functions by finding new ways of performing tasks [12].

Both structural and functional plasticity are highly active and rapidly developing during childhood, explaining why young brains master new skills quickly while remaining deeply sensitive to early life experiences in both positive and negative lights [4]. Both structural and functional plasticity are modifiable from infancy to adulthood, and while neuroplasticity naturally declines with age, the brain remains a life-long "work in progress" - continually adapting, learning, and growing in response to new experiences, environments, and emotions [9].

Formatter: ***Aleena Zhang***

How We Act Differently under Surveillance

BY: ALEX GU & BEN LI



Have you wondered why you act locked in when working at the public library, but don't actually feel productive? Well, it's because you get the impression that everyone around you is peering over your shoulder, fixated on what you are doing. When you believe that eyes are constantly monitoring every word you type or every tab you switch to, you feel pressured to do your work to protect your reputation. However, the feeling of being surveyed distracts your brain from your homework and increases your anxiety and self-consciousness [1]. On the other hand, when you are at home, you feel a sense of security and comfort because the outside pressure from others does not exist, leading you to slack off rather than check off your to-do list. In fact, surveillance plays a major role in shaping how people think and act. The mere feeling of being watched causes people to act more prosocial, performing actions believed to be more socially acceptable at the expense of mental health and productivity [1].

The psychological impact of surveillance stems from research on the audience effect, the tendency for people to alter their behavior when they believe they are being observed [2]. The effect is also triggered by subtle cues of being watched. For example, researchers used an image of a pair of eyes to simulate surveillance, and the results showed that the image significantly affected participants' willingness to contribute to a public good [3]. This shows that the brain craves societal acceptance.

The concept of reputational management is key to the brain's response to surveillance [3]. In seeking acceptance from others, individuals tend to align their behavior with social norms and expectations. Some researchers also argue that humans don't only act out of self-interest; rather, their actions are actually shaped by prosocial or pro-other tendencies, reflecting history's tendency toward group selection [3]. When people demonstrate allegiance to a group, they intend to act altruistically. However, researchers have suggested that people act this way for reasons based in self-interest to protect their reputations.

Because of its psychological effects, surveillance also serves as a double-edged sword in shaping behavior and social responses. As mentioned earlier, one positive effect of surveillance is increased productivity and cooperation. Studies have concluded that people are significantly more likely to contribute to shared resources, follow rules, and exhibit helping behaviors when they feel observed [3]. For example, in the workplace, employers use digital surveillance to try to maintain efficiency and encourage employees to adhere closely to institutional guidelines [3]. As a result, surveillance, or "bossware," has become a popular tool among employers seeking to improve performance and compliance.

However, the effects of surveillance are not entirely positive. Workers who are under digital surveillance reported increased stress and anxiety, feeling less confident, and more pressure to perform [3]. Over time, the stress can lead to more serious psychological consequences like heightened paranoia and disorders associated with anxiety [5].

In addition to influencing behavior, surveillance also alters how the brain processes information. Studies have shown that the presence of a spectator has a measurable impact on key cognitive functions such as vision, memory, and attention [1]. When people get the impression that they are being watched, their visual attention becomes more receptive, becoming quicker to notice faces, more sensitive to gaze direction, and more likely to search their environment for signs of judgment [1].

Similarly, memory is also directly impacted by surveillance. Individuals under perceived observation also exhibit stronger recall of social details, while performance on non-social memory tends to decline [1]. Looking at this information, it concludes that the brain is putting more effort into maintaining a social image by sacrificing some other cognitive functions.

Although many corporations and governments employ surveillance to monitor security in the workplace and prevent crimes from occurring, this often comes at a cost of individual autonomy and privacy. These institutions believe that monitoring their population will promote prosocial behavior and productivity, but in reality, a large psychological toll is placed on individuals. Furthermore, the violation of privacy diminishes individual integrity since trust and compliance are forced from the fear of facing repercussions [6]. When there is a physical distance separating individuals and the watcher, a power dynamic is established where the surveillant has disproportionate control while those being monitored are disempowered. These ethical issues continue to limit individuals from engaging in protests and free speech in our current society. So, the next time you go to the library, understand the psychological effects you go through and do not be afraid to be your true self in public.

Formatter: **Elizabeth Wong**

MAXIMIZING COMMUNICATION: THE MULTIMODAL METHOD

BY: JONINA HOU

The way humans communicate is based on a system that is constantly being modified and adapted by social interactions, beginning with our early ancestors around 2.5 million years ago [2]. Within this system, broad categories have been defined to sort these different ways, or "modes", of transferring information. The linguistic mode is the most widely used, and consists of anything concerning written and spoken words that can be delivered through either audio or paper. Another type that is especially helpful for many people is the visual mode, which combines images, videos, and color to convey meaning more efficiently. In addition, the aural mode is also one of the most common approaches to communication, relating to anything that uses sound, such as music or tone of voice, to enhance emotion in a text. Compared to the linguistic mode, where the focus is on the actual content and meaning, this method specifically emphasizes how the message is delivered. Specifically in face-to-face interactions, people are constantly using their hands and changing their facial expressions to emphasize their points, all of which can be classified under the gestural mode because they require movement. Finally, the spatial mode relies on the physical layout and organization of multiple elements, such as website builders determining where to put each button to maximize user interactions.

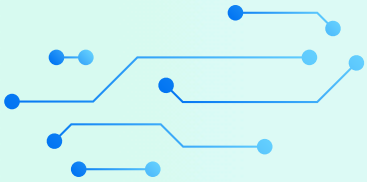
Language isn't always aural—sign language, for example, uses hand motions and visual cues to transmit information. In fact, it is estimated that more than 70 million deaf people worldwide rely on this form of communication [3]. Specifically, American Sign Language, or ASL, has certain non-manual markers, in addition to the manual signals, that refers to the facial expressions or head tilting that signers use to replace voice inflections [4]. For instance, when signing a yes or no question, the eyebrows should be raised with the head slightly tilted forward, while signing a question that includes "who", "what", "when", "where", or "why", eyebrows should be lowered and slightly furrowed with the head tilted back a bit [5]. Such variations in visual cues allow for easier interpretation of a language that doesn't use voice pitches to base emotions off of.

Gestures, along with talking, serve a foundational role in language, and they are an innate component of language production in humans. This is shown by babies gesturing before their first words, or congenitally blind speakers using hand motions to other blind people also lacking sight, indicating that gesturing is a foundational brain mechanism instead of a learned observation [6]. These manual signals are more frequently used by people with neurogenic communication disorders that make it hard to express their ideas verbally, such as aphasia or Alzheimer's, with studies proving that those with non-fluent aphasia (limited to short phrases) tend to gesture at a higher rate compared to those with fluent aphasia (smooth speech) [7]. Using a multimodal approach to communication has been proven to be highly effective and to hold an advantage over unimodal methods [8]. An emotion recognition study reported that multimodal systems had, on average, a 9.83% increase in accuracy in conveying a speaker's intention [9]. Gestures and visual stimuli make up the core of signals, but between using solely gestures and adding on vocalizations, the extra sound component often makes for a more coherent understanding.

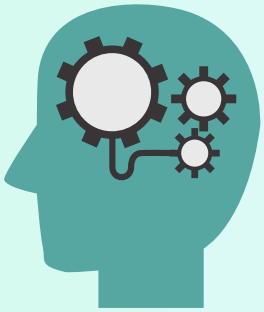
The combination of different communication methods has proven to maximize effectiveness in understanding the meanings of conveyed messages, in addition to increasing expression and emotions in everyday conversations. Multimodal communication has already had profound effects by increasing accessibility for those with different needs and disabilities, and will continue to evolve over time.

THE MIND'S MEMORY VS. MACHINE

BY: LUKE TAYLOR



One day we will all no longer be able to think for ourselves. Every time AI is used, we're all skipping the reps we need our brain muscles to take on, making it weaker over time. Every single time AI is used, it decreases the capacity of anybody's brain to run. Before AI occurred, people graduated from high school creating Google, however currently these massive advancements happen in the older people. In fact this means the younger generation is falling behind. Frequent reliance on AI can lead to weaker memory retention. Digital amnesia is the tendency to forget information due to the extreme reliance on technology. Although technology enhances efficiency, cognition, and problem solving skills, it still greatly negatively impacts the brain [2].



Even though there are positive sides to technology, there are many drawbacks that come with it. In the past, people had to memorize almost everything, including phone numbers, appointments, and directions for traveling. With the ability to save all such important information on one device instead of storing it in one's brain, life becomes much easier. Currently, it is possible to call someone with only the click of a button; it is not even necessary to see the phone number before calling the person. There currently exists a digital calendar to enter any important events, while notifying them when the date is coming closer. For past generations, they had to organize on paper everywhere they had to be, and check it constantly to ensure nothing was accidentally forgotten.

Technology offers instant access to information, making it much easier to retrieve information compared to reading from books.Every single time anyone searches for information, it is right in front of them. AI summaries provide an increased speed of retrieving information. However, this reduces the amount of time the people are actively reading to understand the subject. They do not even have to look for the information in websites, reading through paragraphs and essays. This creates a much larger problem, as it signals that all the information they need is accessible with only a click of a button. They no longer have to read from textbooks, or worry that it will be time consuming to find the information again in the book. This reduces cognitive effort and decreases long-term memory retention, especially demonstrating a negative impact on younger ages, as the prefrontal cortex finishes developing around age of 25 [1]. This correlates to the importance of building strong learning habits during the younger side. Thus, it is important to understand that after a certain point in time, it will not be by choice when using AI for everything starts becoming part of everyday life, making the option to learn independently become much more difficult.

This reliance on AI, such as using ChatGPT to search for information, leads to cognitive effects like reduced memory skills and the decreased ability to recall information. It is much easier to copy down word by word what ChatGPT wrote, than to connect the dots independently from reading a textbook. But what would happen when ChatGPT, or YouTube crashed? This has occurred many times, with articles being made from its moment of occurrence, and thousands of people reporting it affecting them [3]. People who were not heavy AI users did not notice these platforms crashing. The circumstance where articles are made immediately after this event in a short period of time demonstrates there are people who need it to be back running, instead of it being a helpful tool.

Taking the reliance of technology into account, it is crucial to balance technology use. One strategy for this is taking short breaks from technology. With staring at a screen for several hours per day being a major flaw in many lives, taking these short breaks can let someone no longer feel trapped in the AI realm and allow one to enjoy the outside world. Another strategy is note-taking and memorization techniques. While blankly copying down the answers AI outputs may give an easy A, it is more beneficial to practice understanding and memorizing the information and taking notes on what the teacher had given. Technology should instead be used as a tool to improve ideas that are already thought out, instead of AI doing the entire process. Not going down the road of passive reliance encourages active learning.

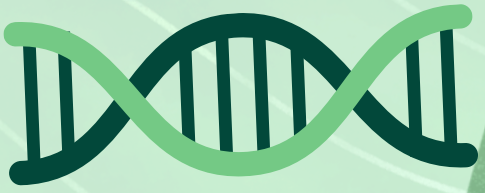
Digital amnesia exists everywhere in the world, and dependence on AI further worsens it, bringing many cognitive consequences. It is important to understand that technology is not meant to replace the human memory, but instead assist it. By still actively learning, information can be understood instead of being memorized only for a test or project. With slow and conscious practice to avoid overusing technology, anyone's brain can become fully developed without interruptions through the use of AI.

Formatters: ***Lia Schlessinger and Claire Menapace***

Nature vs. Nurture: Which One Dominates Behavior?

BY: ETHAN TANG

How much of our brains have been constructed before birth, and how much of it is built up over years of experience? After a person is born, they experience millions of individual memories, experiences, and interactions that are all absorbed. These events contribute to "building" the brain as if they were workers. However, despite the millions of experiences that each person faces every lifetime, there is always a basic genetic blueprint, or foundation, that the brain is built upon. This is the driving question for Nature vs. Nurture: how the blueprint affects how the brain is built, how the "memory construction workers" affect the construction process and behavior, and how these tie together to create the behaviors and personality of every individual.



As stated previously, genetics is the blueprint, passed down from parents to offspring that influence behavior and personality. In the brain, this inherited blueprint is found in the cortical thickness inside the prefrontal cortex. Cortical thickness, the distance between gray and white matter in the brain, is the main driving force behind variation in the Big 5 personality traits. These traits include openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism. Cortical thickness ranges from around 34-80 percent inherited, making much of the variation in it highly dependent on genetics. General tendency to experience negative emotions (neuroticism) and conscientiousness (self control, responsibility) tend to be linked to higher cortical thickness, while sociability and extraversion, agreeableness, and openness to experience tend to be linked to lower cortical thickness . Inherited cortical thickness tends to have a positive correlation with intelligence, discipline, and neuroticism, yet has a negative correlation with overall emotional maturity, agreeableness, and extroversion [3]. Cortical thickness variation is highly dependent on genetics, creating predispositions to the expression of each of the big 5 personality traits. However, due to cortical thickness being a polygenic trait, a person's inherited traits and personality can vary widely, and while it plays a key role in personality development, it is just one of the many different variables in brain structure that can affect inherited traits [5].

Among siblings and especially twins, genetics can play a key role in how traits are developed and expressed, even in entirely different environments. This was made especially clear in the "Jim Twins" study. In this study, two identical twins, separated at birth, ended up with similar lifestyle choices, personality traits, and even preferences in situations where their brain may have been developed completely differently. From genetic inherited traits such as cortical thickness and overall frontal lobe heredity, the twins ended up extremely similar and showed the significant impact genetics had on personality and behavior development [4].

After conception, nurture, or external factors (education, culture, life experiences), additionally shape the human mind and overall personality development. Despite the evidence that the prefrontal cortex and frontal lobe are structurally highly heritable, certain environmental and external factors can very easily influence how these areas mature and develop, especially during adolescence and before the age of 25. As someone ages, there are numerous different factors that can individually and profoundly affect the development of personality and behavior. These include parenting style, education, peer influence, and overall socioeconomic status. Each factor has its own impact on each of the Big 5 personality traits, either negative or positive. For parenting style, studies generally show an authoritative, indulgent parenting style leads to the most positive outcomes on prefrontal cortex (PFC) development, increasing conscientiousness, agreeableness, and decreasing neuroticism. On the contrary, low warmth parenting styles such as a pure authoritarian parenting style or even neglectful parenting can cause developmental issues in the PFC, heavily decreasing conscientiousness and agreeableness in neglectful parenting, and increasing neuroticism in authoritative parenting [8]. With socioeconomic status the big 5 personality traits tend to have a positive correlation. High socioeconomic status tends to improve openness, extroversion, and decrease neuroticism due to more exposure to diverse experiences, while low SES causes the development of neuroticism in the PFC, likely stemming from chronic stress. A similar relationship is found with education, which when present can improve development in conscientiousness, openness, and emotional stability in an adolescent PFC [1, 2].

Unlike most other external factors, peer influence doesn't have a single, specific effect on the development of the prefrontal cortex, and can affect the PFC in different ways depending on the variables involved. Peer influence is characterized by its "spillover" effect on PFC development, often adapting conscientiousness, openness, neuroticism, and agreeableness to the same level shown by the peer group. However, genetics can very easily change this process. Higher genetic extroversion can actively seek out peers, speeding up the "spillover" effect on PFC development, and lower genetic neuroticism can decrease the "spillover" effect as higher emotional stability leads to less of a need to fit into a peer group [7] These are examples of the gene-environment interaction (GxE) and gene-environment correlation (rGE) phenomenon. The rGE phenomenon occurs when an individual's genetic makeup influences their likelihood of exposure to certain environmental conditions that may affect their behavior. For example, a person with higher extroversion is more likely to seek out peers, and therefore are more likely to be influenced by the spillover effects of peer influence. GxE, on the other hand, dictates the effect of the environment on one's development. This is shown in people with higher genetic levels of neuroticism, which are more heavily influenced by peer influence due to lack of emotional stability and a higher need to fit in [6]. With GxE and rGE, the relationship between nature and nurture are illustrated, showing how nature and genetics can often influence either the environmental factors involved and the severity of it.

Formatter: ***Aleena Zhang***

The Science of Consciousness: How the brain creates awareness

BY SANYA BHATT AND ANAYA SINHA

Scientists are able to trace how neurons fire, how sensory information travels in the brain, and how the brain organizes difficult tasks. However, how these physical processes are able to produce something as elaborate as awareness remains undiscovered (Spielman, 2020). The gap between measurable brain activity and mental presence is why consciousness is such a heavily debated topic in both philosophy and neuroscience. This puzzle has become increasingly relevant, as fields of neuroscience and artificial intelligence platforms continue to advance rapidly. Although new developments in these fields present new discoveries, such as detailed maps of brain circuits involved in attention, memory, and perception, nothing has provided an answer for awareness itself (Koch, 2018). Additionally, as AI becomes capable of language and pattern recognition at nearly human levels, it raises questions on whether information alone could ever produce an independent consciousness.

The brain contains roughly 86 billion neurons, each communicating through rapid electrical signals to form complex networks, and facilitate memory and decision making [1]. While consciousness itself does not come from these neurons, other areas such as the prefrontal cortex and temporal areas are strongly linked to awareness [4]. These areas integrate information from different senses, support language and reasoning, as well as maintain a stable sense of self. Damage to these regions results in awareness disruption, suggesting that consciousness depends on a high level of information consolidation. Conscious states rely on constant communication between the cortex and other deeper structures such as the thalamus. This sort of global workspace allows information to be broadcast all across the brain, making it available for memory, attention, and decision making. When this communication weakens, awareness fades.

Sleep and anesthesia give us clues about natural experiments to observe brain activity. Scientists can study consciousness when you are technically unconscious through a variety of medical materials. EEG recordings are able to measure electrical activity across the scalp. (Van Gulick, n.d.) Dreaming (REM sleep) can show fast, active patterns that are similar to wakefulness. MRI's are also able to show networks moving in your brain. Consciousness doesn't require the outside world, just active networks that are communicating. During deep sleep, brain activity becomes less dynamic, allowing for an altered state of consciousness. Similarly, under anesthesia, communication between your brain regions is disrupted even as the neurons still fire, resulting in unconsciousness. When someone is in the active state of dreaming, certain networks reactivate which allows vivid experiences even when there is not much sensory input. In many ways, this dream state consciousness has similarities to our wake state consciousness.

The brain still is able to construct a coherent world, generates emotions, and gives a sense of movement through an environment. The key difference is that our awake brain is connected to the real world through constant sensory inputs, while the dreaming brain relies almost entirely on internally generated signals [5]. These states show that consciousness depends on not only activity, but the right kind of coordinated activity.

Yet whether consciousness is a byproduct of complex information processing or a fundamental property of life continues to be disputed. The gap between brain activity and experience raises the question about why physical processes give rise to our subjective experiences at all. We can measure neural firing, but can't explain why certain patterns feel like colors, pain, or specific emotions. Why humans experience emotions at all follows from an evolutionary perspective; consciousness helps organisms to plan, learn things, and adapt. So, while the purposes of consciousness are well-defined, its origins remain a mystery.

As AI systems grow more capable, the question of consciousness becomes more than theoretical. Could a machine ever be conscious, or will it always simply simulate awareness? While we aren't near a definitive answer, it is useful to look at how today's AI systems are able to work and compare to the human brain. Both brains and AI models take in inputs, transform them, and produce outputs. At a very abstract level, neurons and artificial "neurons" both are able to build patterns from experience. Furthermore, as the brain strengthens certain neural pathways through repeated exposure, AI systems can adjust its internal weights based on training examples from users that it is given. A key difference includes the architecture, where the brain is parallel, organizes itself, and is constantly rewiring. Even the biggest AI structures are just mathematical models that are not as fluid [3]. If an AI system were to behave with consciousness, would we have ethical obligations towards it? How should we as society treat technologies that are able to mimic human reasoning and emotions? As we continue to understand consciousness, new discoveries will continue to shape debates about AI and the responsibilities that come with it, and the boundaries between a biological and artificial mind. It may also influence how future technologies are designed: whether to imitate human cognition or pursue an entirely different architect

UNDERSTANDING MENTAL HEALTH DISORDERS

BY LUNA XU AND CHARISSA HSU

Mental disorders are disorders that affect your emotions, mentality, and behavior. In 2021, researchers found that 1 in every 7 people suffer from mental disorder(s), making them more common than you might think [1]. Common disorders include depression, Post Traumatic Stress Disorder (PTSD), Obsessive Compulsive Disorder (OCD), among others. They are split into categories, such as anxiety disorders, mood disorders, and neurodevelopmental disorders, each with varying levels of severity. Most disorders can significantly disrupt daily life, affecting one's actions, emotions, and decreasing the quality of life of many. There are several treatment options available, including medication such as antidepressants, psychotherapy, as well as brain stimulation treatments among others [2]. There are genetic and external factors causing mental disorders, and it is important to know ways to support friends and family who may suffer from these mental disorders.

Both genetic and environmental factors can have significant effects on the development of mental disorders. Genetic factors can be deemed as anything inherited. There are certain genetic variations in the genome that may contribute to increased likeness of a mental illness. Although not specified, scientists can pinpoint 136 "hotspots" on the genome where these variants may occur [3]. Many doctors were also able to connect some genotypes that would increase likeness in mental disorders. For example, a type of the MAOA gene that metabolizes neurotransmitters has shown to increase the probability of antisocial personality disorders while a certain type of serotonin transporter may cause heavy depression because it affects brain cell communication [4].

Environmental factors are defined as influences on organism health that aren't inherited genetically [5]. Examples include traumatic events such as being a victim of a crime or sexual abuse, which may lead to confusion, exhaustion, sadness, and dissociation [6]. At first, these reactions are considered normal responses; however, they may evolve into mental illnesses as they intensify. These intensified symptoms may include longer periods of unrest, little to no periods of tranquility, or intense disconnection with their identity, reality, or memory [7]. These emotional and physiological stressors may impact how the genes that regulate our emotions and brain chemistry function. Finding the cause of mental illnesses is challenging because it takes shapes in unusual emotions and behavior, unlike many types of physical diseases. They don't have any biological indicators, there are many overlapping symptoms for different illnesses, and the tools for assessing mental health are inconsistent [8].

There are several treatments for mental disorders that vary based on the intensity of the symptoms and its category. Following physical exams, evaluations, and tests, doctors make detailed treatment plans for patients. Different types of drugs may be prescribed in different cases, but one of the most common treatments in all mental disorders is psychotherapy. In psychotherapy, patients talk through issues and mental barriers with a licensed therapist or psychologist, and can learn more about themselves, leading to growth towards better mental health. While this type of treatment is not a drug that is physically benefiting the body, it can benefit the patient's mental stability by, for example, giving the patient the means to draw attention away from triggers. Studies show that 75% of psychotherapy patients improved after just six months [9].

In most cases, psychotherapy is the secondary form of treatment, and drugs are prescribed, which can be more effective treatments. Antidepressants, such as selective serotonin reuptake inhibitors (SSRIs) and serotonin and norepinephrine reuptake inhibitors (SNRIs), are often prescribed, as well as anti-anxiety medications. SSRIs are most commonly prescribed to patients who suffer from depression, anxiety, PTSD, and OCD. They work by blocking serotonin, a neurotransmitter that carries signals to and from brain cells. In doing so, SSRIs stimulate more circulation around the brain. This allows for more messages to be passed between brain cells, therefore promoting brain function. The patient's thoughts and actions are therefore less affected by the condition when brain function is increased, leading to a more normal everyday life without symptoms. For patients with schizophrenia or bipolar disorder, antipsychotics are often prescribed. These drugs are different from antidepressants in that they reduce dopamine activity. Dopamine is another type of neurotransmitter, which acts similarly to serotonin. It is believed that transmission of signals through dopamine to be the cause of many psychotic symptoms such as hallucinations, which allows antidepressants to be effective [10].

There are several methods to help identify or respond to family members or friends who live with mental illness. Some signs to identify mental illness may include being detached, alternating communication patterns, and differences in sleeping and eating patterns. If these signs become increasingly severe, it may be helpful to reach out thoughtfully. Avoid accusation and focus on using "'I' statements", to indicate how you yourself have been feeling. For example, instead of saying, "You never hang out with us anymore, how come?" (which sounds accusatory), a better option would be, "I feel like we barely see each other anymore, is everything okay?"

Once they start opening up, it's important to listen and be empathetic. Then you can encourage them to take action by going to therapy or seeing a doctor [11]. However, if they don't want help, it is important to be patient; refrain from giving advice as they may become defensive. Furthermore, you can research their particular condition to see how you can better support them. It is important to set boundaries and be honest about what you can and cannot do [12].

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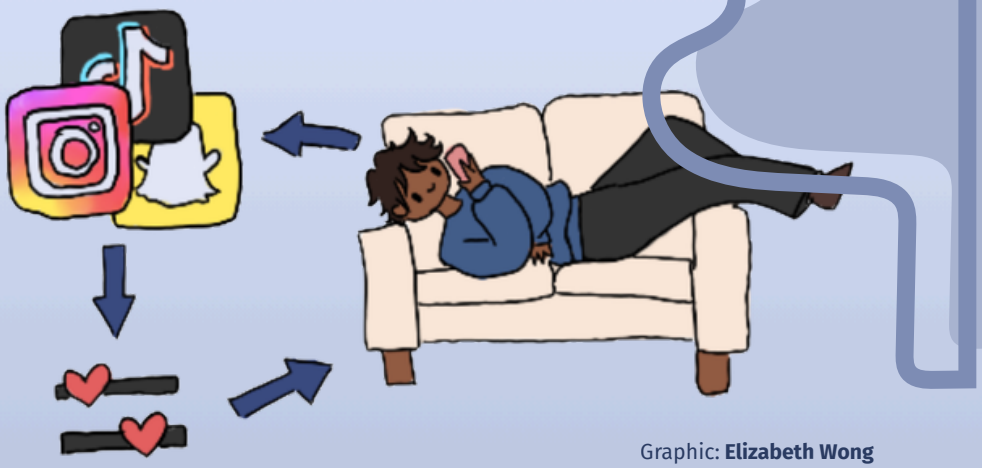
Mental disorders are one of the most misunderstood illnesses and are more common than you may think. Symptoms of mental disorders can be both very significant and create disturbances but can also be small and almost unnoticeable. Mental disorders can be caused by genetic or environmental factors, or both. Genetic variations can cause a defect in the brain's neurotransmitters, which affects the brain's ability to transport messages between cells. Environmental factors such as traumatic events, or psychological stressors can support the development of a mental disorder, even without any biological markers. This aspect of mental disorders makes finding the causes of the disorder very difficult, as anything can trigger or start the development of a disorder. There are various methods of treatment available, ranging from drugs like antidepressants and antipsychotics to psychotherapy. In combination, these methods can prove to be effective, especially with the supplementation of helpful responses of family members and friends. Encouragement and empathetic responses can help the patient and help support them. In conclusion, it is important to be informed about the various ranges of mental disorders with their increasing prevalence in today's world.

The Psychology of Doomscrolling

BY: KAIRA VERMA

In recent years, “doomscrolling” has become a term that’s widely used to describe the habit of constantly consuming negative information online. People may often check social media with the intention of staying up-to-date on what’s going on, but nevertheless experience increased stress, anxiety, or emotional exhaustion as a result. This raises a question—why do people continue to seek out negative information even when it continues to make them feel upset? This answer is complicated and involves a mix of psychology, brain chemistry, and how social media platforms are designed.

Graphic: **Elizabeth Wong**



Graphic: **Elizabeth Wong**

One explanation for doomscrolling comes from a psychological tendency known as negativity bias. Negativity bias is essentially the brain’s tendency to focus more on negative information than positive information. This may seem unnecessary today, but it originally developed as a useful survival mechanism. For thousands of years, people needed to quickly recognize and react to dangers such as predators, hazards, or dangerous groups of people. People who paid more attention to the threats were able to survive and then pass on their genes. As a result of this, the brain evolved to prioritize negative information that may pose a danger to the person. Researchers have described this pattern as “negative memories being more powerful” since humans were focused on surviving [1]. To elaborate, this means that negative information often has a greater impact on attention and memory than positive information.

This evolutionary bias still affects human behavior today. Negative headlines and news stories activate attention systems in the human brain more strongly than content that’s either neutral or positive. Because of this, people may feel impelled to keep reading this negative content despite knowing that it’s making them feel upset.

Other than negativity bias, another reason why doomscrolling is so difficult to quit is that social media platforms are intentionally designed to keep you hooked. A lot of apps use algorithms that continuously deliver new content, allowing the user to endlessly scroll. The user can keep refreshing the page without ever running out of content, which is problematic for the brain. Every time a person scrolls to new content, the brain anticipates the possibility of discovering something important. This anticipation activates the brain’s dopamine reward system, which plays a big role in controlling habits and motivation. Part of why the brain easily makes doomscrolling a habit is that the rewards are so unpredictable. Sometimes scrolling tells you important information, while other times it doesn’t at all. Nonetheless, the possibility of finding new updates keeps people scrolling and scrolling, making it hard for people to stop once they’ve started. Nowadays, social media platforms take advantage of this kind of variable reinforcement, since it causes you to scroll endlessly [2].

Doomscrolling is associated with negative effects on mental health. The amygdala is a structure in the brain involved in detecting threats and generating specific responses such as fear and anxiety. When people consume negative information over and over again, the brain interprets the constant stream of negative information as a threat, which triggers a stress response from the amygdala. Stress is associated with systems like fatigue, difficulty sleeping, and having a hard time focusing, which are very relevant problems for students trying to manage their academic lives [3]. For students specifically, these effects can interfere with concentration, sleep, and overall health. Instead of helping people feel more aware and prepared for what’s coming, doomscrolling can make them feel drained and stressed out.

Formatter: **Elizabeth Wong**

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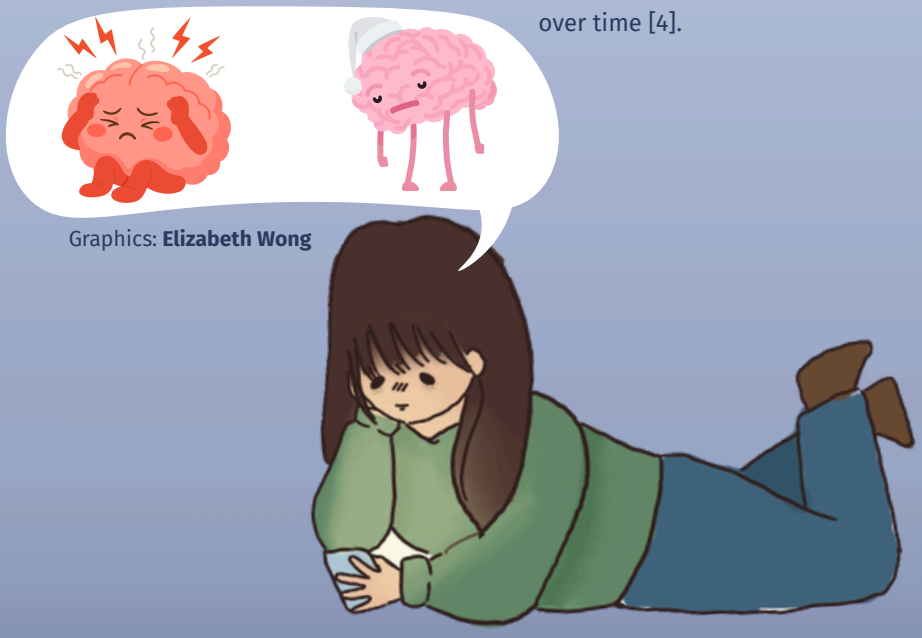
A strategy that's often recommended for reducing doomscrolling is mindfulness, which means paying attention to the present moment without any judgment. Mindfulness has significant effects on brain function, increasing the engagement of the prefrontal cortex, which is involved in decision-making, self-control, and regulating your emotions. However, mindfulness can help break the doomscrolling cycle by strengthening the brain's ability to notice volatile emotions and manage them before they become even worse. Research suggests that mindfulness meditation can reduce stress reactivity and improve emotional regulation by changing how attention and emotion networks in the human brain interact over time [4].



Graphics: **Elizabeth Wong**

Mindfulness can also increase your awareness of habits that normally happen automatically, helping you cut out or reduce the time you spend on those habits. When a person realizes that they're scrolling because of their own anxiety rather than the purpose of being informed, they can create a disconnect between their first impulse and their real action. This disconnect can make it significantly easier to stop scrolling and focus on other, more productive things in your life.

Specific strategies of mindfulness include setting specific times to check the news, turning off your notifications, or pushing yourself to take breaks from social media. All of these habits can help you make your attention become intentional again rather than being used up by endless scrolling. You'll find that you're more engaged in your schoolwork and can more easily transition to working on it.

Doomscrolling is more than some addiction that everyone struggles with. It's the result of complex interactions between psychology, brain biology, and the modern technology that we have today. Your brain has a tendency to be drawn towards negative information and social media platforms exploit this behavior through dopamine reward systems [1, 2]. Additionally, being exposed to negative information over and over again can increase stress and emotional dysregulation [3].

Understanding how doomscrolling works, we can develop healthier ways of getting informed through social media. Practicing mindfulness, having limits with social media, and becoming more conscious about media consumption can reduce the effects of doomscrolling [4]. In an era where different social media algorithms compete for our attention, being aware of how to stay informed without stressing yourself out can help protect your mental health more efficiently and increase your productivity.

Formatter: **Elizabeth Wong**

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