2025 Science Fair Logbook
Group Members: Sargundeep Kaur Deep and Jasnoor Kaur Toor

December 25, 2024 (2:03 PM – 9:16 PM)

- Researched experimental science fair topics

Some selected science fair topics:

- Dealing with Diabetes: The road to developing artificial pancreas

https://www.sciencebuddies.org/science-fair-projects/project-ideas/HumBio_p040/human-biology-health/developing-an-artificial-pancreas

- Obesity/Cancer choices and experiments
- 2 Mouse experiments (living in different environments and 2 different diet consumption)
- Creating a Kidney: How Stem Cells Might Be Used to Bioengineer a Vital Organ

(https://www.sciencebuddies.org/science-fair-projects/project-ideas/BioMed_p013/medical-biotechnology/bioengineer-kidney-with-stem-cells

- Antibiotic Resistance:

https://www.sciencebuddies.org/science-fair-projects/project-ideas/MicroBio_p021/microbiology/antibiotic-resistance

- A Prescription for Success: Drugs & Your Genetics

https://www.sciencebuddies.org/science-fair-projects/project-ideas/BioMed_p005/medical-biotechnology/drug-target-genomics

- Robotics: Build a remotely operated vehicle (ROV) for underwater exploration:

https://www.sciencebuddies.org/science-fair-projects/project-ideas/Robotics_p052/robotics/arduino-underwater-ROV

- Grow Plants in Microgravity:

https://www.sciencebuddies.org/science-fair-projects/project-ideas/PlantBio_p054/plant-biology/plants-grow-microgravity-arduino-clinostat

- Caffeine and Heart Rate: A Pharmacological Study Using Daphnia magna

https://www.sciencebuddies.org/science-fair-projects/project-ideas/Zoo_p048/zoology/caffeine-and-heart-rate-daphnia-magna

- Lung capacity and age:

https://www.sciencebuddies.org/science-fair-projects/project-ideas/HumBio_p003/human-biology-health/lung-capacity-and-age

After picking out a variety of topics, we elaborated as a group and eliminated various unnecessary topics. Therefore, we were left with 3 choices, including:

1. **Dealing with Diabetes: The road to developing artificial pancreas**

https://www.sciencebuddies.org/science-fair-projects/project-ideas/HumBio_p040/human-biology-health/developing-an-artificial-pancreas

2. **Robotics: Build a remotely operated vehicle (ROV) for underwater exploration:**

https://www.sciencebuddies.org/science-fair-projects/project-ideas/Robotics_p052/robotics/arduino-underwater-ROV

3. **Use a Microbial Fuel Cell to Create Electricity from Waste**

https://www.sciencebuddies.org/science-fair-projects/project-ideas/Energy_p026/energy-power/use-a-microbial-fuel-cell-to-create-electricity-from-waste

December 27, 2024 (5:58 PM - 9:46 PM)

- We re-modified our chosen topics and put them from best choice to worst choice
- We came up with catchy titles and Research/testable questions
- Wrote descriptions
- Looked more into the obesity topic
- Observed various diagrams

Title: **Effects of Digital Multitasking on Attention Span** – Assess how constant notifications impact concentration and task performance. (FIRST CHOICE)

Title: Mud 2 Motion! (SECOND CHOICE)

Heading: Use a Microbial Fuel Cell to Create Electricity from Waste

Description: The purpose of this science fair project is about bacteria that breaks down organic waste to produce electrons. It enables the formation of a microbial fuel cell to gather the electrons produced by the anaerobic bacteria. In basic terms, you reuse the mud–an unusual material—in a practical way.
https://www.sciencebuddies.org/science-fair-projects/project-ideas/Energy_p026/energy-power/use-a-microbial-fuel-cell-to-create-electricity-from-waste

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Title: A Revolutionary Rover (THIRD CHOICE)

Heading: Build a Remotely Operated Vehicle (ROV) for Underwater Exploration

Description: The purpose of this science fair project is to create a remote controlled robot vehicle that allows for taking pictures, videos, and provides scientific samples of underwater life and habitats. This experiment enables us to design and build our own miniature ROV that can be tested in a bathtub, pool, or in a nearby lake.

Later on, we were not satisfied with our topics, as we believed we could do a project on something that has more potential. Therefore, we deleted all of our obesity diagrams and continued with research on other topics:

Title: A Cure to a Marine Epidemic (NEW TOPIC)
Heading: Can Oil Eating Microbes be the Revolutionary Solution to Immense Oil spills/Greenhouse Gases?

December 29, 2024 (3:30 PM - 7:48 PM)

- Did further research on the first topic and finalized all 3 topics
- Added more to the descriptions

- Figured out all experimental processes and their pros and cons + materials
- Looked at articles and saved them for evidence

Topic	***Description***
FIRST CHOICE: ***EXPERIMENTAL*** **Effects of Digital Multitasking on Attention Span** – Assess how constant notifications impact concentration and task performance.	This project investigates how constant digital notifications influence attention span and task performance. The experiment involves participants performing tasks under two conditions: one with regular digital interruptions (such as notifications) and one without. The goal is to assess how multitasking affects focus, efficiency, and the ability to complete tasks effectively. The experiment asks participants to complete a series of cognitive tasks, such as problem-solving or reading comprehension. During one session, they receive regular digital notifications (e.g., text messages and social media alerts), while in another session, notifications are disabled. Their performance is measured in terms of task completion time, accuracy, and self-reported focus, allowing researchers to assess how digital multitasking impacts attention and task efficiency. **— GREAT EXPERIMENTAL PROCESS**
SECOND CHOICE: ***EXPERIMENTAL*** ***Mud 2 Motion!*** Use a Microbial Fuel Cell to Create Electricity from Waste	This science fair project aims to create a new and sustainable method of producing electricity using day-to-day waste. This allows for a better and greener future, reducing the impact of climate change (CO2 transmission). This bacteria breaks down organic waste to produce electrons. It enables the formation of a microbial fuel cell to gather the electrons produced by the anaerobic bacteria. In basic terms, you reuse the mud—an unusual material—in a practical way. **— NOT SO ADVANCED EXPERIMENT**
THIRD CHOICE: ***EXPERIMENTAL*** ***A Revolutionary Rover:*** Build a Remotely Operated Vehicle (ROV) for Underwater Exploration	This science fair project aims to create a remote-controlled robot vehicle that allows the taking of pictures and videos and provides scientific samples of underwater life and habitats. This revolutionary method allows mankind to understand marine compounds, discover new species, find surfaces in water covered in pollution, and solve major marine problems. This experiment enables us to design and build our own small ROV that can be tested in a bathtub, pool, or in a nearby lake. **— VERY BRIEF MODEL**

Reference Links

- https://www.sciencebuddies.org/science-fair-projects/project-ideas/Energy_p026/energy-power/use-a-microbial-fuel-cell-to-create-electricity-from-waste
- Build a Remotely Operated Vehicle (ROV) for Underwater Exploration
- https://www.amazon.com/Oil-Eating-Microbes-lb-Shaker/dp/B00AU7OJZK/ref=sr_1_1?crid=21CWI8IT4PPLX&keywords=oil%2Beating%2Bmicrobes&qid=1703731379&sprefix=Oil%2Beating%2Bmic%2Caps%2C123&sr=8-1&th=1

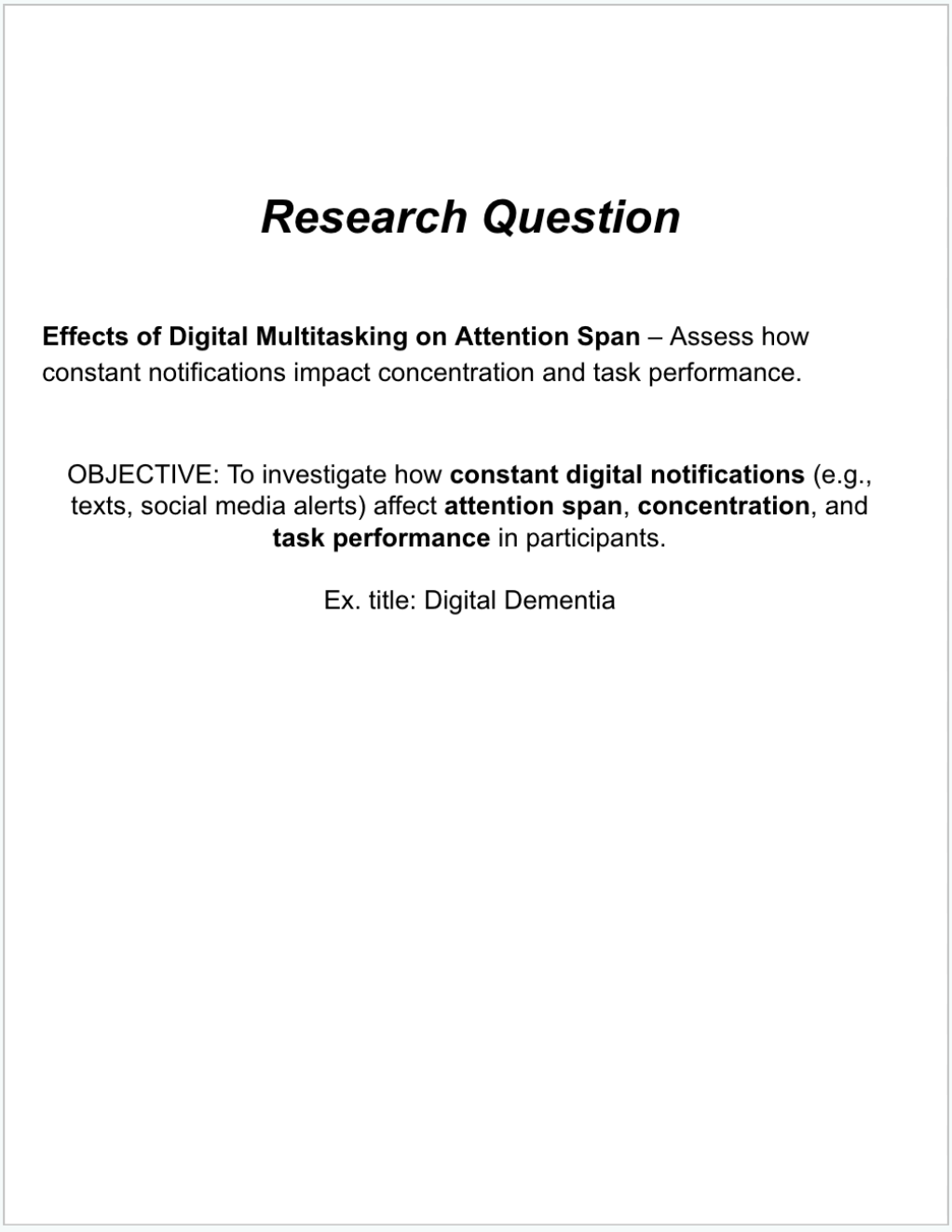
December 30, 2024 (3:23 PM)

- Got the first topic approved: **Effects of Digital Multitasking on Attention Span** – Assess how constant notifications impact concentration and task performance.

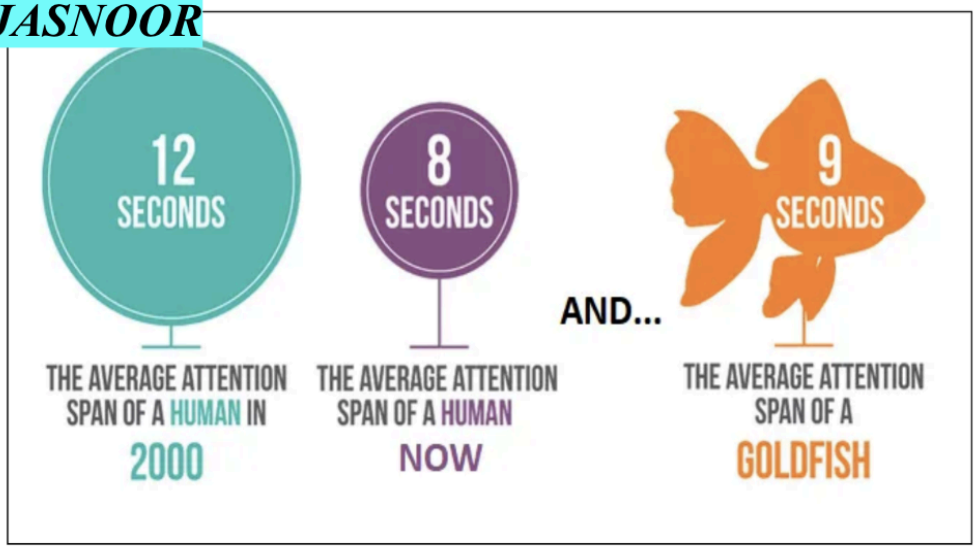
- We watched the recommended documentary to gain more background knowledge regarding the project.
- https://www.youtube.com/watch?v=4pwCFH1LkCw

January 2, 2025 (4:18 PM- 12:43 PM)

- Created the science fair template on Google Slides
- Created a list of background research questions
- Divided the work between both group members
- Finished 8 and a half slides of questions



JASNOOR



EVIDENCE: A study by Microsoft found that attention spans have decreased from 12 seconds in the 2000s' to less than 8 seconds in 2013, which is shorter than the attention span of a goldfish. This decrease has been attributed to the constant use of digital devices and the constant bombardment of information.

Effects of Digital Multitasking on Attention Span – Assess how constant notifications impact concentration and task performance.

OBJECTIVE: To investigate how **constant digital notifications** (e.g., texts, social media alerts) affect **attention span**, **concentration**, and **task performance** in participants.

Abstract: JASNOOR

Can our brains truly handle the relentless flood of notifications, or are we sacrificing focus for the illusion of productivity? In an era dominated by digital connectivity, constant notifications and multitasking have become the norm. This study examines the effects of digital multitasking on attention span, focusing on how frequent interruptions like notifications impact concentration and task performance, as well as how it causes neurological consequences in the brain. Through a review of cognitive psychology and neuroscience research, as well as experimental findings, our project highlights the cognitive costs of divided attention, including reduced information retention, slower task completion, and increased mental fatigue. This project explores how digital distractions reshape brain function, impair task performance, and contribute to mental fatigue. Finally, it examines strategies to counteract these effects — practices like mindfulness and structured work environments, to mitigate these effects. Understanding the implications of digital multitasking is crucial for optimizing productivity and well-being in an increasingly connected world.

Hypothesis: SARGUN

- **H1:** Participants exposed to constant digital notifications (High frequency notifications - Group 1) will show **decreased attention span** and **impaired task performance**.
- **H2:** The more frequent and diverse the notifications, the **greater the impact** on concentration. In fact, the more dopamine-inducing ("feel good chemical") notifications, the greater increase in task-switching costs and time.
- **H3:** Participants exposed to irrelevant notifications (Group 3) will perform better on tasks than group 1 - high frequency notifications, however, will not be considered rank 1 in performance.
- **H4:** Participants in the no-notification (control group) condition will **perform better** on tasks that require sustained attention.

What is attention span, and how is it measured in cognitive psychology? - JASNOOR

Attention span: Refers to the amount of time a person can remain focused on a particular task or stimulus without being distracted. Attention span varies depending aspects of one's' age, interest level, cognitive ability, and external distractions.

Attention span can be measured using various methodologies, including:

1. **Simple behavioural observations:** watching how long an individual can focus on a task before looking away or getting distracted by their surroundings.
2. **Psychological tests (standardized tests):**
   - CPT Test (Continuous Performance Test) - Measures sustained attention and response.
   - TMT Test (Trail Making Test) - Assesses attention, speed processing, and cognitive flexibility.
   - Stroop Test - Assesses attention control by measuring reaction times to stimuli.
3. **Neuro Physical assessments:**
   - Eye-tracking Technology - Measures how long an individual can maintain visual focus on a screen display or object.
   - Self-Reports and surveys - Individuals asses themselves by rating their own ability to focus (ex. The Adult ADHD Self- Report Scale)
   - EEG (Electroencephalography) and Neuroimaging: Monitoring Brain activity to study attention-related neural activity.

EVIDENCE: The rapid advancement of technology has had a profound impact on attention spans and mental activity. A study by Microsoft found that attention spans have decreased from 12 seconds in the 2000s' to less than 8 seconds in 2013, which is shorter than the attention span of a goldfish. This decrease has been attributed to the constant use of digital devices and the constant bombardment of information.

DIAGRAM ON NEXT PAGE

Top 10 Average Human Attention Span Statistics and Facts

Here are the top 10 statistics about human attention span:

- The average human attention span is **only 8.25 seconds**, which is less than the goldfish's 9-second attention span.
- The average adult internet user's attention span is 8.25 seconds, **influenced by the increasing distractions on the internet**, social media, and the environment.
- The average attention span of a human has decreased significantly over the years, **from 12 seconds in 2000 to 8 seconds in 2013**.
- Childhood development experts suggest that a child's attention span is **approximately two to three minutes per year** of their age.
- A study involving 262 individuals aged 7-85 found that **attention span was longer in young adults than in children** and older adults.
- Children had an **average attention span of 29.61 seconds**, experiencing an attention span decline of -27.41% over the course of the Continuous Performance Test.
- The attention span of teenagers increases with age. The average **14-year-old teenager has a 28 to 42 minute attention span**, and the average 16-year-old teenager has a 32 to 48 minute attention span.
- Gender appears to influence attention span as well. **Girls performed better in distractibility** and impulsive reaction tendencies.
- Multitasking often **leads to increased stress**, fatigue, and reduced productivity.
- Prolonged screen time can have adverse effects on mental health, with 42% of individuals using electronic devices reporting **experiencing adverse effects**.

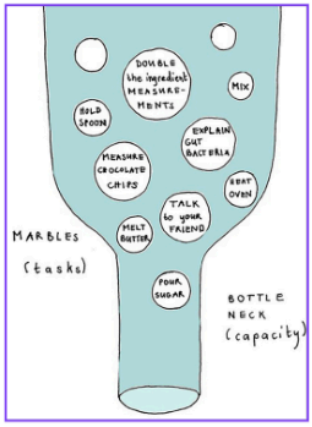
Year	Average Attention Span (Seconds)
2000	12
2013	8
2015	8.25

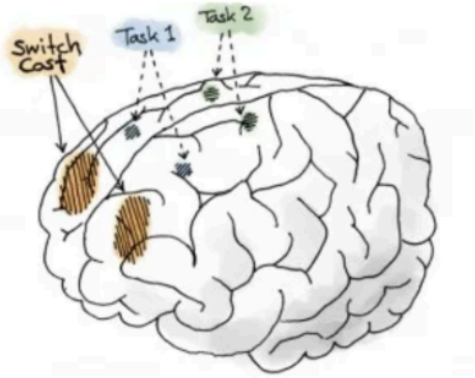
Age Group	Average Attention Span
Children	29.61 seconds
Teenagers (14 years old)	28 - 42 minutes
Teenagers (16 years old)	32 - 48 minutes
Adults	8.25 seconds

How does the human brain process multitasking, and what are its cognitive limits?SARGUN

- The human brain handles multitasking by quickly switching from one task to another instead of doing multiple tasks simultaneously. This is called "task switching."
- Trying to do several things at once increases the mental effort needed, making it harder for the brain to process information efficiently, especially if the tasks use similar thinking skills. This creates a "switch cost," where the time and energy needed to refocus reduce productivity.
- Since our attention is limited, the brain focuses on specific tasks, which can lead to poorer performance, more mistakes, and longer time to finish tasks. Working memory plays a significant role in this process; balancing information from different tasks can overload the brain, causing errors or forgotten details.
- Experienced individuals can multitask better because they have practiced specific skills, but they, too, hit limits when switching between tasks that need deep focus. While the brain can take in many inputs, it works best when concentrating on one task at a time or switching between them strategically.

How does the human brain process multitasking, and what are its cognitive limits?





January 2, 2025 (1:36 PM- 11:54 PM)

- Completed more background research questions
- Modified and added more necessary questions
- Added tables to present the information in a well-suited manner

SARGUN

What are the different types of attention and how does digital multitasking affect each?

Attention is the cognitive process that enables us to focus on specific information or tasks while ignoring distractions. There are various types of attention, each related to how we manage and direct our focus. Below are the m Draw types of attention and how digital multitasking impacts each one.

Sustained Attention

The ability to focus on a single task for an extended period of time.

Maintaining focus during lectures or reading assignments.

Following through on instructions or completing multi-step tasks.

Staying engaged in conversations without interrupting.

Completing routine tasks, organizing their belongings or keeping track of deadlines.

Selective Attention

The ability to maintain attention on one specific task while ignoring irrelevant or distracting stimuli.

Focusing on relevant information in the classroom.

Following along with the lesson or the teacher's instructions.

Taking practical notes and participating in class discussions.

Filtering sensory input, filtering out irrelevant information.

Divided Attention

The ability to split focus and perform two or more tasks simultaneously.

Remembering all the steps required to complete an assignment while paying attention to other classroom activities.

Listening to and processing other students' ideas while also expressing their own thoughts and opinions in group discussions.

Driving and listening to the radio.

Alternating Attention

The ability to shift focus between two or more tasks, adjusting to different demands as needed.

Remembering what they were doing before they switched tasks.

Finding evidence from within a text.

Correcting errors or proofreading work as they work.

Organizing their time and prioritizing tasks.

What is Dopamine? - JASNOOR

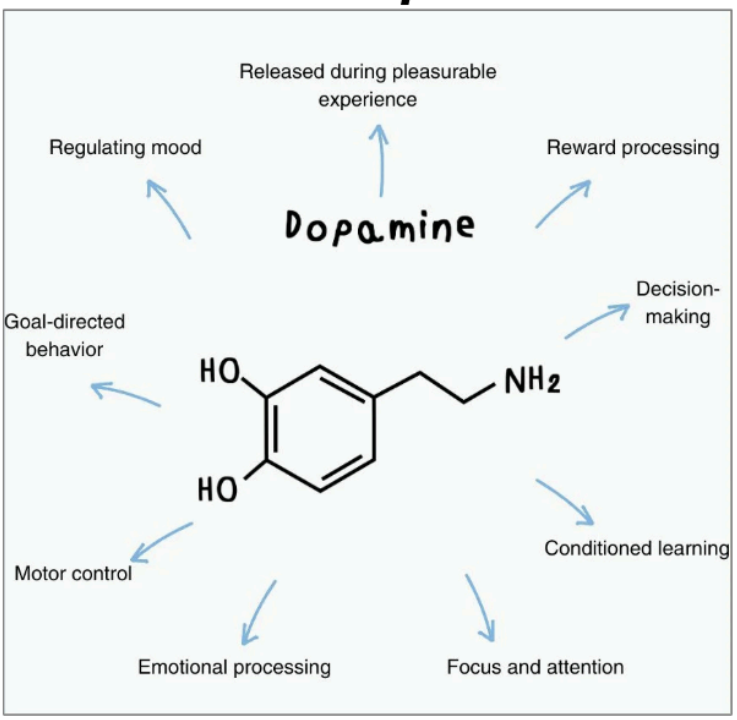
Dopamine is a neurotransmitter, a chemical messenger present in the brain that plays an important role in movement, reward, motivation, and pleasure. Dopamine is created in the brain and communicates messages between nerve cells in the brain and the rest of the body. It is involved in regulating mood, attention, learning, and motor control. Dopamine is also called a "feel-good" chemical, which is released in response to pleasurable activities like eating, exercising, achieving goals, and behaviours that promote well-being. Dopamine is released when one experiences pleasure, which can make one want to repeat that behaviour. Dopamine levels are carefully regulated and balanced in the brain, and imbalances can result in neurological and psychological conditions. Dopamine also acts as a hormone—made by an adrenal gland, a small hat shaped gland present on the top of each kidney. Dopamine is also a neurohormone released by the hypothalamus located in the brain.

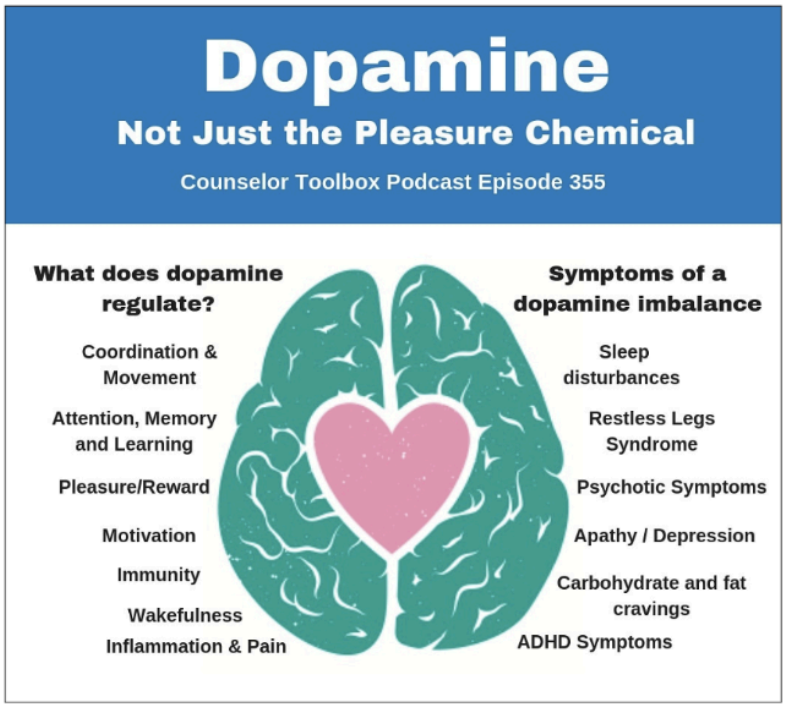
**hormone: chemical messengers produced by glands in the body that help with growth and development, metabolism, mood, and reproduction by travelling through the bloodstream.

Roles of Dopamine:

1. **Reward System:** Dopamine is part of the brain's reward system–motivating people to repeat certain behaviours to seek pleasure.
2. **Movement:** Dopamine aids to control physical movement.
3. **Memory:** Dopamine plays a key role in memory and learning.
4. **Mood:** Dopamine tends to affect mood and emotions.
5. **Focus:** Dopamine allows one to focus and work towards achieving goals.
6. Causes blood vessels to relax
7. Increases sodium (salt) and urine removal from the body
8. Reduces insulin production in the pancreases
9. Slow gastrointestinal (gut) content movements– protects GI lining
10. Reduces lymphocyte activity in the immune system

Roles of Dopamine



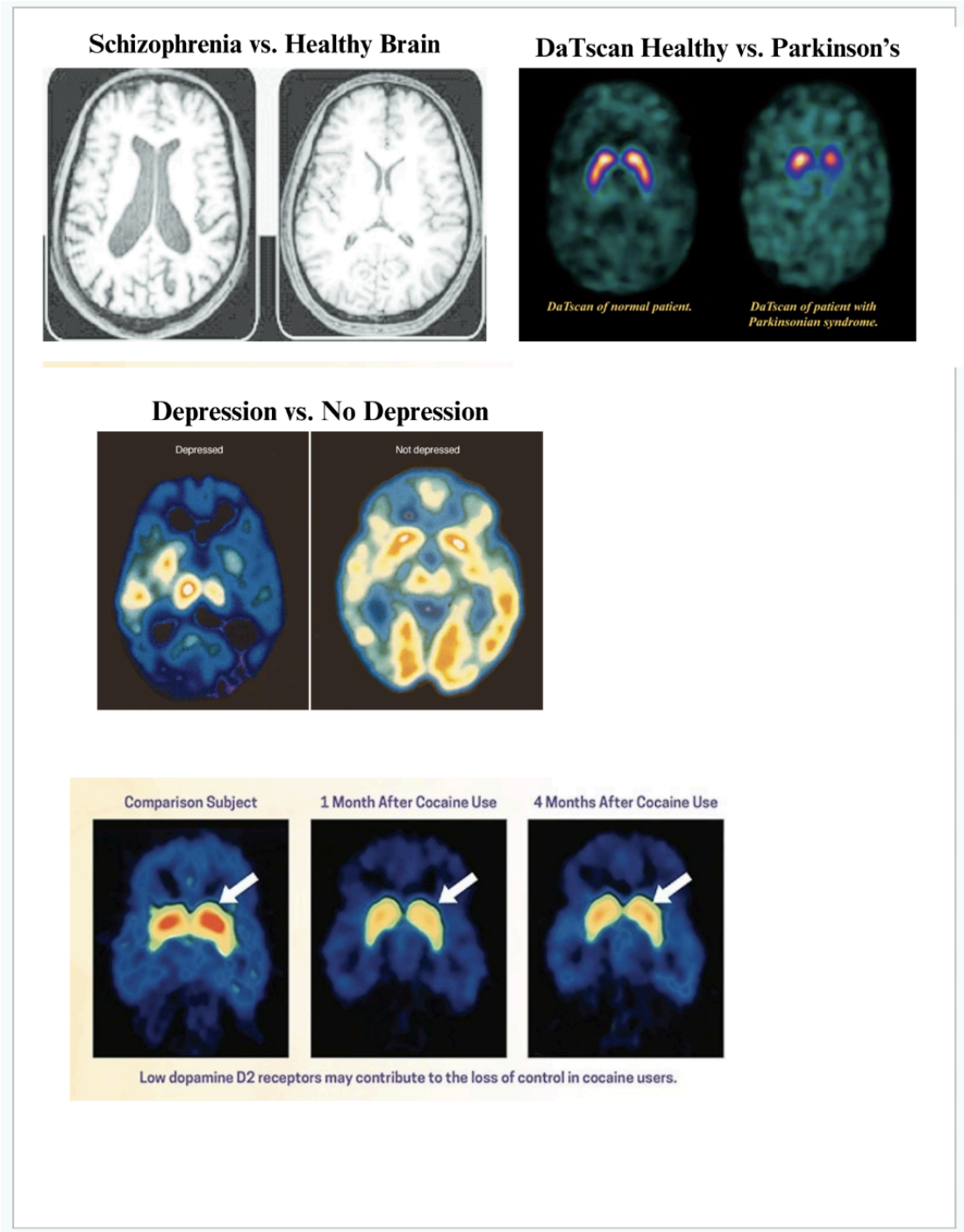


Diseases Associated With Dopamine Levels - JASNOOR

Low Dopamine Levels:	*High Dopamine Levels:*
Parkinson's disease: Parkinson's disease is a brain disorder that causes shaking (tremors), slow movement, stiffness, and balance problems. Dopamine helps control movement. In Parkinson's, dopamine-producing brain cells die, leading to low dopamine levels. Without enough dopamine, the brain struggles to send proper movement signals, causing the symptoms of the disease. **Depression:** Some forms of depression, particularly anhedonic depression (inability to feel pleasure), are associated with low dopamine levels. **ADHD (Attention deficit hyperactivity disorder):** In ADHD, low dopamine levels in the brain's prefrontal cortex make it harder to focus, control impulses, and stay motivated. Dopamine helps with attention and reward processing, so when there's not enough, the brain struggles to stay engaged, filter distractions, and regulate behavior, leading to ADHD symptoms like inattention, impulsivity, and hyperactivity. **Schizophrenia:** In some cases of schizophrenia, low dopamine in the prefrontal cortex (the area controlling thinking and motivation) causes negative symptoms like lack of motivation, social withdrawal, and trouble thinking clearly. While high dopamine in other brain areas causes hallucinations and delusions, low dopamine in the prefrontal cortex leads to cognitive and emotional difficulties.	**Schizophrenia:** High dopamine levels, especially in the mesolimbic pathway of the brain, can overstimulate neurons, leading to hallucinations, delusions, and disorganized thinking—the key symptoms of schizophrenia. This excess dopamine causes the brain to misinterpret sensory information and reality, making a person see or believe things that aren't real. **Bipolar Disorder (Manic Episodes):** In bipolar disorder, high dopamine levels during manic episodes overstimulate the brain, leading to excess energy, racing thoughts, impulsive behavior, and euphoria. This dopamine surge makes the person feel overly excited and act recklessly. When dopamine levels drop, it can lead to depressive episodes. **Tourette Syndrome & Tics:** In Tourette syndrome and tics, high dopamine levels cause overactive brain signals, leading to uncontrollable movements and sounds (tics). The excess dopamine makes it harder for the brain to filter and control these impulses, causing sudden, repetitive actions or vocalizations. **Addiction:** High dopamine levels reinforce addiction by overstimulating the brain's reward system. When a person uses addictive substances (like drugs or alcohol) or engages in addictive behaviors (like gambling), dopamine surges, creating intense pleasure and reinforcing the habit. Over time, the brain adapts by reducing natural dopamine production, making the person crave more of the substance or behavior to feel normal, leading to dependence and addiction.

January 3, 2024 (3:22 PM- 11:54 PM)

- Completed more background research questions
- Added more necessary research questions
- Made sure to include well-detailed diagrams showcasing the anatomy of the brain:



4. What is the Brain's Reward System— the mesolimbic system? - **JASNOOR**

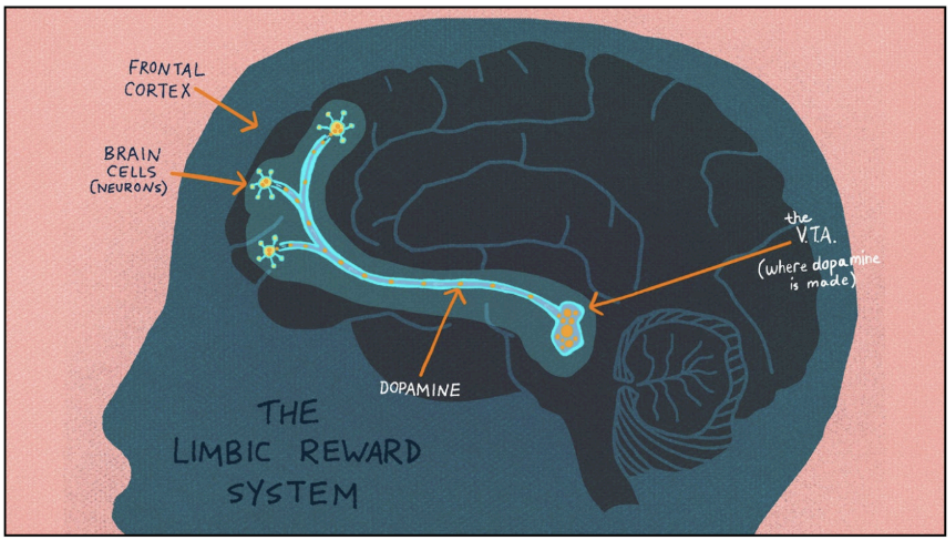
The brain's reward system, also known as the mesolimbic system, is interconnected networks of brain cells that regulate, control, and balance pleasure, motivation, and behaviours. It makes activities like eating, socializing, and achieving goals feel rewarding, encouraging the repetition of these behaviours. The key part of this system is known as the mesolimbic dopamine pathway, which includes the ventral tegmental area (VTA), where dopamine is produced, and the nucleus accumbens (NAc), which processes rewards and pleasure. When anything pleasurable is experienced, dopamine is released, which reinforces this behaviour. This system is crucial for survival, as it motivates essential behaviours like eating and drinking, but can also contribute to addiction when it is overstimulated by substances like drugs or highly rewarding activities such as gambling or social media use.

Function: This system associates positive experiences with certain stimuli, encouraging one to seek them out and repeat these behaviours that lead to rewards.

The Mesolimbic Dopamine Pathway:

1. **Trigger:** You experience something enjoyable, like listening to music, achieving a goal, or eating delicious food.
2. **Dopamine Release:** The ventral tegmental area (VTA) in the brainstem produces and releases dopamine. The VTA produces dopamine using special brain cells called dopaminergic neurons– when you experience something rewarding, these neurons become active and release dopamine.
3. **Pleasure Signal:** Dopamine travels to the nucleus accumbens (NAc), which creates feelings of pleasure and motivation. When dopamine is released, the NAc activates brain circuits that make you "feel good" and encourage the repetition of the reward.
4. **Emotional Connection:** The amygdala processes emotions linked to the experience, making it feel even more rewarding.
5. **Decision Making:** The prefrontal cortex evaluates the experience and helps you decide whether to repeat the behaviour.
6. **Reinforcement:** If the experience is enjoyable, you brain remembers it and encourages you to seek it again.

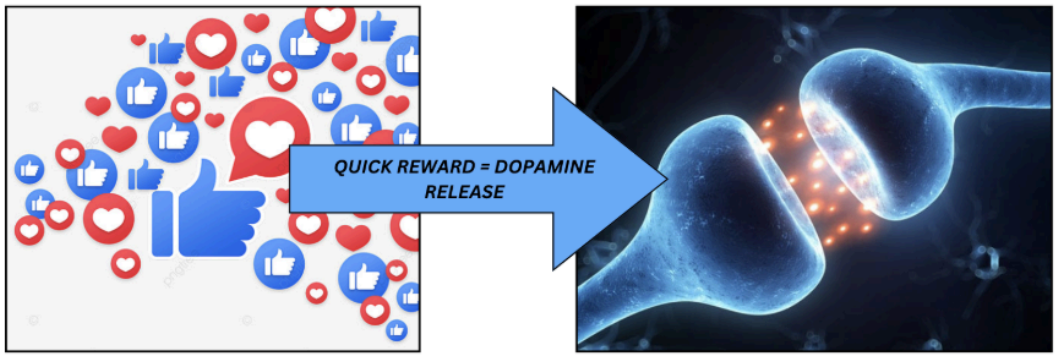
The Limbic Dopamine Pathway



How do social media and app notifications trigger dopamine release in the brain? (COMBINE w 7) - SARGUN

Social media and app notifications trigger dopamine release in the brain by providing “quick rewards” like comments, likes, or new updates– also known as the brain’s reward system. When one receives a notification, the brain sees it as a potential source of pleasure or social validation, this then incentives one to keep checking for more notifications and engagement, creating a cycle of seeking that rewards. Even the expectation of a notification releases more of that “feel good dopamine” chemical that causes one to continuously come back to social media during times of stress and anxiety. This anticipation causes the ventral tegmental area (VTA) to release dopamine, which travels to the nucleus accumbens, making one feel good and motivated to check the phone again— to repeatedly reinforce that rewarding behaviour.

How do social media and app notifications trigger dopamine release in the brain?



January 4, 2024 (3:30 PM- 9:44 PM)

- Completed more background research questions
- Found more useful links, containing useful information
- Added tables to organize information in a well- formatted manner

4. How does the frequency of interruptions affect the ability to return to a primary task (task-switching costs)? - SARGUN

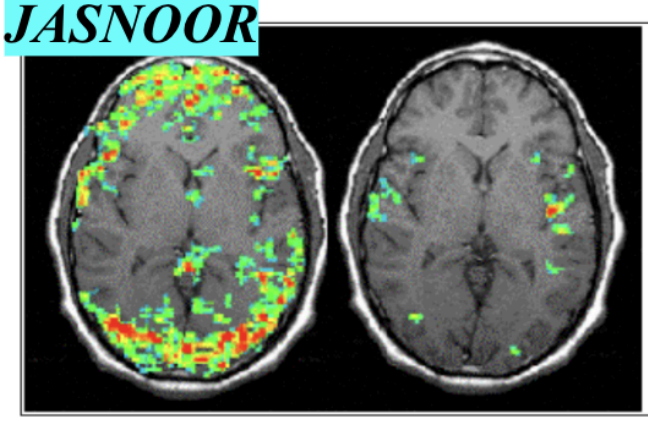
The frequency of interruptions increases task-switching costs, both cognitive and time-related penalties associated with multitasking. Each time an individual is interrupted, the brain needs to disengage from the current activity, process the interruption, and then re-engage with the primary task. This process of switching creates a cognitive load, where the brain must activate the specific set of rules, goals, and processes associated with the primary task while inhibiting the irrelevant task information stimulus.

Studies have proven, that task-switching costs can result in significant delays in performance, with the time required to reorient to the primary task, as the brain's working memory becomes overloaded, making it more difficult to retain task-relevant information. In fact, the shift from one task to another requires the brains' "recovery period" to restore focus on the initial task. Overtime, this reduces efficiency, performance, and quality.

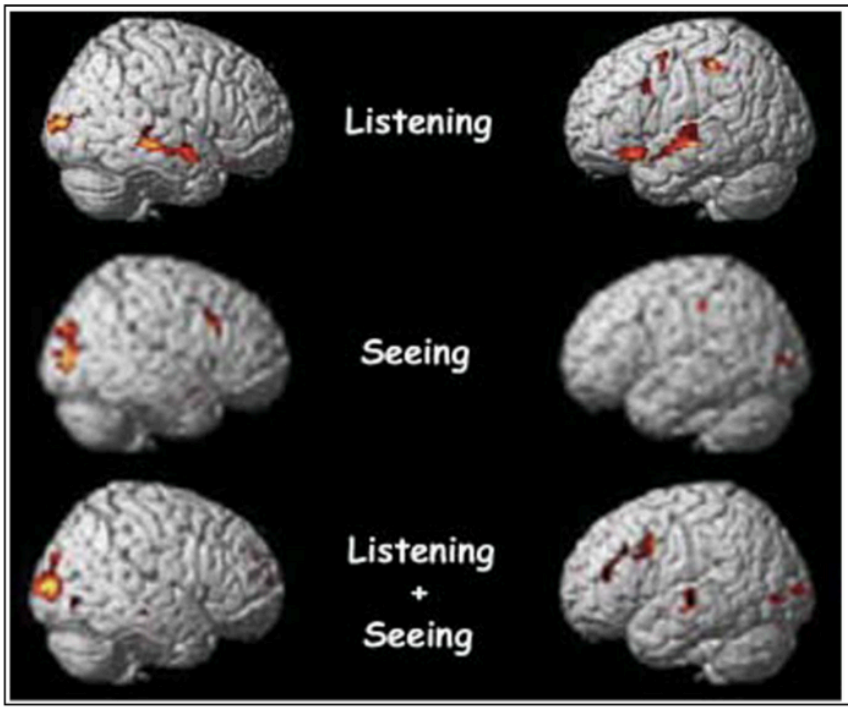
Pros & Cons of Task-Switching Based on Real-life studies: JASNOOR

Cons of Task Switching based on studies: (2007: Iqbal and Horvitz; 2001: Jackson)	**Pros of Task Switching based on studies: (Speier & Zijlstra 1999, Mark 2008)**
Procrastination: In 2007, two researchers (Iqbal and Horvitz) noticed people spent **10 minutes** on task-switches caused by alerts, such as email notifications, and **another 10 to 15 minutes** doing other stuff before they got back to the original task. 27% of all task-switching ended up in **more than 2 hours** of time doing something else before people got back to their original jobs! ***Short Interruptions add up:*** Office workers reacted to the majority of their incoming emails within **6 seconds** of it arriving (Jackson 2001). Then it took them on average **64 seconds** to resume work. Checking email was estimated to cause **96 interruptions** in a typical 8-hour work day, which adds up to **1.5 hours per day** reorienting.	***Time-loss motivation:*** A few studies prove that interruptions don't actually make us complete tasks any slower (Speier 1999, Zijlstra 1999, Mark 2008). It seems to be the case that a few interruptions actually make people work faster, as they compensate for the lost time they know they are experiencing. It may also explain why many people work best on deadlines. There's a little bit of pressure to get the work finished. ***Drawback:*** Gloria Mark has proposed that although the occasional interruption might give us a bit of a time crunch and light a fire under us to hustle, there is added stress and frustration, and that the work requires additional effort. In other words, it's less efficient and might then require more time to recover from the work.

JASNOOR



When we first start multitasking, the brain is more engaged, but as we get used to the tasks and they become more familiar, less brain attention is required to perform them. The fMRI on the left shows intense brain activity in someone trying to walk and chew gum for the first time. The scan on the right shows that same person after walking and chewing gum for an hour (experimenters controlled for the gum losing flavor during that time).



An fMRI showing that multitasking -- in this case, listening and seeing -- actually reduces brain activity

8. How does digital multitasking affect **workplace productivity and academic performance**? — Impact on memory, problem-solving, and comprehension—SARGUN

Digital multitasking has become a common behavior in both workplace and academic settings, especially with the rise of smartphones, instant messaging, and constant notifications. Although multitasking may seem beneficial for productivity, research consistently shows that it can harm cognitive performance, especially when frequently switching between tasks that require active thinking.

1. ***Impact on Memory:***

- ***Working Memory:*** Multitasking, especially when tasks are cognitively demanding, can overload working memory. Research shows that shifting between tasks reduces the amount of cognitive resources available for each individual task. When multitasking, people tend to have difficulty holding onto information and recalling it later. Therefore, a study conducted in 2019 by Arnsten et al. found that multitasking negatively affects the prefrontal cortex, which is responsible for working memory and executive functions like decision-making. It leads to more errors and reduced retention of information.
- ***Long-term Memory****:* Some studies also suggest that multitasking can make it harder to consolidate information into long-term memory. When you're not giving your full attention to a task, it's harder to encode and store new knowledge. In fact, a 2020 meta-analysis by Snyder and colleagues found that multitasking negatively affects long-term memory retention, especially in attention-demanding situations like studying or critical thinking tasks.

2. Impact on Problem-Solving:

- ***Task switching:*** Multitasking involves constant "task switching," which takes more cognitive effort than focusing on one task. This switching can hinder problem-solving skills because switching back and forth depletes cognitive resources and increases cognitive load, leading to slower and less accurate problem-solving. In addition, a study conducted by Ophir, Nass, and Wagner in 2009 found that high-frequency multitaskers performed worse on tasks that demanded cognitive control and problem-solving abilities. The results indicated that individuals who engage in frequent multitasking struggle to filter out irrelevant information and maintain focus on the task at hand.
- ***Cognitive Flexibility****:* Multitasking reduces cognitive flexibility, which is the ability to adapt one's thinking to new, unexpected situations. Constantly splitting attention makes the brain less capable of quickly adapting to new information or changing goals.

3. Impact on Comprehension:

- ***Reading and Writing:*** Multitasking can also negatively affect reading comprehension and overall understanding of material. When people attempt to read or study while responding to messages or browsing the internet, they tend to process less information and often have a diminished grasp of the subject matter. In fact, a study conducted by Junco and Cotten in 2016 found that students who frequently multitasked while studying exhibited lower academic performance, which included lower test scores and a poorer understanding of complex concepts.
- ***Depth of Understanding****:* Multitaskers tend to skim through information, which affects their ability to understand it deeply. This shallow processing prevents the kind of deep engagement required for learning new concepts or solving problems creatively.

General Productivity Impact of Multitasking:

- ***Slower work pace****:* Digital multitasking can make workers slower and less efficient. Studies suggest that the time taken to reorient after switching tasks means that total productivity tends to drop rather than increase. Constant interruptions from emails or messages lead to longer overall time spent completing tasks. Therefore, many studies have found that digital notifications can disrupt workflow, leading to longer completion times and increased errors.

January 6, 2025 (4:20 PM - 8:46 PM)

- Found various links to access the online tests: STROOP TEST, N-BACK TEST, TASK-SWITCHING TEST, SELF REPORT
- Did more research through other websites

*https://www.absorbentsonline.com/cgi-absorbentsonline/sb/billing.cgi?storeid=*246986afb4c3b0ca741bb651f6a2790a11436384&fromid=order.cgi&redirect=yes&shopinfo=SSMSB120562534911342556 39.21669*

Does chronic digital multitasking lead to long-term attention deficits? - JASNOOR

Chronic digital multitasking can contribute to long-term attention deficits. In a modern, fast-paced digital environment, multitasking has become an everyday occurrence. We frequently find ourselves hopping between multiple tasks like responding to emails and pursuing social media within the same time period. Digital multitasking can cause long-term effects on brain hyperactivity and cognitive health. According to an APA survey (American Psychological Association, roughly 40% of adults routinely multitask with digital devices– contributing to stress and low productivity. Wilmer et al. discovered that frequent digital multitasking is associated with decreased cognitive control and higher distractibility. It's found that chronic multitaskers' perform poorly on task-switching tests. In fact, they tend to have a low working memory capacity, increased mental fatigue and stress, and difficulty filtering out irrelevant information. Human brains are not designed to handle multiple things at once. Multitasking divides tasks– leading to higher cognitive load and hyperactivity. Cognitive load refers to the amount of mental effort needed in a working memory. When one multitasks, the cognitive load increases because the brain has to move attention between tasks, overloading the memory and reducing the brain's' efficiency. Increased cognitive load can cause mental tiredness, decreased concentration, and poor decision making. It overloads the brain's ability to transition between activities quickly, hindering planning, problem-solving, and sustained attention. Multitasking can impair cognitive abilities such as memory, focus, and decision-making. Rubinstein, Meyer, and Evans discovered that task-switching might cost upto 40% of a person's productive time due to the load of moving back and forth between tasks. Thus, multitasking might result in significant time loss and lower task performance. Switching between tasks causes the brain to reposition itself, consuming more cognitive resources and causing mental tiredness.

Prolonged multitasking can result in brain hyperactivity, characterized by neuronal activity. Becker, Alzahabi and Hopwood found that people who often multitask are more likely to experience symptoms of depression and anxiety. Heavy multitaskers had considerably greater levels of anxiety and depression that those who multitask less frequently. This indicates that prolonged multitasking is associated with substantial consequences for mental health and strain. This type of hyperactivity can inhibit the brain's' ability to absorb information efficiently, adding to feelings of tension and anxiety. Some research suggests that multitaskers are more distractible, and they may have trouble focusing their attention even when they're not working on multiple tasks at once.Recent neuroimaging research has revealed important insights into the effect of digital multitasking on brain function. For example, fMRI (functional magnetic resonance imaging) studies have shown that multitasking reduces activation in brain regions involved with cognitive control, while increasing activation in areas associated with stress and arousal.

Does chronic digital multitasking lead to long-term attention deficits? - JASNOOR

Furthermore, electrophysiological investigations using EEG (electroencephalography) have revealed that multitasking is associated with alterations in brain wave patterns, indicating increased cognitive load and decreased task performance efficiency.Understanding these neural pathways is critical to determining the long-term effects of chronic multitasking on the health of the brain.

Digital multitasking can have harmful long-term effects on cognitive health. Prolonged multitasking has been linked to decreased working memory capacity and poor executive function, which is essential for tasks that require planning, problem solving, and sustained focus– basically, our every-day, time-to-time tasks. Cognitive impairments can have an impact on both academic and professional performance, as well as the overall quality of life.

Benefits of multitasking: While digital multitasking might have a negative impact on cognitive health, it also has several benefits. Multitasking can promote digital knowledge, task switching efficiency and flexibility in some professional settings. Some research indicates that “managed multitaskers”, (not heavy ones) might boost creativity and problem-solving abilities by fostering flexible thinking.

Why This Happens;

- Weakened focus
- Impaired working memory
- Lower cognitive control
- Increased Stress and Fatigue

Long-Term Effects:

- Reduced deep work capability (difficulty concentrating on complex tasks)
- Increased impulsivity
- Shorter Attention Span
- High risk of cognitive overload

*Are certain age groups (e.g., adolescents vs. adults) more susceptible to the negative effects of digital multitasking?*SARGUN

Research indicates that **adolescents** are more susceptible to the negative cognitive effects of digital multitasking because of ongoing brain development, especially in areas like attention control and working memory. They often find it challenging to concentrate and manage multiple tasks at once. While **adults** may have more experience with multitasking, they can still face difficulties with memory, problem-solving, and decision-making, especially when tasks are complicated or when there are many distractions.

1. Adolescents and Digital Multitasking —

Adolescents (ages 12-18) are particularly vulnerable to the negative effects of digital multitasking due to ongoing brain development, especially in areas related to attention control, executive functions, and working memory.

- **Cognitive Development:** Adolescence is a key time for brain development. The prefrontal cortex, which helps with attention, decision-making, and self-control, is still growing. Because of this, teenagers often find it harder to manage several tasks at the same time. A study by ***Loh, K.K., and Kanai, R. (2016),*** titled ***"How Does Multitasking Affect Cognitive Performance?"***, investigated how using digital devices like smartphones affects performance. It highlighted that adolescents may have more difficulties with multitasking due to their still-developing prefrontal cortex compared to adults. This part of the brain is important for skills like cognitive flexibility and working memory. Since the prefrontal cortex matures later in adolescence, teens' ability to control their thinking is more easily disrupted when multitasking.
- **Attention Control:** Research indicates that adolescents often struggle to concentrate on a single task due to the prevalence of digital distractions. Their brains are particularly wired to seek immediate rewards, such as notifications or updates from social media. This tendency makes it challenging for them to ignore these distractions and maintain their focus on important tasks. In fact, a study by ***Ophir, Nass, and Wagner (2009)***, titled ***"Media Multitasking and Cognitive Control in Adolescents and Young Adults,"*** found that adolescents were likelier to multitask with digital devices while studying or completing tasks, leading to poorer academic outcomes. It showed how adolescents were less able to filter distractions and experienced more significant adverse effects on their learning and memory than adults.
- **Emotional and Social Influences:** Adolescents are particularly sensitive to peer influence and social feedback, which often leads them to check social media and messages frequently. This behavior disrupts their focus and decreases their cognitive capacity for learning. Additionally, it can negatively impact their emotional regulation and stress levels. A study by ***Rosen, Lim, Carrier, and Cheever (2011)***, titled ***"Multitasking and Emotional Well-being in Adolescents: The Impact of Digital Media,"*** uncovered that adolescents who engage in frequent digital multitasking reported higher levels of stress and lower emotional well'being, further impairing their cognitive performance.

2. Adults and Digital Multitasking —

Adults are also affected by digital multitasking but tend to have better cognitive control, attention regulation, and emotional maturity than adolescents. However, even adults experience productivity losses, memory impairments, and reduced problem-solving efficiency when multitasking.

- **Cognitive Flexibility:** Adults typically have better-developed cognitive flexibility, which helps them switch between tasks more efficiently than adolescents. However, multitasking still affects their cognitive resources, especially when complex tasks require deep thinking. A study by ***Ophir, Nass, and Wagner (2009)***, titled ***"Cognitive control in media multitaskers,"*** found that high-frequency multitaskers (adults in this study) struggled with tasks requiring cognitive control and selective attention, demonstrating that frequent multitaskers were less able to focus and filter irrelevant information, leading to slower processing speeds and errors.
- **Workplace Productivity:** In professional environments, adults often engage in multitasking, attempting to manage multiple tasks simultaneously. While this strategy may initially seem to boost productivity, it can frequently result in decreased efficiency. Research on multitasking often shows that while adults may experience a decline in performance when multitasking, the effects are typically less severe than those seen in adolescents. A more recent study in ***Psychology of Aesthetics, Creativity, and the Arts (2024)*** showed that adults, while better at handling multitasking, still suffer from slower task-switching times and decreased cognitive efficiency, especially in environments with high levels of digital interruptions (e.g., frequent notifications).
- **Memory and Decision-making:** Adults can handle more complex multitasking than adolescents, but they still experience declines in memory retention and decision-making accuracy when switching between tasks, especially when exposed to digital distractions like emails or social media. Recent studies suggests that adults who frequently engage in multitasking while working experience cognitive overload, which impairs memory retention and affects decision-making processes.

Do people with different conditions experience less/more distraction from notifications? JASNOOR

More Susceptible to Notification Distraction:	*Less Susceptible to Notification Distraction*
ADHD (Attention Deficit Hyperactivity Disorder): People with ADHD are more susceptible to notification distractions because their brains have difficulty filtering out irrelevant stimuli and controlling impulsive responses. Notifications trigger dopamine release, making them even more tempting to check. Since ADHD affects focus and task-switching, frequent interruptions make it harder to return to the original task, leading to reduced productivity and mental fatigue. **Anxiety Disorders:** People with anxiety disorders are more susceptible to notification distractions because they often feel a strong urge to check messages due to fear of missing out (FOMO) or worry about urgent news. Notifications can heighten stress and make it harder to focus, as their brain stays in a hyper-alert state, making task-switching even more mentally exhausting.	**Autism Spectrum Disorder (ASD):** Some people with autism spectrum disorder (ASD) are less susceptible to notification distractions because they can experience hyperfocus, an intense concentration on a task that makes it easier to ignore interruptions. Additionally, many individuals with ASD prefer structured routines and may be less inclined to impulsively check notifications, especially if they are deeply engaged in something of interest. **Highly trained individuals (e.g, Musicians and Meditation Practitioners):** Highly trained individuals, like musicians and meditation practitioners, are less susceptible to notification distractions because they have developed strong cognitive control and focus discipline. Musicians train their brains to sustain attention and filter out irrelevant stimuli, while meditation practitioners enhance their ability to stay present and resist impulsive reactions. This mental training helps them stay engaged in tasks despite interruptions.

14. What strategies have been proven effective in **reducing digital distractions** (e.g., notification blockers, focus apps)?-- ***SARGUN***

Reducing digital distractions requires a combination of technology-based tools and behavioural strategies. Here are some proven approaches:

Technology-based Solutions:	***Behavioural Strategies:***
1. <u>Notification Blockers</u> - Use built-in Do Not Disturb modes on your devices (e.g., iOS, Android, Windows, macOS). - Customize app notifications to only allow critical alerts. By doing this you minimize the likelihood of getting sidetracked by incoming messages or social media updates. **2. <u>Focus Apps & Website Blockers</u>** - Use websites/apps like Flow, FocusPomo, Forest, Freedom, Cold Turkey, and StayFocusd since they will help you stay concentrated by either blocking distracting websites out of your view or offering productivity-enhancing music. - ***Fun Fact:*** Studies have shown that these tools can improve focus and reduce distractions, especially when you're trying to finish a specific task in a set period. **3. <u>Time Management Apps</u>** - Apps such as RescueTime tracks your digital habits and provides insights, helping you to check and reflect on your actions. - Apps like Toggl and Clockify help manage focused work sessions. **4. <u>Gray-scaling & Minimalist Interfaces</u>** - Turn your phone screen to grayscale, since it is an effective way to reduce visual appeal. Apps, notifications, and icons are designed with bright colors to grab your attention and trigger dopamine-driven habits. Grayscale removes these stimulating colors, making your phone less engaging and reducing the urge to check it mindlessly.	**1. <u>The Pomodoro Technique</u>** - Work in 25-minute focused sprints, followed by short, structured breaks (3-5 minute rest periods). This allows your brain to rest and refocus before returning to work. - Using a Pomodoro timer to keep track of your work and break-time periods would be a great approach! **2. <u>Environment Design</u>** - Keep your phone out of sight (e.g., in another room). This reduces visual and psychological triggers that can lead to distraction. - ***Fun Fact:*** Studies have indicated that seeing your phone, even if it's locked, can trigger habitual checking (e.g., emails, social media, etc.) - Try working in a clutter-free workspace as it signals focus time by creating a mental and phsyical environment that encourages deep work. **3. <u>Define Digital Boundaries</u>** - Set tech-free hours (e.g., no screens 1 hour before bed) as it will improve sleep quality, mental clarity, and overall well-being. - Check emails and messages only at scheduled times (e.g., twice a day — once at 9am, second at 7pm). **4. <u>Mindfulness & Deep Work Practices</u>** - Regular mindfulness practices, including deep breathing or meditation, have been shown to help individuals improve focus and resist the temptation to check distractions. - Mindfulness exercises can help you train your brain to stay on task and resist impulsive urges.

17. What brain regions are primarily involved in maintaining focus, and how are they affected by interruptions? -JAS

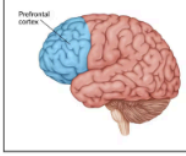
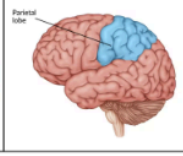
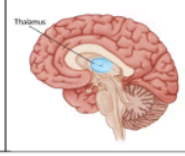
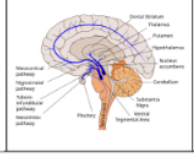
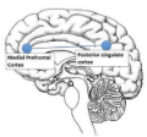
Maintaining focus involves several key brain regions, including:

1. **Prefrontal Cortex (2 types)**
   - The dorsolateral prefrontal cortex (DLPFC) is crucial for executive function, working memory, and attention control– thinking and decision making.
   - The ventrolateral prefrontal cortex (VLPF) helps control distractions– focus and self control.
2. **Parietal Cortex**
   - The parietal cortex helps with attention, spatial awareness, and processing sensory information. It works with the prefrontal cortex to focus attention on important tasks and filter out distractions.
3. **Thalamus**
   - The thalamus acts like a relay station for the brain, filtering and sending sensory information (sight, sound, and touch) to the right areas. It also helps with attention, alertness, and focus by deciding which signals are important.
4. **Dopaminergic System (Basal Ganglia & Midbrain Structures)**
   - The dopaminergic system (including the basal ganglia and midbrain structures) control motivation, rewards, movement, and focus. It releases dopamine, which helps with attention, learning, and reinforcing behaviours by making certain actions feel rewarding.
5. **Default Mode Network (DMN)**
   - The default mode network (DMN) is active when one is daydreaming, mind wandering, thinking about oneself, the past, or the future. It turns off when one focuses on a task and turns back on when the mind drifts.

How do Interruptions Affect These Regions?

Frequent interruptions tend to conflict signals sent to the certain brain regions and reduce the efficiency of the tasks performed by these regions.

- **PFC Disruption:** External interruptions (notifications, sudden noises) or internal distractions (intrusive thoughts) disrupt the PFC's control over sustained attention.
- **Parietal Shift:** The parietal cortex may redirect attention to the external and internal interruptions, reducing focus on the primary tasks.
- **Thalamic Overload:** Unimportant external and internal interruptions can overwhelm the thalamus, making it harder to filter out distractions.
- **Dopamine Reset:** Interruptions may trigger a dopamine response, reinforcing distraction-seeking behaviours.
- **DMN Reactivication:** When attention is lost, the DMN may become more active, making it harder to return to the primary task.

Prefrontal Cortex	*Parietal Cortex*	*Thalamus*	*Dopaminergic System*	*Default Mode Network*
				

20. How do notifications impact EEG-measured brainwave activity (e.g., increased beta waves associated with heightened alertness or stress)?----SARGUN

Notifications can significantly impact EEG-measured brainwave activity, especially by influencing the balance of various brainwaves, such as alpha, beta, and theta waves.

1. **Increased Beta Waves:** Beta waves (13-30 Hz) are commonly associated with heightened alertness, cognitive focus, and active thinking. Notifications—whether from text messages, social media, or apps—often trigger a spike in beta activity. This occurs because the brain shifts into a more alert and engaged state in response to the potential for new information or tasks. While this is useful for staying alert, it can also contribute to mental fatigue and stress if notifications are frequent, as the brain is continuously shifting into a state of heightened focus.
2. **Potential Stress Responses:** Research has shown that the presence of notifications can also increase stress-related brainwave patterns. For example, the sudden attention shift to a notification can cause a spike in sympathetic nervous system activity (fight-or-flight response), leading to higher levels of beta waves and potentially even alpha wave suppression (which is typically linked to relaxed and calm states). If notifications are seen as a constant source of potential distraction or demand, this can increase feelings of stress, making beta waves more dominant and potentially leading to a chronic state of tension.
3. **Disruption of Theta and Alpha Waves:** The constant interruption from notifications can suppress the deeper, slower brainwave states like theta (4-8 Hz), which are associated with deep relaxation and creativity, and alpha waves (8-12 Hz), associated with calm, awake but relaxed states. These interruptions can make it harder to maintain focus on tasks that require sustained attention or creativity. In turn, the reduction in theta and alpha waves can lower performance in tasks that involve deep thinking or creative insight.

21. Do notifications induce stress-related physiological changes (e.g., elevated cortisol levels, heart rate variability changes)? JASNOOR

Notifications can induce stress-related physiological changes, including elevated cortisol levels and changes in heart rate variability (HRV). When a notification arrives—especially if it's unexpected or urgent—the autonomic nervous system (ANS) activates the sympathetic "fight-or-flight" response, leading to a spike in cortisol (the stress hormone) and an increase in heart rate. Frequent interruptions can keep the brain in a heightened state of alertness, reducing HRV (a marker of stress resilience) and leading to chronic stress, anxiety, and mental fatigue. Over time, this can impair focus, memory, and emotional regulation, making it harder to sustain attention and manage workload effectively. Reducing notifications or managing them in controlled time blocks can help mitigate these stress effects.

22. Does habitual exposure to digital distractions lead to long-term changes in brain structure or function? - JASNOOR

Habitual exposure to digital distractions can lead to long-term changes in brain structure and function. Research suggests that frequent multitasking and constant digital interruptions may weaken connections in the prefrontal cortex (PFC), responsible for attention, decision-making, and self-control. This can lead to reduced gray matter density, affecting cognitive abilities like focus and impulse control. Moreover, chronic digital distractions can alter the default mode network (DMN), making the brain more prone to mind-wandering and reducing the capacity for deep, focus. The dopaminergic system can also be affected, with repeated exposure to notifications and social media reinforcing reward-seeking behaviors, making it harder to concentrate without external stimuli. These changes may decrease cognitive flexibility, working memory, and emotional regulation, potentially increasing anxiety and reducing overall mental well-being. Individuals who explore smartphones notification frequently also have shorter attention spans than those who used them less often (Lui and Wong, 2012).

Research has also shown that excessive digital interruptions can alter brain structure and function, leading to a range of cognitive impairments. In one recent (2024) study, participants were divided into three groups: one group was allowed to use their phones during a lecture, one group was asked to place their phones face down on the desk, and one group was asked to leave their phones outside the room. The results showed that the group that used their phones during the lecture had the lowest recall of the lecture material (Thornton et al., 2014). In fact, just the mere presence of a cell phone alone and the digital accessibility it represents itself was found to be distracting. Similarly, the use of smartphones during a memory task can decrease accuracy. In another study, participants who used their phone during the task to remember words had lower accuracy compared to those who did not use their phone (Ward et al., 2017). The constant stream of information from digital tools can also impair our ability to retain information over time. In addition, college students with increased levels of Facebook usage demonstrated worse outcomes on cognitive tasks such as free recall activities (Frein et al., 2013). Participants who reported using Facebook more frequently also had lower gray matter density in the anterior cingulate cortex, a brain region involved in memory and emotional regulation (Kanai et al., 2012).

A study found that heavy social media use was associated with decreased gray matter volume in the amygdala, a brain region involved in emotion regulation (Montag et al., 2017). Excessive digital interruptions/notifications has also been linked to cognitive impairments resembling those seen in dementia. Interestingly, these effects are increasingly observed in younger adults who are not typically expected to experience age-related neurodegeneration associated with old age (Manwell et al., 2022).

February 1st, 2025 (1:18 PM - 2:58 PM)

- Completed more background research– until completion
- Researched about the experiment
- Gathered 60 close participants (family members and friends)
- Separated everyone into 4 groups of 15–balances with adolescents, young adults, and middle-aged adults.

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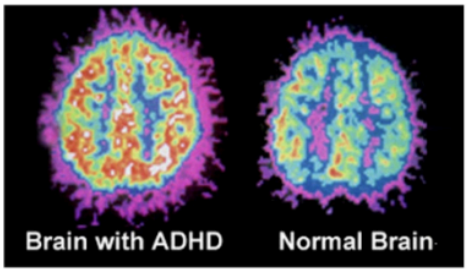
Are chronic digital multitaskers at risk of developing attention deficits similar to ADHD? SARGUN

Chronic digital multitaskers may develop attention deficits that resemble ADHD-like symptoms, even if they do not have ADHD. Research suggests that excessive multitasking with digital devices can impair focus, reduce working memory, and increase impulsivity—hallmarks of ADHD.

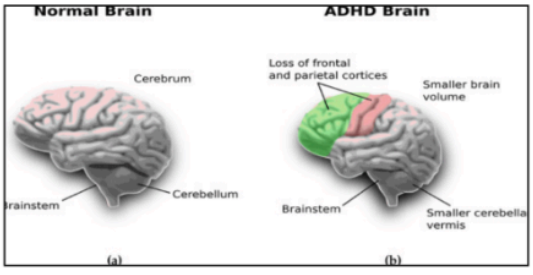
ADHD-like symptoms that chronic digital multitaskers may experience:

- The ability to maintain focus on a single task for a long period declines. Multitaskers often find it difficult to stay engaged in one task without being distracted by external stimuli (like notifications).
- The ability to focus on relevant information while ignoring distractions weakens. Multitasking creates a constant switching of attention, which reduces the brain's capacity to prioritize important tasks and filter out irrelevant stimuli.
- Multitaskers become more sensitive to external interruptions, whether from notifications, environmental noise, or other distractions. The brain gets trained to expect frequent shifts in focus, making it harder to resist external stimuli.

Scan of Brain Activity



Structure Difference: Normal vs. ADHD



Materials- SARGUN

Materials:

- Computers or tablets to administer the Stroop Test, N-back Task, and Task-Switching Test.
- Time-based screen recordings of notifications per experiment group; software or online platforms to deliver notifications at specified intervals.
    a. Group 1: High frequency - every 15 seconds
    b. Group 2: Low Frequency - every 45 seconds
    c. Group 3: Irrelevant Notifications
- Clock/stopwatch for measuring the 5-minute task duration.
- Questionnaire for self-report on mental fatigue, focus, and motivation.
- Well-formatted Stroop Test (Hard or Soft copy): A cognitive test where participants name the color of words that represent different colors.
- Different level intensity N-back Tasks (**recommended: online video for better accuracy)
    a. Intensity: Easy - N-back Activity | Working Visual Memory - Mini 83 - Easy
    b. Intensity: Medium - N-Back Activity - Mini 83 - Medium
    c. Intensity: Hard - N-back Activity | Working Visual Memory - Mini 83 - hard
- 4 simple word-searches
- 10 sets of simple subtraction & addition math problems

Variables: JASNOOR

Variables:

1. **Independent Variables:**
    a. Group Type (Notification Condition)
        i. Group 1: High Notification Frequency (notifications every 15 secs)
        ii. Group 2: Low Notification Frequency (notifications every 45 secs)
        iii. Group 3: Irrelevant Notifications
        iv. Group 4: No-notifications (control group) (no notifications)
2. **Dependent Variables:**
    a. Stroop Test
    b. N-back Task
    c. Task Switching Test
    d. Self-reported data
3. **Controlled Variables:**
    a. Age range
    b. Pre-screening for ADHD conditions
    c. Familiarity with digital devices
    d. Corrected-to-normal vision
4. **Extraneous Variables: (Potentially Affecting Results):**
    a. Environmental distractions (noise, room temp)
    b. Participants intrinsic motivation levels before entering
    c. Previous experiences with similar tasks (ex. N-back task, stroop test, etc.)

procedure

Participants:

- **60 participants** (divided into 4 groups of 15):
    - **Age Range:** (Adolescents: 12-22 years; Young Aged Adults: 23-32 years; Middle-aged adults: 32-45 years)
        i. Seniors were not included in this experiment as they do not comply with the following criteria.
    - Participants should have **normal or corrected-to-normal vision** and **be familiar with digital devices**.
    - **Pre-screening** for ADHD is recommended to ensure external variables don't heavily influence results.

Experimental Conditions:

- **Group 1 (High Notification Frequency)**: Participants will receive notifications every 1 minute (e.g., texts, emails, social media) during a task.
- **Group 2 (Low Notification Frequency)**: Participants will receive notifications every 5 minutes during a task.
- **Group 3 (Irrelevant Notification Types)**: Participants will receive notifications, but they will be random and not task-related (e.g., weather updates, news).
- **Group 4 (Control Group, No Notifications)**: Participants will perform the task without any digital interruptions or notifications.

Experiment Procedure:

1. **Attention Control Task (Primary Measure): ATTENTION SPAN**
    - **Stroop Test**: This cognitive test measures attention by asking participants to name the color of words that are names of different colors (e.g., the word "RED" written in blue). The interference between word meaning and ink color provides a measure of attention and cognitive control.
        - Time: 5 minutes
        - Task Design: Participants must perform as many Stroop trials as possible within the time frame. Accuracy and response time will be tracked.
2. **Working Memory Task: CONCENTRATION**
    - **N-back Task**: This test measures short-term memory and concentration. Participants are shown a sequence of images or letters and must respond when an image or letter matches one that appeared "N" steps earlier.
        - Time: 5 minutes
        - Task Design: Vary difficulty by adjusting the "N" parameter (e.g., 1-back, 2-back, etc.).
3. **Performance Task (Secondary Measure): TASK PERFORMANCE**
    - **Task-Switching Test**: Participants alternate between two different cognitive tasks (math problems and short word-search) to test their ability to shift attention quickly.
        - Time: 5 minutes
        - Task Design: Track both accuracy and time spent on each task to assess efficiency and flexibility of switching.
4. **Self-Reported Focus & Mental Fatigue:**
    - After each task, participants fill out a questionnaire to rate their perceived mental fatigue, focus, and motivation on a scale from 1-10.

3. Data Collection Metrics:

- Reaction time and accuracy on Stroop and N-back tasks. Slower responses or errors can indicate reduced focus due to multitasking.
- Task-switching efficiency: Number of correct switches in the task-switching test (fewer correct responses could indicate distraction).
- Self-report on focus and mental fatigue after each task.
- Measure reaction time trends during the test (increasing fatigue typically correlates with slower reaction times).
- Task completion time on each cognitive task (slower times can indicate distraction or multitasking interference).
- Accuracy and response consistency across tasks.

4. Data Analysis:

- **Statistical Tests:**
    - **ANOVA (Analysis of Variance)** to compare performance across the 4 groups.
    - **Correlation Analysis** to examine the relationship between notification frequency and task performance.
    - **Regression Analysis** to analyze how **reaction time** and **accuracy** change with notification frequency.
    - **Venn Diagrams:** Compare group-to-group differences for specific tasks to evaluate the precise effects of notifications.

Sources of Error:

- Variation in the participants: differences in baseline attention, memory, and cognitive abilities affect the overall results.
- Participants have varying levels of sensitivity to notifications, leading to inconsistent distractions.
- Some participants may be more or less prone to stress or distraction from notifications, impacting focus.
- Participants may vary in their familiarity with the Stroop Test, N-back task, or Task-Switching test, leading to learning effects or differing baselines.
- The 5-minute time limit per task may induce stress or fatigue, influencing performance consistency.
- The task-switching test was too difficult or too easy for some participants, leading to inaccurate measurements of cognitive flexibility.
- External environmental factors' (e.g., noise, distractions from the room) interference with participants' ability to focus during the tasks.
- Participants may have over- or under-reported their focus or fatigue levels due to social desirability bias or a lack of self-awareness.
- Although the groups were carefully balanced to limit variables during the experiment, slight variations in group composition (age, experience, baseline cognitive function) may have affected group comparison and make the results less generalizable.

February 2nd, 2025 (1:00 PM- 10:28 PM)

- Transferred all the information/research onto Canva for aesthetic and organizational purposes.
- Conducted the experiment on Group 2 (Low Frequency Notification Group) -15 participants
- Conducted it on half of the individuals of Group 3 (Irrelevant Notifications) - 7 participants

February 3rd, 2025 (12:22 AM- 8:40 PM)

- Chose various pictures and diagrams
- Changed the font size and made minor changes
- Added more data graphs
- Conducted the experiment on the last Group (Group 4: No notifications; control group)
- Compiled majority of the data and input the raw data into booklets of graphs and tables.
- Worked on the trifold– figured out the colour scheme and did the printing and cutting of the slide templates.

Feb 4th, 2024 (4:18 PM- 11:40 PM)

- Pasted the cut-out slide templates onto coloured card-stock paper
- Rearranged and Pasted all the information on the trifold
- Came up with a title idea: “Distracted by the Ding?”
- Assembled the title on a foam board and placed it on the trifold
- Printed out scripts and practiced together while timing ourselves
- Practiced our individual parts in front of the mirror to prepare for the day of the science fair, February 5th, 2025.

Citations:

- **Ophir, E., Nass, C., & Wagner, A. D.** (2009). Cognitive control in media multitaskers. *Proceedings of the National Academy of Sciences, 106*(37), 15583-15587.
- **Miller, M. A., & S. D. McKendrick** (2018). Effects of digital multitasking on attention and learning. *Journal of Educational Psychology*, 110(5), 654-667.
- **Salanova, M., Agut, S., & Peiró, J. M.** (2010). Linking organizational resources and work engagement to employees' performance and customer outcomes. *Journal of Applied Psychology, 95*(3), 395–406.
- **Rosen, L. D., Carrier, L. M., & Cheever, N. A.** (2013). Facebook and texting made me do it: Media multitasking and academic performance. *Computers in Human Behavior, 29*(3), 566–574.
- **Kuss, D. J., & Griffiths, M. D.** (2017). Social networking sites and addiction: Ten lessons learned. *International Journal of Environmental Research and Public Health, 14*(3), 311.
- **Junco, R.** (2012). The relationship between frequency of Facebook use, participation in Facebook activities, and student engagement. *Computers in Human Behavior, 28*(1), 187-198.
- **Kaufman, L., & Scudder, G.** (2016). The Impact of Information Overload on Employee Performance: Insights from a Multitasking Experiment. *Journal of Managerial Psychology, 31*(4), 235-249
- **Rosen, L. D., Lim, A. F., Carrier, L. M., & Cheever, N. A.** (2011). An empirical examination of the educational impact of text message-induced task switching in the classroom. *Computers in Human Behavior, 27*(3), 1307-1314.
- **Schmidt, S. M., & Green, M. J.** (2018). The impact of multitasking on cognitive performance and the use of technology: A literature review. *Computers in Human Behavior, 80*, 262–274.
- **Loh, K. Y., & Kanai, R.** (2016). The impact of digital media on the brain and attention. *NeuroImage, 124*, 131-136.
- **Lepp, A., Barkley, J. E., & Karpinski, A. C.** (2015). The relationship between cell phone use and academic performance. *Computers in Human Behavior, 49*, 122–127.
- **Koeppel, T., & Jenkins, R.** (2019). Digital distractions and cognitive control: How multitasking affects executive function. *Journal of Cognitive Enhancement, 3*(2), 185-201.
- **Unsworth, N., & Robison, M. K.** (2015). The role of working memory in media multitasking: The effect of cognitive load and multitasking behavior on task performance. *Journal of Experimental Psychology, 41*(6), 2211–2224.
- **Schaeffer, L. J., & Fox, R. L.** (2020). The impact of smartphone notifications on attention and work productivity: A meta-analysis. *Journal of Applied Psychology, 105*(7), 780–794.
- **Tindle, H. A., & Matthews, T. A.** (2017). Task-switching and performance: The impact of constant interruptions and digital media. *Journal of Experimental Psychology, 64*(4), 311-324.
- **Wang, Y., & Lee, M. K. O.** (2016). How does multitasking affect task performance and cognitive load? *Journal of Consumer Research, 42*(5), 824–836.
- **Ophir, E., Nass, C., & Wagner, A. D.** (2009). Cognitive control in media multitaskers. *Proceedings of the National Academy of Sciences, 106*(37), 15583-15587.

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