Effects of Physical Exercise on Cognitive Functions

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*Note
Coll = Collectively
Indv = individually

__Introduction__

Welcome to an exploration that delves into the intriguing realm of the effects of physical exercise on cognitive functions. Within the complex fabric of the human body, the relationship between physical exercise and cognitive performance has garnered both attention and debate. Ongoing research has yielded diverse viewpoints: while some studies propose a positive link between regular physical activity and cognitive prowess, including memory enhancement and problem-solving acumen, others present inconclusive or even contradictory findings. Beyond its potential cognitive impact, physical exercise has long been acknowledged for its holistic health benefits, spanning improved cardiovascular resilience, augmented muscular strength, and stress reduction. This has ignited widespread curiosity about whether physical exercise might yield cognitive advantages, catalyzing an earnest pursuit of insights into the underlying mechanisms at play. Consequently, the exploration of how physical exercise influences cognitive functions has emerged as a significant and captivating field of study. This research endeavor embarks on an investigative journey, seeking to uncover the diverse pathways through which physical exercise could potentially shape cognitive function. By surveying the current landscape of research within this domain, this study aspires to shed light on the intricate interplay between physical exercise and cognitive performance. To achieve this, a variety of methodological approaches, including empirical experiments, comprehensive surveys, and meticulous data analysis, will be employed. The ultimate goal is to offer a comprehensive understanding of the nuanced relationship between physical exercise and cognitive function, fostering deeper insights into this fascinating interaction.

I have always been interested in the connection between physical activity and brain function. As a student, I have noticed that after a workout, I tend to feel less focused and energized. This led me to wonder about the potential negative effects physical exercise has on cognitive functions, such as memory, attention, and decision-making. I believe that understanding the link between exercise and brain function could have important implications for education, productivity, and overall well-being. That is why I have chosen to continue exploring the effects of physical exercise on cognitive functions in my research since I was not satisfied with my original project last year. I wanted to take my project to the next level by conducting a more thorough and extensive study, gathering more data, and analyzing it more deeply. Additionally, I wanted to present my findings in a more engaging and interactive way, using a variety of mediums such as posters, graphs, and presentations. Overall, I wanted to create a project that was bigger and better than my original one, and that would truly showcase the important relationship between physical exercise and cognitive function.

__Introduction__

Another reason for my choosing of this topic was that partaking in physical exercise can negatively affect your cognitive functions, causing you to perform worse in school. When you engage in intense physical activity, your body is focused on the physical demands of the activity and diverts energy away from cognitive processes. This can lead to reduced attention span, impaired memory, and decreased problem-solving skills. Additionally, excessive physical exercise can lead to fatigue, which can further hinder cognitive performance. Hindered cognitive performance causes students to do poorly in school. When a student is consistently struggling to understand course material or is receiving poor grades, it can lead to feelings of inadequacy, frustration, and even hopelessness. This can be especially true if the student is also experiencing other stressors in their life, such as personal or family problems. The constant stress and anxiety of not being able to succeed academically can take a serious toll on a student's mental health and overall well-being. It can also lead to negative self-perception, low self-esteem, and a lack of motivation, making it even harder for students to improve their grades and succeed in school. Overall, doing badly in school can be a major drain on a student's mental energy, leading to negative impacts on their overall well-being and academic success.

My hypothesis for this project is that "if you partake in physical exercise, then there will be negative effects on your cognitive functions." This hypothesis is based on the idea that physical exercise can be physically and mentally draining, and that it may take away from the energy and focus needed for cognitive tasks.

I am excited to test this hypothesis through my extensive research because I believe that understanding the effects of physical exercise on cognitive function is important for many people, including athletes, students, and busy professionals. By understanding the relationship between physical exercise and cognitive function, we may be able to optimize our daily routines and activities to improve both our physical and mental performance. Furthermore, this topic is important because it has the potential to impact how we think about physical exercise and its place in our daily lives. If my hypothesis is supported by the data, it may suggest that we need to be more mindful of how much physical exercise we engage in and how it impacts our cognitive function. On the other hand, if the results of my project contradict my hypothesis, it could suggest that physical exercise has positive effects on

cognitive function and that we should be more proactive about incorporating it into our lives.

Introduction/Important Terms

Cognitive Functions

Cognitive functions refer to the mental processes that enable us to perceive, think, remember, and learn. These processes include attention, perception, problem-solving, memory, and language. Cognitive functions are essential for our daily functioning and help us to adapt to our environment. They allow us to process and analyze information, make decisions, and communicate with others. Understanding and studying cognitive functions can help us to better understand how the brain works and how we can optimize our mental abilities.

Brain Chemistry

The human brain is made up of millions of neurons and glial cells that communicate through chemical signalling. When a neuron is stimulated, it releases chemical neurotransmitters into the synapse, or gap, between it and the next neuron. These neurotransmitters bind to receptors on the receiving neuron, transmitting the signal and causing it to either excite or inhibit the next neuron. The balance of neurotransmitters in the brain is crucial for proper brain function and can be affected by various factors such as genetics, environment, and behaviour. Some of the most important neurotransmitters in the brain include serotonin, dopamine, and GABA, which are involved in regulation of mood, motivation, and anxiety. Dysregulation of these neurotransmitters can lead to mental health conditions such as depression and anxiety disorders. It is important to maintain a healthy balance of neurotransmitters in the brain to ensure optimal brain function.

Brain chemistry refers to the chemical processes and substances that are essential for the proper functioning of the human brain. These neurotransmitters are chemical messengers that transmit information between neurons; hormones, are chemical messengers produced by glands in the body that regulate various functions; and enzymes, are proteins that help to break down and synthesize substances in the body. Other important chemical processes in the brain include the synthesis and breakdown of glucose, the primary source of energy for the brain, and the regulation of the balance of electrolytes in the body. Understanding basic brain chemistry is crucial for understanding how the brain functions and

how it can be affected by various factors, including genetics, environment, and health conditions.

Introduction/Important Terms

Dopamine

Dopamine is a neurotransmitter, which is a chemical that is produced in the brain and is used to transmit messages between nerve cells. It is involved in a variety of functions in the brain, including movement, learning, and motivation. Dopamine is produced in the brain through a complex process that involves several different neurotransmitters and enzymes. One way that dopamine is produced is through physical exercise. When you engage in physical activity, your body releases a number of chemicals, including dopamine. This release of dopamine can lead to feelings of pleasure and reward, which can motivate you to continue exercising. In addition, regular physical exercise has been shown to increase the production of dopamine in the brain, which may contribute to the overall sense of well-being and happiness that many people experience after exercising.

HIIT (High Intensity Interval Training)

HIIT, or High-Intensity Interval Training, is a form of exercise that involves short bursts of high intensity activity followed by brief periods of rest. These intervals can be varied in length and intensity depending on the specific workout, but the goal is to push the body to its maximum effort for short periods of time. HIIT is known for being an efficient way to burn calories and improve cardiovascular fitness, as well as building muscle and increasing overall endurance. It is also popular because it can be done with minimal equipment and can be customized to fit individual fitness levels. HIIT workouts can include exercises such as sprints, burpees, jumping jacks, and mountain climbers, and are typically completed in 30 minutes or less. Overall, HIIT is a challenging but effective way to improve physical fitness.

Tabata

Tabata is a type of high-intensity interval training (HIIT) that is named after Japanese researcher Dr. Izumi Tabata, who first developed the protocol in 1996. It typically consists of eight rounds of high-intensity exercise performed for 20 seconds, followed by 10 seconds of rest. The exercises performed during Tabata can vary, but it consists of 4 sets of jump squats and 4 sets of running on the spot in my research. The idea behind Tabata is to push yourself to your maximum effort for each 20-second interval, then allow for brief rest before repeating the interval again. It's a very intense and demanding workout, but

due to its short duration, it can be a highly effective way to improve cardiovascular fitness, endurance, and build muscle

Experiment

In my controlled experiment, a sample population of students from grades 8 and 9 were divided into two groups. The first group participated in a cognitive assessment while in a rested state, while the second group participated in a similar assessment while in an unrested state. The experimental protocol was subsequently reversed, with the second group participating in the cognitive assessment while in a rested state and the first group participating in the assessment while in an unrested state. The aim of this study was to examine the correlation between physical exercise and cognitive performance, by evaluating the impact of physical exertion on cognitive functions. A replication of the aforementioned experiment was conducted, with the modification of the cognitive function under evaluation being limited to memory. The results of the two assessments will be analyzed to determine any correlation between physical exercise and cognitive performance

For the purpose of my experiment, I will be collecting data from a diverse group of subjects, including a class of students in grades 8 and 9, and two specifically chosen female and male subjects in grade 11. The female subjects are of similar weight (differing by less than 5 pounds) and have a 1-centimeter height difference, and both excel in competitive ice skating. The male subjects have a similar weight difference (less than 5 pounds) and a 2-centimeter height difference and are both team captains of their school soccer teams. The data I will be collecting includes test scores, time taken to complete the tests, and for the four grade 11 subjects, additional data such as their heart rate.

During the judging process for my project at both the VDSF and GVRSF last year, a recurring issue I encountered was the simplicity of the data collection process and the data itself. Therefore, I took extra measures this year to gather a diverse range of data and analyze it both collectively and individually. I also implemented various procedures and conducted multiple testing days to ensure a more thorough and comprehensive approach.

In conducting my experiment, a key consideration was to ensure the validity and appropriateness of the testing materials for the target population of grade 8 and grade 9 students. To this end, I engaged in a rigorous process of evaluating various past exams and current curriculum standards for these grades to develop a method for creating a logic and reasoning test that was both appropriate and feasible. Through this process, I identified two credible logic and reasoning tests that were deemed suitable for the student's grade level. I then employed a systematic approach to selecting questions from these tests, using a

combination of questions from both sources to ensure a balanced and representative test instrument.

Experiment

Necessary apparatus and resources for conducting the experiment include

- Test-taking materials, including writing paper and pens
- Timing device
- Access to an outdoor field or similar location for data collection
- Classroom or similar space for conducting the classroom portion of the experiment
- Presentation equipment, such as a projector

Uncontrollable Variables

1. Weather conditions (temperature, humidity, precipitation, wind)
2. Natural variations in the growth rate or characteristics of participants
3. Human error or bias in data collection or analysis
4. Variations in the timing of experiments
5. Variations in the environment (e.g. altitude, light intensity, noise levels)
6. Variations in the genetic makeup of participants
7. Interference from other independent variables that are not part of the experiment.(stress, sleep, etc.)
8. Amount of effort put in by the participants

Controllable Variables

1. The sample size
2. Gender and age of participants
3. The grade level of the tests
4. Rules for the test writing
5. Number of times the procedure was repeated

<u>Experiment</u>

Requirements, expectations, and rules that must be followed:
1. On the first day of testing, all students must follow the following guidelines:
2. Do not skip any questions on the test.
3. Do not change your answers once you have written them.
4. Use either a coloured pencil or pen to complete the test.
5. There is a time limit of ten minutes for completing the test. If you do not finish within this time, write "n/a" on the top right corner of the front page.
6. During the testing process, be respectful to your classmates and give everyone enough space.
7. Put in 100% effort to do your best on the test and (HIIT).

Procedure testing week 1 (Logic/Reasoning rested) Gr. 8/9s
To begin the testing process:
1. Divide the students into two groups: Group A and Group B.
2. Administer the logic/reasoning test version 1 to Group A, and the logic/reasoning test version 2 to Group B.
3. Start the timer for 25 minutes.
4. Each student should write the time they finish on the top right corner of the front page. If they do not finish within the time limit, they should write "n/a."
5. Collect the completed tests, grade them, and record the data.

Procedure testing week 2 (Logic/Reasoning unrested) Gr. 8/9s
To begin the testing process:
1. Divide the students into two groups: Group A and Group B.
2. Administer the logic/reasoning test version 1 to Group A, and the logic/reasoning test version 2 to Group B.
3. Have students participate in a warm-up consisting of 20 seconds of jumping jacks, 10 hip rotations, and 10 toe touches.
4. After the warm-up, begin a Tabata (HIIT) exercise with 4 sets of 20 seconds of jump squats, followed by 4 sets of 20 seconds of running on the spot, with intervals of 10 seconds rest in between each set.
5. After the exercise, return to the classroom and start the test within 1 minute.
6. Each student should write the time they finish on the top right corner of the front page.
7. Collect the completed tests, grade them, and record the data.

<u>**Experiment**</u>

Procedure testing week 3 (Memory rested) Gr. 8/9s

To begin the testing process:

1. Divide the students into two groups: Group A and Group B.
2. Hand out paper to each student
3. Go through 5 slides each including 2 images with 2 made-up words. Each slide will be shown for 30 seconds then once again quickly at the end
4. Turn off the slides and wait 1 minute
5. Start asking questions. Each question will be asked once
   Collect the completed tests, grade them, and record the data

Procedure testing week 4 (Memory unrested) Gr. 8/9s

To begin the testing process:

1. Divide the students into two groups: Group A and Group B.
2. Hand out blank paper to each student
3. Take students outside
4. Have students participate in a warm-up consisting of 20 seconds of jumping jacks, 10 hip rotations, and 10 toe touches.
5. After the warm-up, begin a Tabata (HIIT) exercise with 4 sets of 20 seconds of jump squats, followed by 4 sets of 20 seconds of running on the spot, with intervals of 10 seconds rest in between each set.
6. After the exercise, return to the classroom and start the test within 1 minute.
7. Each student should write the time they finish on the top right corner of the front page.
8. Collect the completed tests, grade them, and record the data.

Experiment (Logic/Reasoning Gr 8)

The following are the comprehensive data charts that have been meticulously compiled and analyzed from the extensive array of data collected during the execution of my newly devised and enhanced research , held this current year.

The present chart represents the data collected from Group A (grade 8) during the initial experimentation phase when the participants were in a state of rest. It is essential to note that for the purpose of protecting the privacy of the individual students, the names of the participants have been omitted from the experiment.

Group A (grade 8) (rested)	Test Finishing Time (seconds)	Test Score (logic/reasoning)
Student 1	423 seconds	90%
Student 2	298 seconds	80%
Student 3	315 seconds	100%
Student 4	295 seconds	70%
Student 5	249 seconds	80%
Student 6	334 seconds	90%
Student 7	367 seconds	80%
Student 8	231 seconds	80%
Student 9	260 seconds	80%
Student 10	308 seconds	60%
Student 11	213 seconds	70%
Student 12	229 seconds	70%
Student 13	443 seconds	100%

Upon conducting a comprehensive analysis of the 13 students in the subject of logic, it was determined that the average time required for completion of the logic/reasoning test while rested was approximately 305 seconds, or 5 minutes and 5 seconds and the test score average was 79%

Experiment
(Logic/Reasoning Gr 8)

The present chart represents the data collected from Group A (grade 8) during the second experimentation phase when the participants were in a state of fatigue. It is essential to note that for the purpose of protecting the privacy of the individual students, the names of the participants have been omitted from the experiment.

Group A (grade 8) (unrested)	Test Finishing Time (seconds)	Test Score (logic/reasoning)
Student 1	532 seconds	80%
Student 2	398 seconds	60%
Student 3	310 seconds	70%
Student 4	324 seconds	90%
Student 5	404 seconds	60%
Student 6	353 seconds	80%
Student 7	570 seconds	70%
Student 8	324 seconds	60%
Student 9	250 seconds	70%
Student 10	309 seconds	50%
Student 11	416 seconds	30%
Student 12	390 seconds	70%
Student 13	487 seconds	50%

Upon conducting a comprehensive analysis of the 13 students in the subject of logic, it was determined that the average time required for completion of the logic/reasoning test while unrested was approximately 389 seconds, or 6 minutes and 29 seconds and the test score average was 64%

Experiment
(Logic/Reasoning Gr 8)

The present chart represents the data collected from Group B (grade 8) during the second experimentation phase when the participants were in a state of rest. It is essential to note that for the purpose of protecting the privacy of the individual students, the names of the participants have been omitted from the experiment.

Group B (grade 8) (rested)	Test Finishing Time (seconds)	Test Score (logic/reasoning)
Student 1	333 seconds	60%
Student 2	298 seconds	70%
Student 3	253 seconds	90%
Student 4	295 seconds	80%
Student 5	314 seconds	100%
Student 6	230 seconds	80%
Student 7	256 seconds	70%
Student 8	309 seconds	70%
Student 9	340 seconds	60%
Student 10	199 seconds	90%
Student 11	294 seconds	70%
Student 12	421 seconds	70%
Student 13	367 seconds	70%

Upon conducting a comprehensive analysis of the 13 students in the subject of logic, it was determined that the average time required for completion of the logic/reasoning test while rested was approximately 301 seconds, or 5 minutes and 1 second and the test score average was 80%

Experiment
(Logic/Reasoning Gr 8)

The present chart represents the data collected from Group B (grade 8) during the initial experimentation phase when the participants were in a state of rest. It is essential to note that for the purpose of protecting the privacy of the individual students, the names of the participants have been omitted from the experiment.

Group B (grade 8) (unrested)	Test Finishing Time (seconds)	Test Score (logic/reasoning)
Student 1	368 seconds	20%
Student 2	390 seconds	70%
Student 3	378 seconds	70%
Student 4	345 seconds	50%
Student 5	298 seconds	80%
Student 6	353 seconds	80%
Student 7	470 seconds	40%
Student 8	352 seconds	70%
Student 9	248 seconds	80%
Student 10	534 seconds	70%
Student 11	219 seconds	50%
Student 12	195 seconds	70%
Student 13	465 seconds	60%

Upon conducting a comprehensive analysis of the 13 students in the subject of logic, it was determined that the average time required for completion of the logic/reasoning test while unrested was approximately 365 seconds, or 6 minutes and 5 seconds and the test score average was 62%

Experiment
(Memory Gr 8)

The present chart represents the data collected from Group A (grade 8) during the third experimentation phase when the participants were in a state of rest taking a memory test. It is essential to note that for the purpose of protecting the privacy of the individual students, the names of the participants have been omitted from the experiment.

Group A (grade 8) (rested)	Test Score (Memory)
Student 1	80%
Student 2	80%
Student 3	90%
Student 4	90%
Student 5	60%
Student 6	80%
Student 7	70%
Student 8	90%
Student 9	80%
Student 10	60%
Student 11	90%
Student 12	70%
Student 13	100%

Upon conducting a comprehensive analysis of the test scores of the 13 students in the subject of memory, it was determined that the average test score of the memory test while rested was approximately 80%

Experiment
(Memory Gr 8)

The present chart represents the data collected from Group A (grade 8) during the fourth experimentation phase when the participants were in a state of rest taking a memory test. It is essential to note that for the purpose of protecting the privacy of the individual students, the names of the participants have been omitted from the experiment.

Group A (grade 8) (unrested)	Test Score (Memory)
Student 1	60%
Student 2	50%
Student 3	100%
Student 4	70%
Student 5	70%
Student 6	60%
Student 7	50%
Student 8	80%
Student 9	70%
Student 10	50%
Student 11	80%
Student 12	80%
Student 13	70%

Upon conducting a comprehensive analysis of the test scores of the 13 students in the subject of memory, it was determined that the average test score of the memory test while rested was approximately 68%

Experiment
(Memory Gr 8)

The present chart represents the data collected from Group B (grade 8) during the fourth experimentation phase when the participants were in a state of rest taking a memory test. It is essential to note that for the purpose of protecting the privacy of the individual students, the names of the participants have been omitted from the experiment.

Group B (grade 8) (rested)	Test Score (Memory)
Student 1	70%
Student 2	90%
Student 3	80%
Student 4	90%
Student 5	80%
Student 6	70%
Student 7	100%
Student 8	70%
Student 9	90%
Student 10	50%
Student 11	90%
Student 12	90%
Student 13	100%

Upon conducting a comprehensive analysis of the test scores of the 13 students in the subject of memory, it was determined that the average test score of the memory test while rested was approximately 83%

Experiment
(Memory Gr 8)

The present chart represents the data collected from Group B (grade 8) during the third experimentation phase when the participants were in a state of fatigue taking a memory test. It is essential to note that for the purpose of protecting the privacy of the individual students, the names of the participants have been omitted from the representation.

Group B (grade 8) (unrested)	Test Score (Memory)
Student 1	40%
Student 2	60%
Student 3	90%
Student 4	70%
Student 5	70%
Student 6	50%
Student 7	60%
Student 8	40%
Student 9	80%
Student 10	40%
Student 11	90%
Student 12	60%
Student 13	70%

Upon conducting a comprehensive analysis of the test scores of the 13 students in the subject of memory, it was determined that the average test score of the memory test while rested was approximately 63%

Experiment
(Logic/Reasoning Gr 9)

The present chart represents the data collected from Group A (grade 9) during the initial experimentation phase when the participants were in a state of rest. It is essential to note that for the purpose of protecting the privacy of the individual students, the names of the participants have been omitted from the representation.

Group A (grade 9) (rested)	Test Finishing Time (seconds)	Test Score (logic/reasoning)
Student 1	304 seconds	80%
Student 2	489 seconds	100%
Student 3	345 seconds	90%
Student 4	195 seconds	70%
Student 5	269 seconds	70%
Student 6	243 seconds	100%
Student 7	247 seconds	80%
Student 8	321 seconds	80%
Student 9	280 seconds	90%
Student 10	198 seconds	60%
Student 11	213 seconds	60%
Student 12	210 seconds	70%
Student 13	343 seconds	90%

Upon conducting a comprehensive analysis of the 13 students in the subject of logic, it was determined that the average time required for completion of the logic/reasoning test while rested was approximately 281 seconds, or 4 minutes and 41 seconds and the test score average was 80%

Experiment
(Logic/Reasoning Gr 9)

The present chart represents the data collected from Group A (grade 9) during the initial experimentation phase when the participants were in a state of unrest. It is essential to note that for the purpose of protecting the privacy of the individual students, the names of the participants have been omitted from the representation.

Group A (grade 9) (unrested)	Test Finishing Time (seconds)	Test Score (logic/reasoning)
Student 1	460 seconds	90%
Student 2	595 seconds	80%
Student 3	456 seconds	70%
Student 4	320 seconds	60%
Student 5	278 seconds	80%
Student 6	264 seconds	70%
Student 7	298 seconds	50%
Student 8	400 seconds	90%
Student 9	341 seconds	70%
Student 10	198 seconds	30%
Student 11	210 seconds	40%
Student 12	240 seconds	80%
Student 13	391 seconds	60%

Upon conducting a comprehensive analysis of the 13 students in the subject of logic, it was determined that the average time required for completion of the logic/reasoning test while unrested was approximately 342 seconds, or 5 minutes and 42 seconds and the test score average was 66%

Experiment
(Logic/Reasoning Gr 9)

The present chart represents the data collected from Group B (grade 9) during the initial experimentation phase when the participants were in a state of rest. It is essential to note that for the purpose of protecting the privacy of the individual students, the names of the participants have been omitted from the representation.

Group B (grade 9) (rested)	Test Finishing Time (seconds)	Test Score (logic/reasoning)
Student 1	200 seconds	100%
Student 2	403 seconds	70%
Student 3	302 seconds	90%
Student 4	203 seconds	90%
Student 5	243 seconds	80%
Student 6	292 seconds	60%
Student 7	198 seconds	70%
Student 8	303 seconds	90%
Student 9	390 seconds	90%
Student 10	508 seconds	50%
Student 11	323 seconds	90%
Student 12	410 seconds	100%
Student 13	233 seconds	90%

Upon conducting a comprehensive analysis of the 13 students in the subject of logic, it was determined that the average time required for completion of the logic/reasoning test while rested was approximately 315 seconds, or 5 minutes and 15 seconds and the test score average was 82%

Experiment
(Logic/Reasoning Gr 9)

The present chart represents the data collected from Group A (grade 9) during the initial experimentation phase when the participants were in a state of unrest. It is essential to note that for the purpose of protecting the privacy of the individual students, the names of the participants have been omitted from the representation.

Group B (grade 9) (unrested)	Test Finishing Time (seconds)	Test Score (logic/reasoning)
Student 1	494 seconds	70%
Student 2	600 seconds	60%
Student 3	451 seconds	60%
Student 4	405 seconds	60%
Student 5	346 seconds	80%
Student 6	304 seconds	70%
Student 7	299 seconds	50%
Student 8	432 seconds	90%
Student 9	341 seconds	70%
Student 10	198 seconds	30%
Student 11	210 seconds	40%
Student 12	240 seconds	80%
Student 13	391 seconds	60%

Upon conducting a comprehensive analysis of the 13 students in the subject of logic, it was determined that the average time required for completion of the logic/reasoning test while unrested was approximately 362 seconds, or 6 minutes and 2 seconds and the test score average was 63%

Experiment
(Memory Gr 9)

The present chart represents the data collected from Group A (grade 9) during the Third experimentation phase when the participants were in a state of rest taking a memory test. It is essential to note that for the purpose of protecting the privacy of the individual students, the names of the participants have been omitted from the experiment.

Group A (grade 9) (rested)	Test Score (Memory)
Student 1	60%
Student 2	90%
Student 3	80%
Student 4	80%
Student 5	70%
Student 6	100%
Student 7	80%
Student 8	90%
Student 9	60%
Student 10	90%
Student 11	50%
Student 12	90%
Student 13	70%

Upon conducting a comprehensive analysis of the test scores of the 13 students in the subject of memory, it was determined that the average test score of the memory test while rested was approximately 78%

Experiment
(Memory Gr 9)

The present chart represents the data collected from Group A (grade 8) during the fourth experimentation phase when the participants were in a state of rest taking a memory test. It is essential to note that for the purpose of protecting the privacy of the individual students, the names of the participants have been omitted from the experiment.

Group A (grade 9) (unrested)	Test Score (Memory)
Student 1	30%
Student 2	60%
Student 3	70%
Student 4	60%
Student 5	90%
Student 6	80%
Student 7	50%
Student 8	90%
Student 9	80%
Student 10	50%
Student 11	50%
Student 12	80%
Student 13	40%

Upon conducting a comprehensive analysis of the test scores of the 13 students in the subject of memory, it was determined that the average test score of the memory test while rested was approximately 64%

Experiment
(Memory Gr 9)

The present chart represents the data collected from Group B (grade 8) during the fourth experimentation phase when the participants were in a state of rest taking a memory test. It is essential to note that for the purpose of protecting the privacy of the individual students, the names of the participants have been omitted from the experiment.

Group B (grade 9) (rested)	Test Score (Memory)
Student 1	90%
Student 2	80%
Student 3	100%
Student 4	90%
Student 5	80%
Student 6	90%
Student 7	80%
Student 8	90%
Student 9	60%
Student 10	90%
Student 11	50%
Student 12	90%
Student 13	90%

Upon conducting a comprehensive analysis of the test scores of the 13 students in the subject of memory, it was determined that the average test score of the memory test while rested was approximately 84%

Experiment
(Memory Gr 9)

The present chart represents the data collected from Group B (grade 8) during the fourth experimentation phase when the participants were in a state of rest taking a memory test. It is essential to note that for the purpose of protecting the privacy of the individual students, the names of the participants have been omitted from the experiment.

Group B (grade 9) (unrested)	Test Score (Memory)
Student 1	60%
Student 2	50%
Student 3	80%
Student 4	40%
Student 5	70%
Student 6	20%
Student 7	90%
Student 8	50%
Student 9	60%
Student 10	40%
Student 11	80%
Student 12	50%
Student 13	50%

Upon conducting a comprehensive analysis of the test scores of the 13 students in the subject of memory, it was determined that the average test score of the memory test while rested was approximately 57%

Experiment Grade 11
(solo experiment)

The experimentation protocol for the four grade 11 students was modified to provide a more comprehensive evaluation. A small and controlled group of four grade 11 students were utilized. These participants were administered tests with 25 questions, as opposed to the 10-question tests administered to the rest of the sample. The allotted time for completion of the tests was also increased to 25 minutes, as opposed to the standard 10 minutes. Additionally, heart rate and blood pressure were recorded as supplementary data to provide further insight into the participants' effort during the High-Intensity Interval Training (HIIT) exercise.

The same Requirements, expectations, and rules must be followed as stated on page 8

Procedure testing week 1 (Logic/Reasoning rested) Gr.11's

To begin the testing process:
1. Divide the grade 11s into two groups: Group A and Group B. (1 female, 1 male each group)
2. Collect the resting heart rate of each student
3. Administer the logic/reasoning test version 1 to Group A, and the logic/reasoning test version 2 to Group B.
4. Start the timer for 25 minutes.
5. Each student gets told to write the time they finish on the top right corner of the front page. If they do not finish within the time limit, they should write "n/a."
6. Collect the completed tests, grade them, and record the data.

Procedure testing week 2 (Logic/Reasoning unrested) Gr. 11's

To begin the testing process:
1. Divide the grade 11s into two groups: Group A and Group B.
2. Administer the logic/reasoning test version 2 to Group A, and the logic/reasoning test version 1 to Group B.
3. Collect resting heart rate from all students
4. Have students participate in a warm-up consisting of 20 seconds of jumping jacks, 10 hip rotations, and 10 toe touches.
5. After the warm-up, begin a Tabata (HIIT) exercise with 4 sets of 20 seconds of jump squats, followed by 4 sets of 20 seconds of running on the spot, with intervals of 10 seconds rest in between each set.
6. Collect heart rate after
7. After the exercise, return to the test writing area and start the test within 1 minute.
8. Each student should write the time they finish on the top right corner of the front page.
9. Collect the completed tests, grade them, and record the data.

Experiment Grade 11
(solo experiment)

The present chart represents the data collected from Group A and B (grade 11) during the solo experimentation phase when the participants were in a state of rest taking a Logic/Reasoning test. It is essential to note that for the purpose of protecting the privacy of the individual students, the names of the participants have been omitted from the experiment.

Subjects (Rested)	Test Score	Test Finishing Time	Heart Rate
Male 1	19/25 = 76%	912 seconds	82 bpm
Male 2	21/25 = 84%	821 seconds	73 bpm
Female 1	23/25 = 92%	979 seconds	69 bpm
Female 2	22/25 = 88%	1005 seconds	77 bpm

Upon conducting a comprehensive analysis of the 4 students in the subject of logic, it was determined that the average time required for the male subjects in the average completion time of the logic/reasoning test while rested was approximately 866 seconds, or 10 minutes and 26 seconds and the test score average was 80%

For the female subjects their average completion time of the logic/reasoning test while rested was approximately 992 seconds or 12 minutes and 32 seconds and the test score average was 90%

Additionally the heart rates recorded for all 4 subjects prove that they were in a state of rest before writing the test as their heart rates fall within the average resting heart rates for their age. Their heart rates also drastically change when they are active and not rested. Further proving their state of rest.

Experiment Grade 11
(solo experiment)

       The present chart represents the data collected from Group A and B (grade 11) during the solo experimentation phase when the participants were in a state of fatigue taking a Logic/Reasoning test. It is essential to note that for the purpose of protecting the privacy of the individual students, the names of the participants have been omitted from the experiment.

Subjects (unrested)	Test Score	Test Finishing Time	Heart Rate
Male 1	14/25 = 56%	1254 seconds	160 bpm
Male 2	19/25 = 76%	1078 seconds	143 bpm
Female 1	22/25 = 88%	934 seconds	159 bpm
Female 2	17/25 = 68%	1350 seconds	156 bpm

       Upon conducting a comprehensive analysis of the 4 students in the subject of logic, it was determined that the average time required for the male subjects in the average completion time of the logic/reasoning test while unrested was approximately 1,166 seconds, or 19 minutes and 26 seconds and the test score average was 66%

       For the female subjects their average completion time of the logic/reasoning test while unrested was approximately 1,142 seconds or 19 minutes and 2 seconds and the test score average was 78%

       The heart rates once again prove their state of fatigue and unrest as all 4 subjects heart rates sit in the range of average bpm while being active

<u>Discussion/analysis</u>

In accordance with the introduction, it has been posited that engaging in physical exercise prior to utilizing cognitive functions may have a detrimental impact on cognitive performance. In order to arrive at a conclusive determination, a thorough examination of the accumulated data must be conducted. This includes conducting individual assessments as well as comprehensive evaluations of all the collected data. Furthermore, for the purpose of providing a comprehensive understanding, the results obtained from this study will be compared to those obtained from a previous investigation by me conducted during the preceding year.

The data that has been recorded from the previous year has been thoroughly analyzed and evaluated in order to provide a comprehensive understanding of the trends and patterns that emerged over the course of the project. A detailed examination of the data was conducted in order to identify any areas of concern or potential opportunities for growth. The analysis was performed utilizing a variety of techniques, including statistical analysis and data visualization methods, in order to gain a more complete understanding of the data. The results of this analysis have been summarized in a brief report, which will serve as a valuable resource for decision-making and strategic planning moving forward.

Discussion/Analysis (Previous year)

Average Test scores for each group (rested vs unrested)
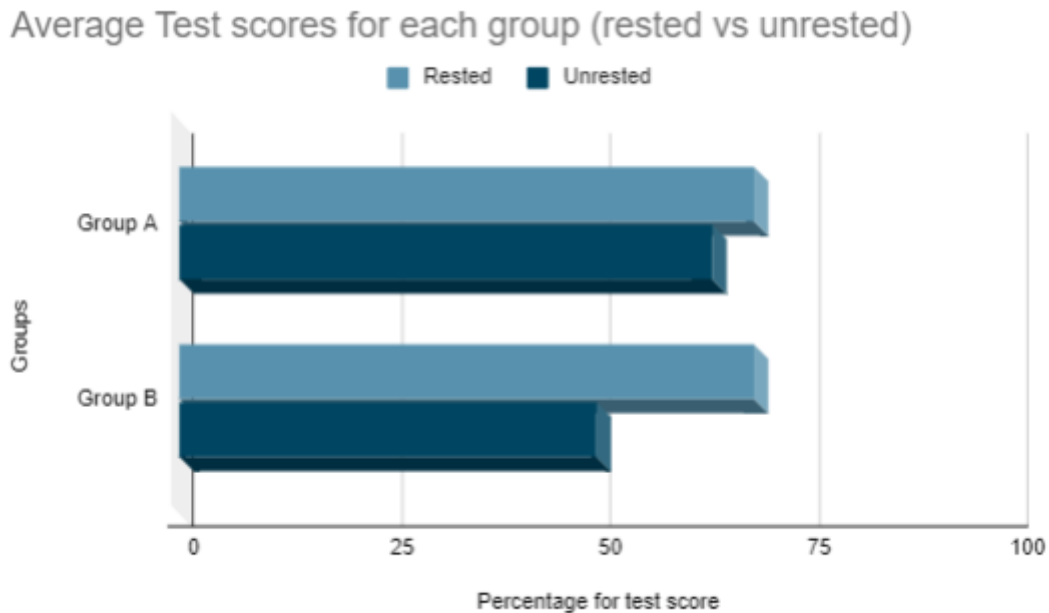
The above graph illustrates a comparison of the average test scores of Group A and Group B, both in a rested and unrested state. As depicted, Group A demonstrated a minimal deviation in their test scores, with a slight 5% change observed. However, upon conducting surveys with members of Group A, it was revealed that they rated the test on a 10-point scale of difficulty, with an average score of 8/10. Additionally, they reported experiencing a high degree of fatigue and difficulty in maintaining focus during the test. While these findings may suggest a potential correlation between fatigue and test performance, it is important to note that further research and conclusive evidence are required to fully establish this relationship.

In contrast, the average test scores of Group B exhibited a much more substantial fluctuation, with a range of nearly 20%. Furthermore, members of Group B rated the test as 9/10 on average on the same scale of difficulty and reported feeling overwhelmed, and struggling to catch their breath and retain information. These observations may suggest that the level of exertion experienced by Group B may have had a significant impact on their test performance. However, it is crucial to note that more conclusive research is necessary to determine the exact cause and effect relationship between physical exertion and cognitive performance.

Discussion/Analysis (Previous year)

Group A and B's Average Time to finish the test rested vs unrested)
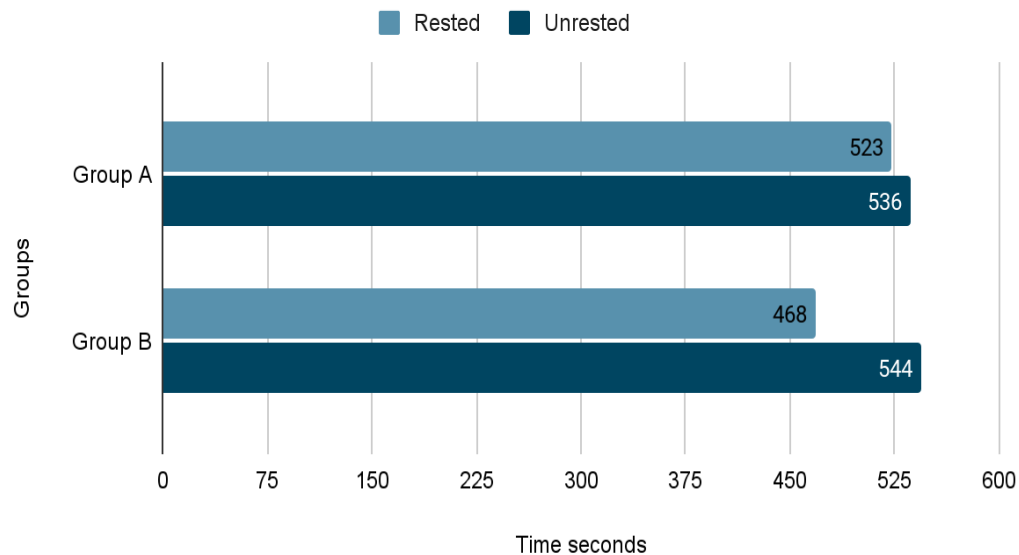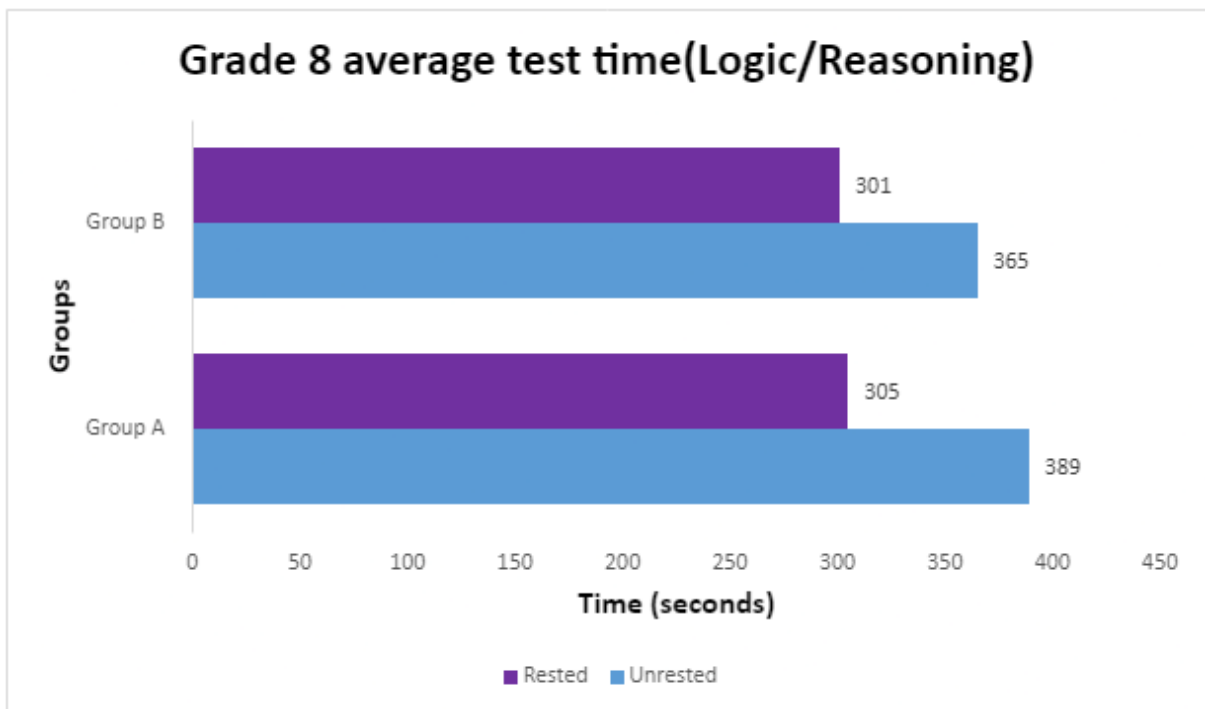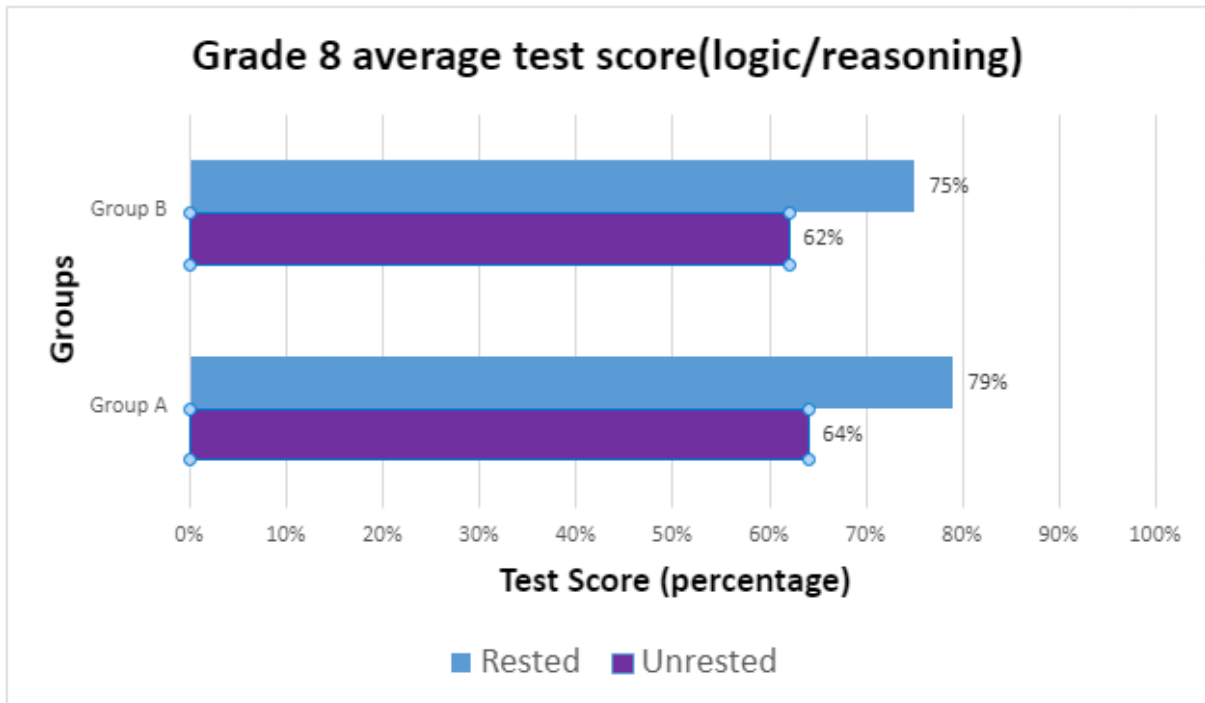

The graph presented above is a comparison of the average completion time for the test for each group when the participants were both rested and unrested. As depicted in the graph, there was not a significant difference in the average completion time for Group A, with a mere 13-second variation. However, upon further examination of the individual data for each participant in Group A, it was discovered that one individual had a significantly faster completion time, which likely skewed the overall average. On the other hand, Group B displayed a significant difference in their average completion time, with a deviation of over 1 minute. This is particularly noteworthy, as the test has a 10-minute time limit, and a deviation of 1:12 minutes can greatly affect the outcome.

It is important to note that these results do not necessarily provide insight into cognitive functions. However, they do indicate that there is a correlation between one's level of rest and their ability to focus and complete tasks efficiently. This suggests that a lack of rest can impede one's ability to process information and reasoning, leading to a delay in the thinking process. As previously mentioned, the primary focus of this study was to examine the reasoning and logic portions of cognitive functions. However, the findings regarding the correlation between rest and completion time are still important, as they indicate that adequate rest is crucial for optimal cognitive performance.

Discussion/Analysis
(Logic/Reasoning Gr.8 Coll.)

Grade 8 average test score(logic/reasoning)

Grade 8 average test time(Logic/Reasoning)

Discussion/Analysis Group A (Logic/Reasoning Gr.8 Coll.)

Comparing Group A's Logic/Reasoning Data Collectively (Gr.8)

The graphs presented on page 19 are a comparison of the average completion time for the test and average test scores of each group when the participants were both rested and unrested.

Upon conducting a comprehensive analysis on data from the 13 students of group A in the subject of logic/reasoning, it was determined that the average time required for completion of the logic/reasoning test while unrested was approximately 389 seconds, or 6 minutes and 29 seconds and the test score average was 64%.

In contrast, when the same group of students took the logic/reasoning test while rested, the results were quite different. The average time required for completion of the test was approximately 305 seconds, or 5 minutes and 5 seconds and the test score average was 81%. This data suggests that when the students were rested, they were able to complete the test faster and had a higher overall score average.
The major difference between the two sets of data is that the students had better performance when they were rested. The students were able to complete the test faster and had a higher score average when they were rested. For example, there was a 84 seconds increase in the average time required for completion of the test and a 17% decrease in their test average. This suggests that being unrested hinders the students' ability to use their cognitive functions to their maximum ability.
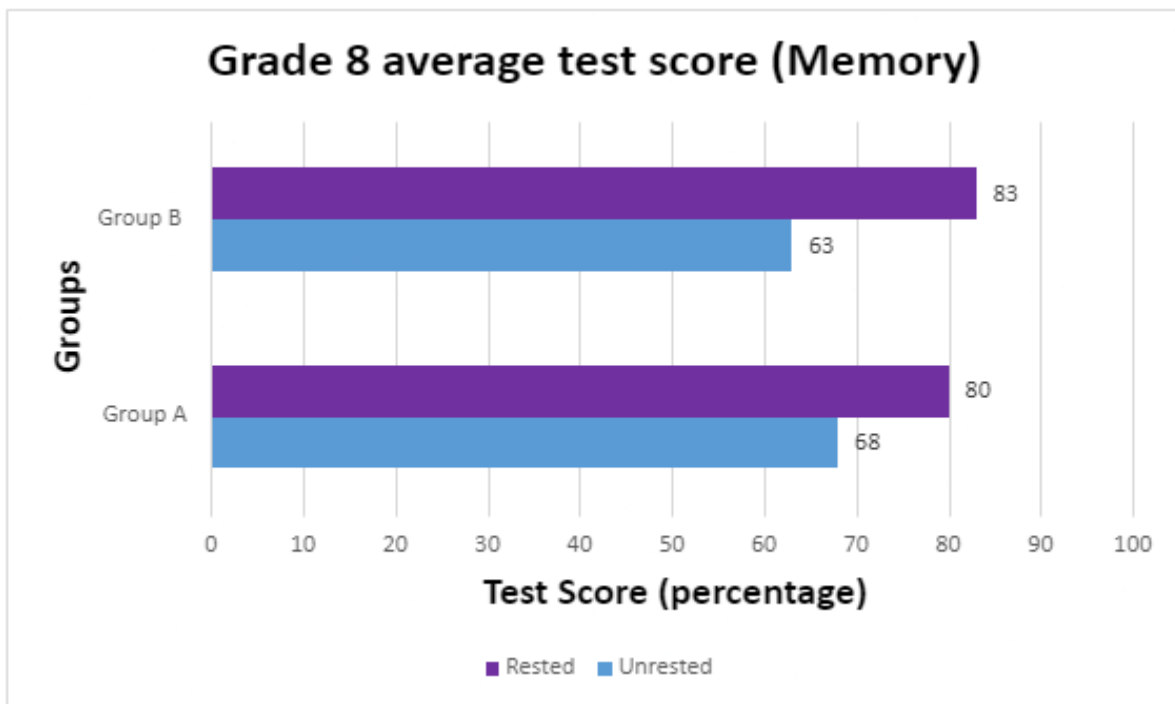
Discussion/Analysis Group A (Logic/Reasoning Gr.8 Coll.)

Comparing Group B's Logic/Reasoning Data Collectively (Gr.8)

The graphs presented on page 19 are a comparison of the average completion time for the test and average test scores of each group when the participants were both rested and unrested.

Upon conducting a comprehensive analysis on data from the 13 students of group B in the subject of logic/reasoning, it was determined that the average time required for completion of the logic/reasoning test while unrested was approximately 365 seconds, or 6 minutes and 5 seconds and the test score average was 62%.

In contrast, when the same group of students took the logic/reasoning test while rested, the results were quite different. The average time required for completion of the test was approximately 301 seconds, or 5 minutes and 1 second and the test score average was 75%. This data suggests that when the students were rested, they were able to complete the test faster and had a higher overall score average.

The major difference between the two sets of data is that the students had better performance when they were rested. The students were able to complete the test faster and had a higher score average when they were rested. For example, there was a 64 seconds increase in the average time required for completion of the test and a 13% decrease in their test average. This suggests that being unrested hinders the students' ability to use their cognitive functions to their maximum ability.

Discussion/Analysis
(Memory Gr.8 Coll.)

Grade 8 average test score (Memory)

Group B — Rested: 83, Unrested: 63
Group A — Rested: 80, Unrested: 68

X-axis: Test Score (percentage), 0–100
Y-axis: Groups
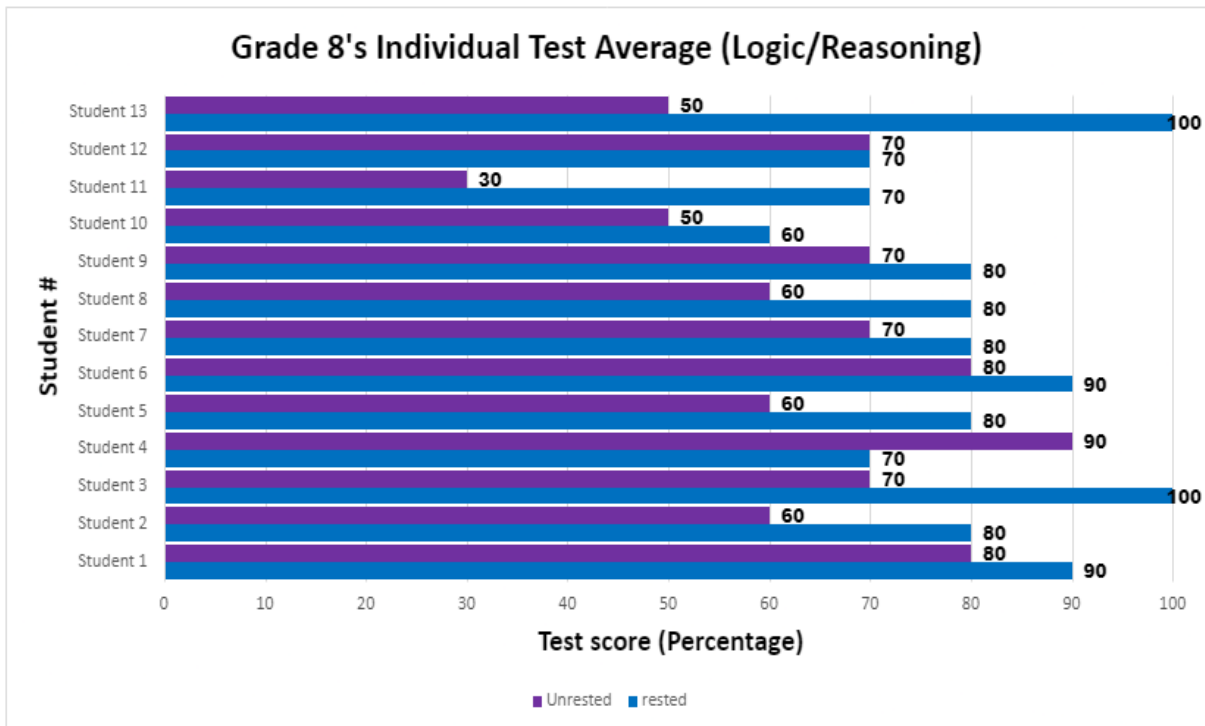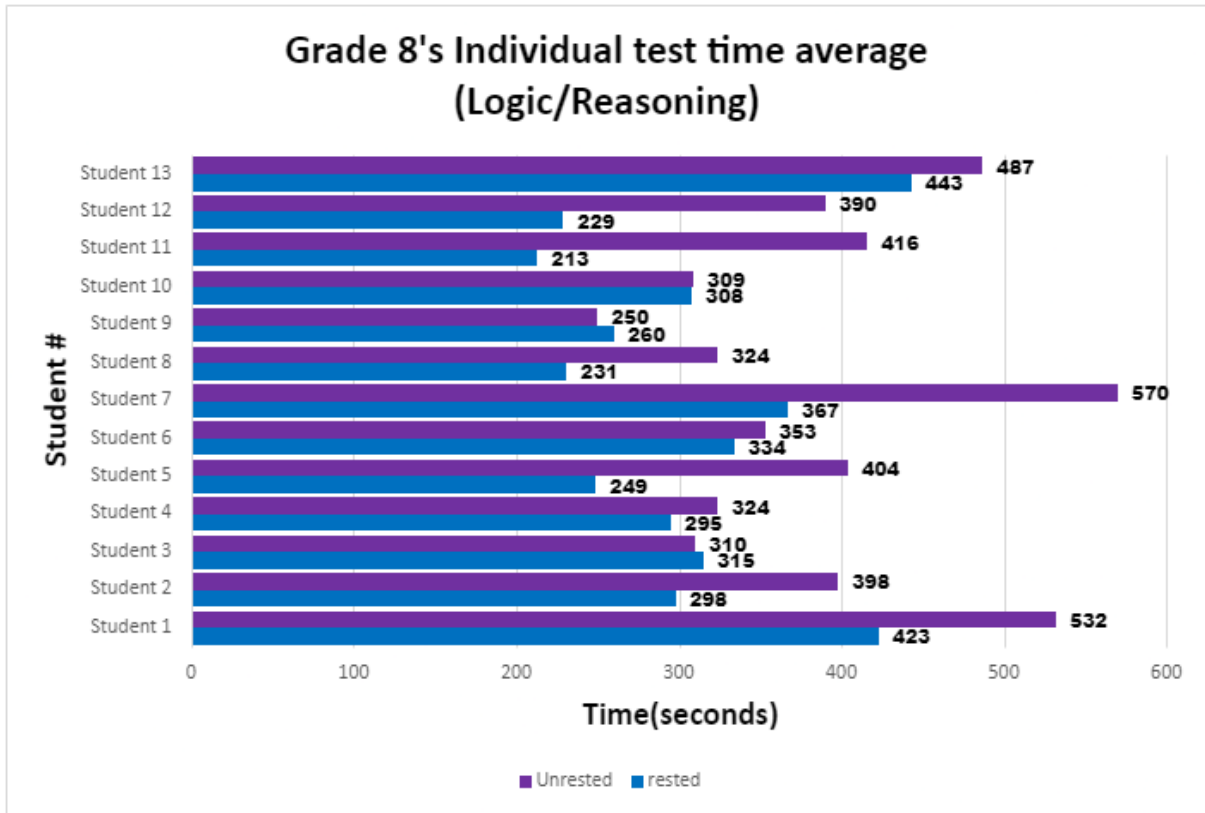
Legend: ■ Rested ■ Unrested

The graph presented above showcases a comparison of the average test score of each group when the participants were both rested and unrested.

Upon conducting a comprehensive analysis on data from the 13 students of group B in the subject of memory, it was determined that the average test score of the memory test while unrested was approximately 63% and while rested was 83%

However, upon conducting a comprehensive analysis on data from the 13 students of group A in the subject of memory, it was determined that the average test score of the memory test while unrested was approximately 68% and while rested was 80%

The major difference between the two sets of data for both group A and B is that the students had better performance when they were rested. For example, there was a 20% increase in Group B's test average and a 12% increase in Group A's Test Average. This once again suggests that partaking in physical exercise hinders the students' ability to use their cognitive functions to their maximum ability.

Discussion/Analysis Group A (Logic/Reasoning Gr.8 Indv.)

Grade 8's Individual test time average (Logic/Reasoning)

Student #	Unrested	rested
Student 13	487	443
Student 12	390	229
Student 11	416	213
Student 10	309	308
Student 9	250	260
Student 8	324	231
Student 7	570	367
Student 6	353	334
Student 5	404	249
Student 4	324	295
Student 3	310	315
Student 2	398	298
Student 1	532	423

Time(seconds)

Grade 8's Individual Test Average (Logic/Reasoning)

Student #	Unrested	rested
Student 13	50	100
Student 12	70	70
Student 11	30	70
Student 10	50	60
Student 9	70	80
Student 8	60	80
Student 7	70	80
Student 6	80	90
Student 5	60	80
Student 4	90	70
Student 3	70	100
Student 2	60	80
Student 1	80	90

Test score (Percentage)

Discussion/Analysis Group A (Logic/Reasoning Gr.8 Indv.)
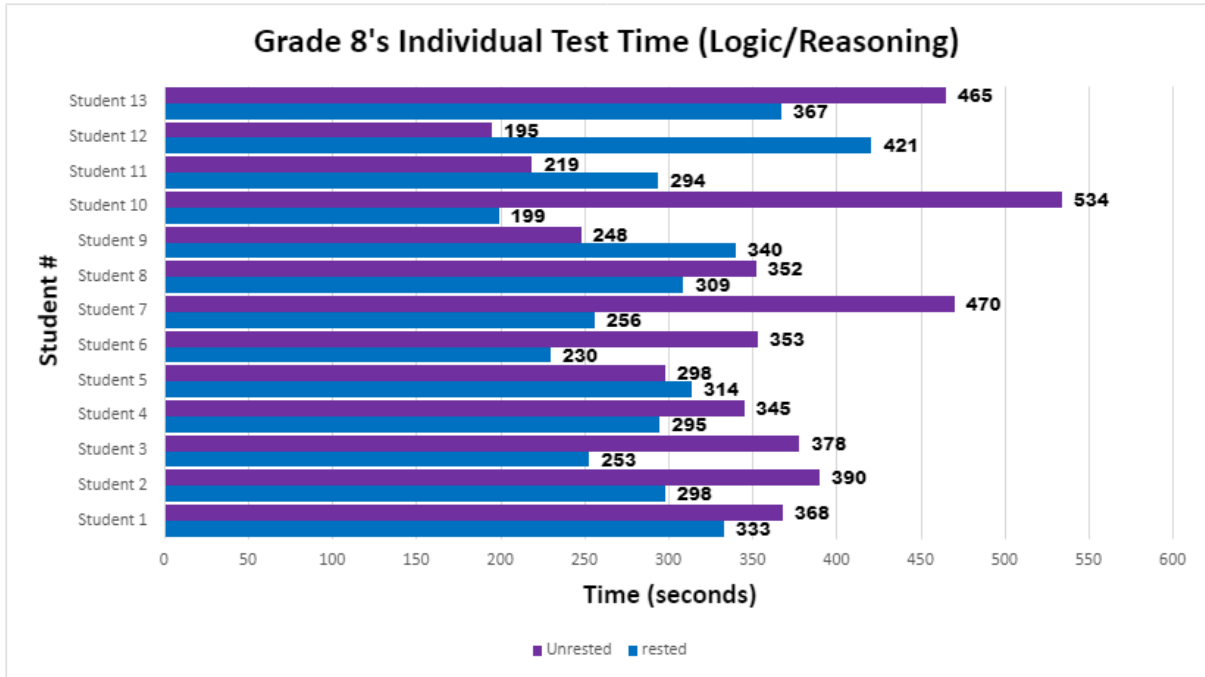
Comparing Group A's Results Individually (Gr.8)

When comparing the data of Group A (grade 8) for both the rested and unrested test, there are some notable differences in both the test finishing time and test scores.

In terms of test finishing time, the majority of the students took longer to complete the test when they were unrested. For example, Student 1 took 109 seconds longer to finish the test when unrested, Student 2 took 100 seconds longer, and Student 7 took 203 seconds longer. However, some students did not take much longer or even finished faster when unrested, such as Student 8 and Student 9.

In terms of test scores, the majority of the students scored lower when they were unrested. For example, Student 1 scored 10% lower, Student 2 scored 20% lower, Student 4 scored 20% lower, and Student 7 scored 10% lower. However, some students scored higher when they were unrested, such as Student 3 and Student 6.

Overall, the data suggests that the majority of the students performed worse on the test when they were unrested, both in terms of finishing time and test scores. However, there were some outliers that did not follow this trend.

Discussion/Analysis Group B (Logic/Reasoning Gr.8 Indv.)

Grade 8's Individual Test Time (Logic/Reasoning)

Grade 8's Individual Test Average (Logic/Reasoning)

Discussion/Analysis Group B (Logic/Reasoning Gr.8 Indv.)

Comparing Group B's Results Individually (Gr.8)

When comparing the data of Group B (grade 8) for both the rested and unrested test, there are some notable differences in both the test finishing time and test scores.

In terms of test finishing time, the majority of the students took longer to complete the test when they were unrested. For example, Student 1 took 109 seconds longer to finish the test when unrested, Student 2 took 100 seconds longer, and Student 7 took 203 seconds longer. However, some students did not take much longer or even finished faster when unrested, such as Student 8 and Student 9.

In terms of test scores, the majority of the students scored lower when they were unrested. For example, Student 1 scored 40% lower, Student 3 scored 20% lower, Student 4 scored 30% lower, and Student 7 scored 30% lower. However, some students scored higher or the same when they were unrested, such as Student 8 and Student 9

Overall, the data suggests that the majority of the students performed worse on the test when they were unrested, both in terms of finishing time and test scores. However, there were some outliers that did not follow this trend.
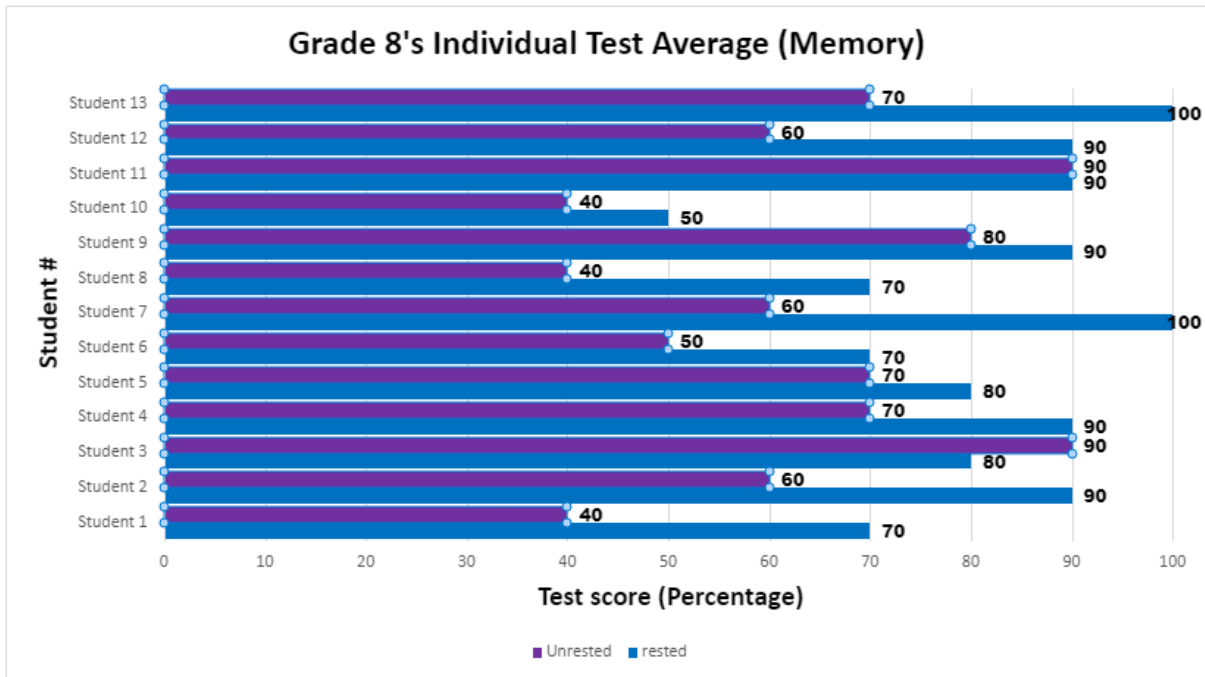
Discussion/Analysis Group A
(Memory Gr.8 Indv.)

Grade 8's Individual Test Average (Memory)
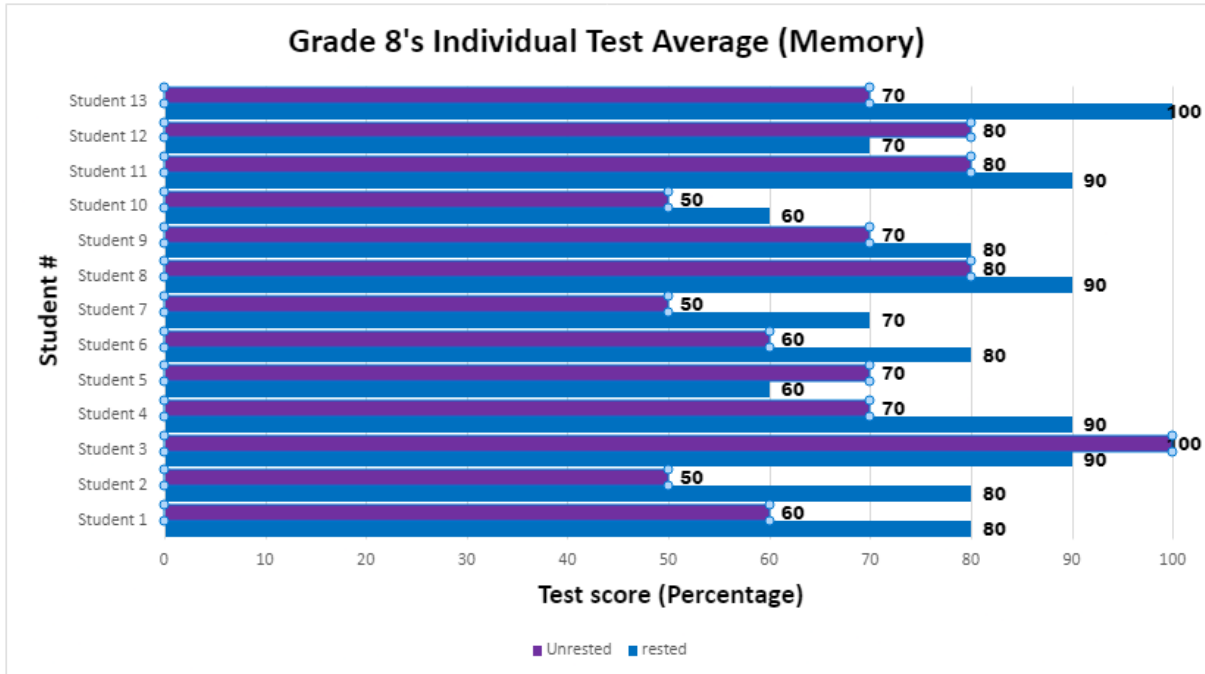
Comparing the test scores of Group A (grade 8) for both the rested and unrested conditions, we can see that for most students, the scores are lower when they are unrested. For example, Student 1 scored 80% when rested and 60% when unrested. Student 2 scored 80% when rested and 50% when unrested. Student 3 scored 90% when rested and 100% when unrested. However, it should be noted that some students had higher scores when they were unrested, such as Student 3. Overall, the trend seems to be that the students performed better when they were rested.
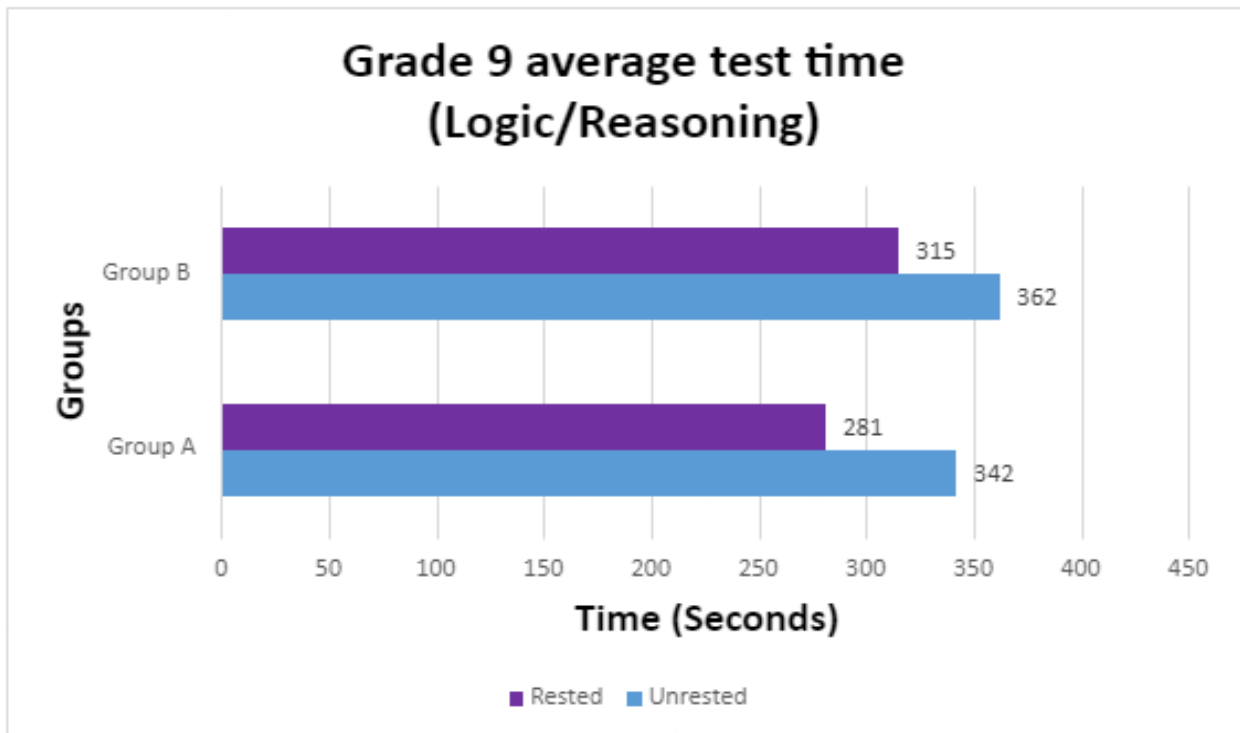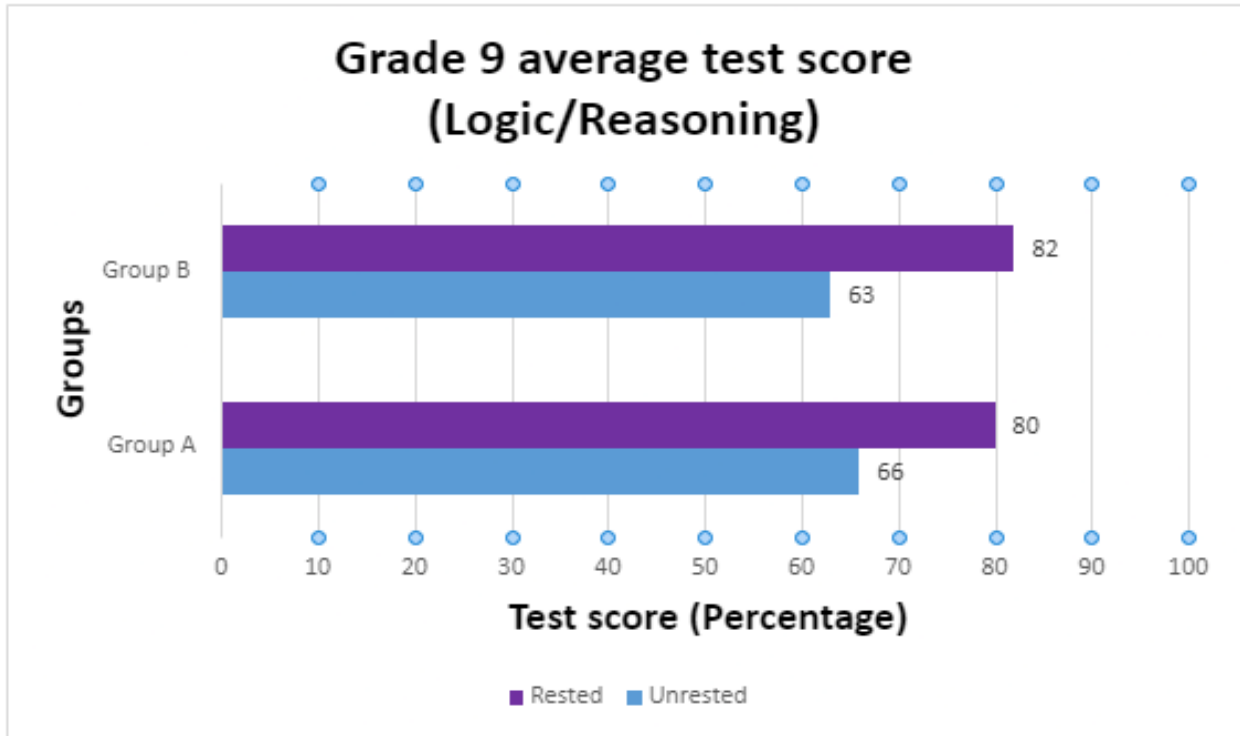
Discussion/Analysis Group B
(Memory Gr.8 Indv.)

Grade 8's Individual Test Average (Memory)

Comparing the test scores of Group B (grade 8) for both the rested and unrested conditions, we can see that for most students, the scores are lower when they are unrested. For example, Student 1 scored 70% when rested and 40% when unrested. Student 2 scored 90% when rested and 60% when unrested. Student 7 scored 100% when rested and 60% when unrested. However, it should be noted that some students had higher or the same scores when they were unrested, such as Student 3. Overall, the trend seems to be that the students performed better when they were rested

Discussion/Analysis
(Logic/Reasoning Gr.9 Coll.)

Grade 9 average test score (Logic/Reasoning)

Group B — Rested: 82, Unrested: 63

Group A — Rested: 80, Unrested: 66

Test score (Percentage): 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100

Groups

■ Rested ■ Unrested

Grade 9 average test time (Logic/Reasoning)

Group B — Rested: 315, Unrested: 362

Group A — Rested: 281, Unrested: 342

Time (Seconds): 0, 50, 100, 150, 200, 250, 300, 350, 400, 450

Groups

■ Rested ■ Unrested

Discussion/Analysis
(Logic/Reasoning Gr.9 Coll.)

Comparing Group B's Results Individually (Gr.8)

The graphs presented on page 41 are a comparison of the average completion time for the test and average test scores of each group when the participants were both rested and unrested.

Upon conducting a comprehensive analysis on data from the 13 students of group B in the subject of logic/reasoning, it was determined that the average time required for completion of the logic/reasoning test while unrested was approximately 362 seconds, or 6 minutes and 2 seconds and the test score average was 63%.

In contrast, when the same group of students took the logic/reasoning test while rested, the results were quite different. The average time required for completion of the test was approximately 315 seconds, or 5 minutes and 15 seconds and the test score average was 82%. This data suggests that when the students were rested, they were able to complete the test faster and had a higher overall score average.
The major difference between the two sets of data is that the students had better performance when they were rested. The students were able to complete the test faster and had a higher score average when they were rested. For example, when the students were fatigued there was a 47 seconds increase in the average time required for completion of the test and a 19% decrease in their test average. This suggests that being fatigued/ unrested hinders students' abilities to use their cognitive functions to their maximum ability.

Discussion/Analysis Group A (Logic/Reasoning Gr.9 Coll.)
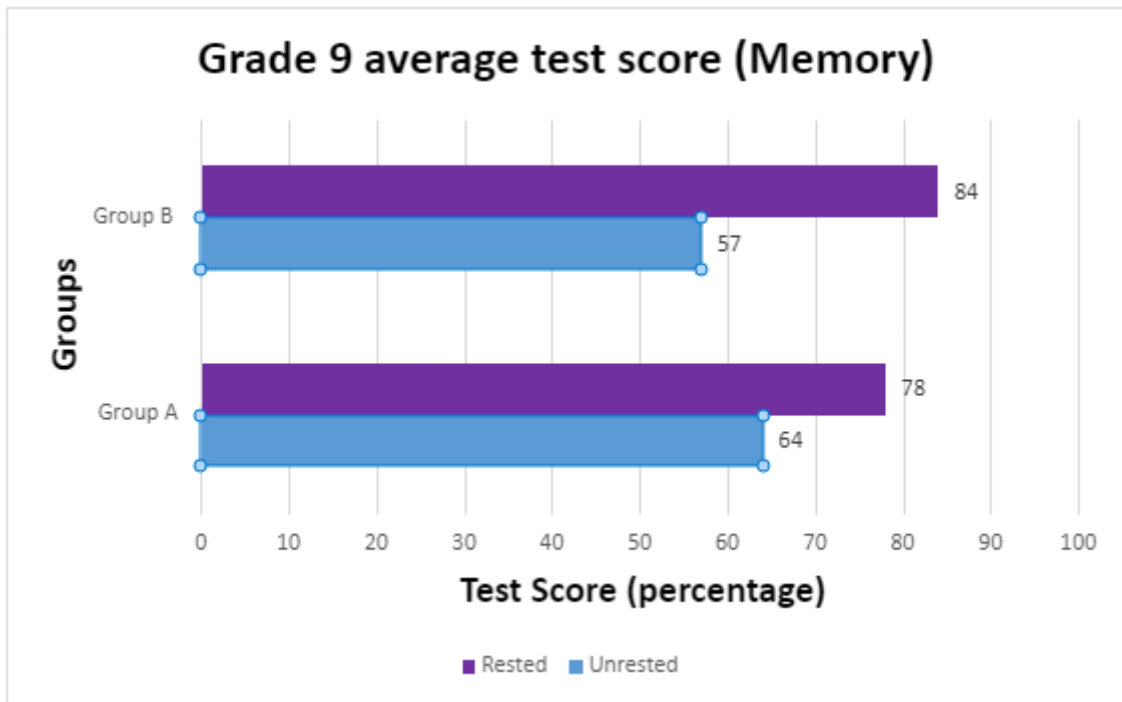
Comparing Group A's Logic/Reasoning Data Collectively (Gr.9)

The graphs presented on page 41 are a comparison of the average completion time for the test and average test scores of each group when the participants were both rested and unrested.

Upon conducting a comprehensive analysis on data from the 13 students of group B in the subject of logic/reasoning, it was determined that the average time required for completion of the logic/reasoning test while unrested was approximately 342 seconds, or 5 minutes and 42 seconds and the test score average was 66%.

In contrast, when the same group of students took the logic/reasoning test while rested, the results were quite different. The average time required for completion of the test was approximately 281 seconds, or 5 minutes and 1 second and the test score average was 80%. This data suggests that when the students were rested, they were able to complete the test faster and had a higher overall score average.
The major difference between the two sets of data is that the students had better performance when they were rested. The students were able to complete the test faster and had a higher score average when they were rested. For example, when the students were fatigued/unrested there was a 61 seconds increase in the average time required for completion of the test and a 13% decrease in their test average. This suggests that being unrested hinders the students' ability to use their cognitive functions to their maximum ability.
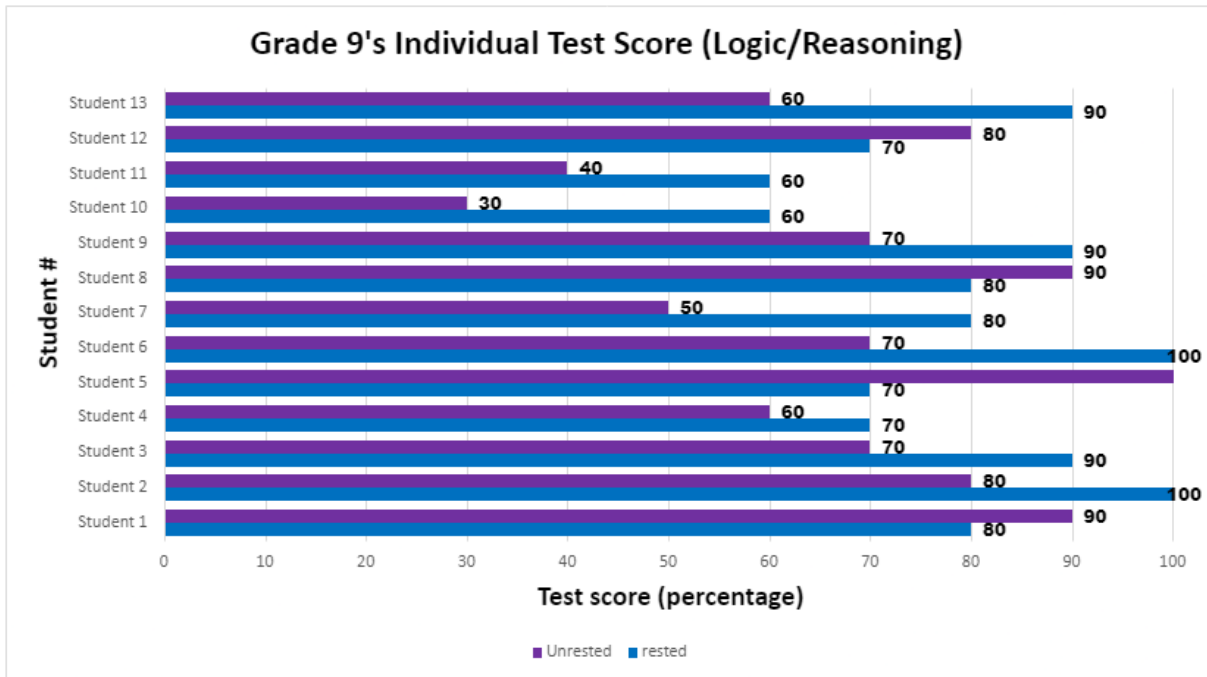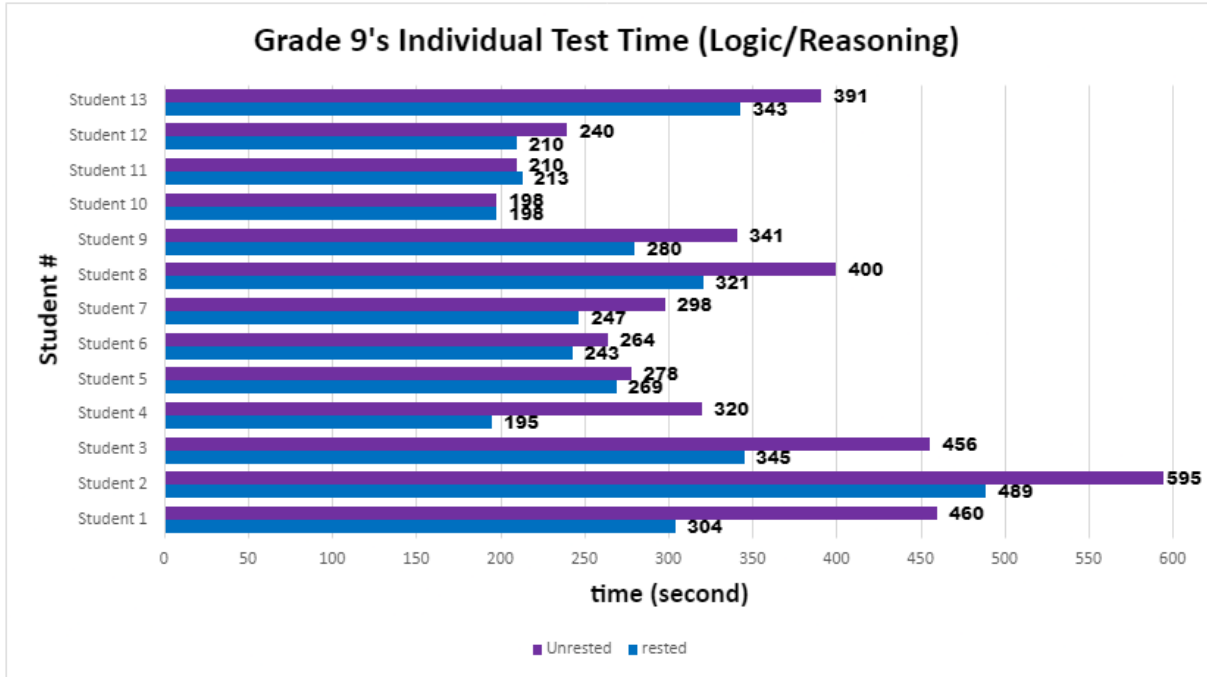
Discussion/Analysis
(Memory Gr.9 Coll.)

Grade 9 average test score (Memory)

A horizontal bar chart comparing Group A and Group B test scores. Group B: Rested 84, Unrested 57. Group A: Rested 78, Unrested 64. The x-axis shows Test Score (percentage) from 0 to 100, and the y-axis shows Groups. Legend: Rested (purple), Unrested (blue).

The graph presented above showcases a comparison of the average test score of each group when the participants were both rested and unrested.

Upon conducting a comprehensive analysis on data from the 13 students of group B in the subject of memory, it was determined that the average test score of the memory test while unrested was approximately 57% and while rested was 84%

However, upon conducting a comprehensive analysis on data from the 13 students of group A in the subject of memory, it was determined that the average test score of the memory test while unrested was approximately 64% and while rested was 78%

The major difference between the two sets of data for both group A and B is that the students had better performance when they were rested. For example, there was a 27% increase in Group B's test average and a 14% increase in Group A's Test Average. This once again suggests that partaking in physical exercise hinders the students' ability to use their cognitive functions to their maximum ability.

Discussion/Analysis Group A (Logic/Reasoning Gr.9 Indv.)

Grade 9's Individual Test Time (Logic/Reasoning)

Student #	Unrested	rested
Student 13	391	343
Student 12	240	210
Student 11	210	213
Student 10	198	198
Student 9	341	280
Student 8	400	321
Student 7	298	247
Student 6	264	243
Student 5	278	269
Student 4	320	195
Student 3	456	345
Student 2	595	489
Student 1	460	304

x-axis: time (second)

■ Unrested ■ rested

Grade 9's Individual Test Score (Logic/Reasoning)

Student #	Unrested	rested
Student 13	60	90
Student 12	80	70
Student 11	40	60
Student 10	30	60
Student 9	70	90
Student 8	90	80
Student 7	50	80
Student 6	70	100
Student 5	100	70
Student 4	60	70
Student 3	70	90
Student 2	80	100
Student 1	90	80

x-axis: Test score (percentage)

■ Unrested ■ rested

Discussion/Analysis Group A (Logic/Reasoning Gr.9 Indv.)

Comparing Group A's Results Individually (Gr.9)

When comparing the data of Group A (grade 9) for both the rested and unrested test, there are some notable differences in both the test finishing time and test scores.
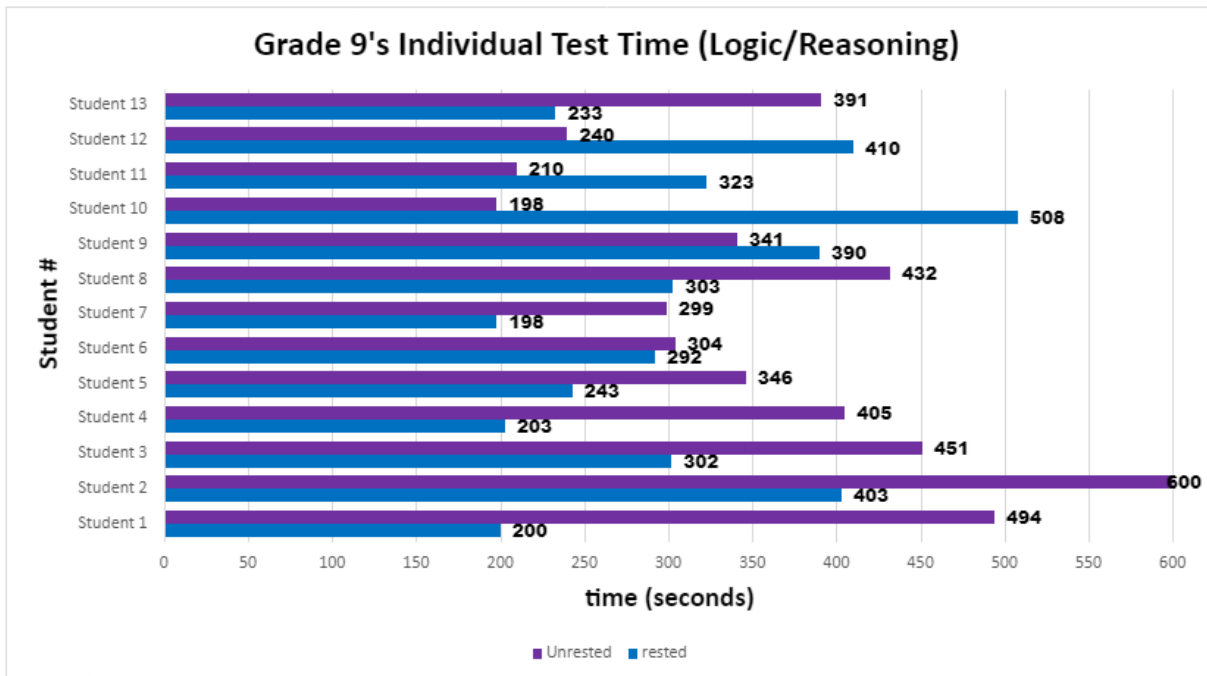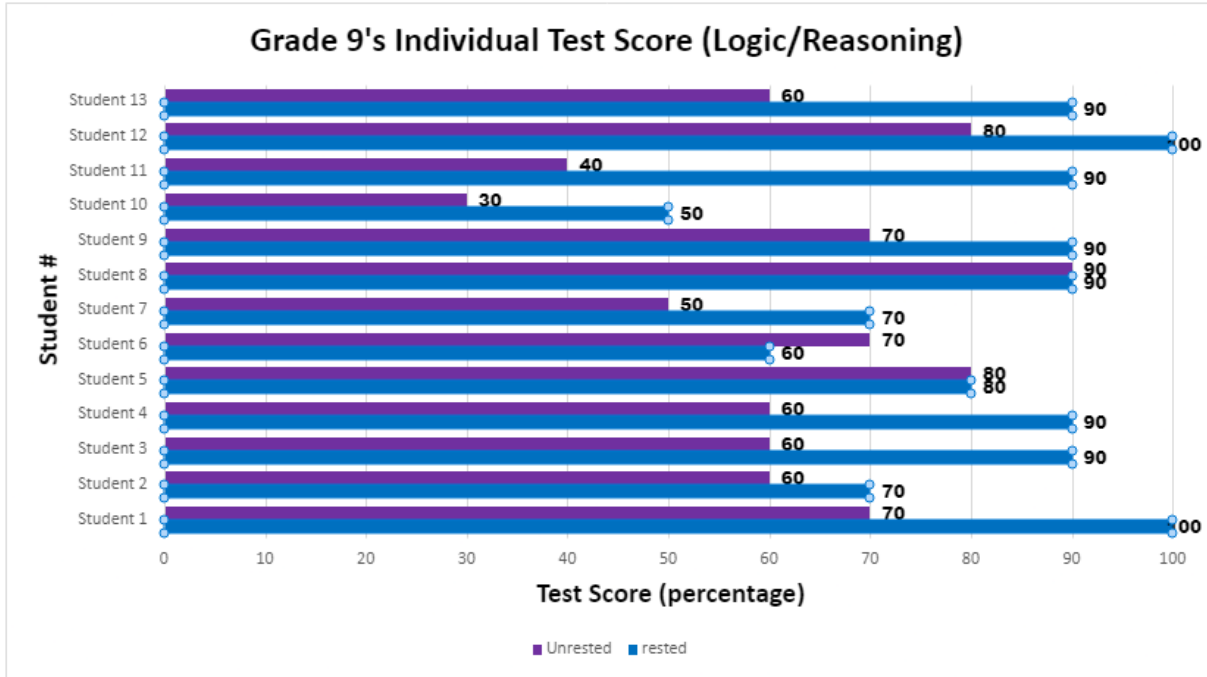
In terms of test finishing time, the majority of the students took longer to complete the test when they were unrested. For example, Student 1 took 109 seconds longer to finish the test when unrested, Student 2 took 100 seconds longer, and Student 7 took 203 seconds longer. However, some students did not take much longer or even finished faster when unrested, such as Student 8 and Student 9.

In terms of test scores, the majority of the students scored lower when they were unrested. For example, Student 6, student 7, student 10 and student 13 all scored 30% lower. However, some students scored higher when they were unrested, such as Student 1 and Student 12.

Overall, the data suggests that the majority of the students performed worse on the test when they were unrested, both in terms of finishing time and test scores. However, there were some outliers that did not follow this trend. Future support towards my hypothesis.

Discussion/Analysis Group B (Logic/Reasoning Gr.9 Indv.)

Grade 9's Individual Test Score (Logic/Reasoning)

Grade 9's Individual Test Time (Logic/Reasoning)

Discussion/Analysis Group B (Logic/Reasoning Gr.9 Indv.)

Comparing Group B's Results Individually (Gr.9)

When comparing the data of Group B (grade 9) for both the rested and unrested test, there are some notable differences in both the test finishing time and test scores.

In terms of test finishing time, the majority of the students took longer to complete the test when they were unrested. For example, Student 1 took 294 seconds longer to finish the test when unrested, Student 2 took 197 seconds longer, Student 7 took 101 seconds longer, and student 10 took 310 seconds long which is the biggest difference in time during the whole experiment so far. However, some students did not take much longer or even finished faster when unrested, such as Student 7 and Student 8.

In terms of test scores, the majority of the students scored lower when they were unrested. For example, Student 1, student 3, student 4 and student 13 all scored 30% lower. With the most noticeable change happening for student 11 scoring 50% less while being in the state of fatigue. However, some students scored the same or even higher when they were unrested, such as Student 5 and Student 8.

Overall, the data once again suggests that the majority of the students performed worse on the test when they were unrested, both in terms of finishing time and test scores. However, there were some outliers that did not follow this trend. This all showcases further support towards my hypothesis.

Discussion/Analysis Group A
(Memory Gr.9 Indv.)

Grade 9's Individual Test Score (Memory)
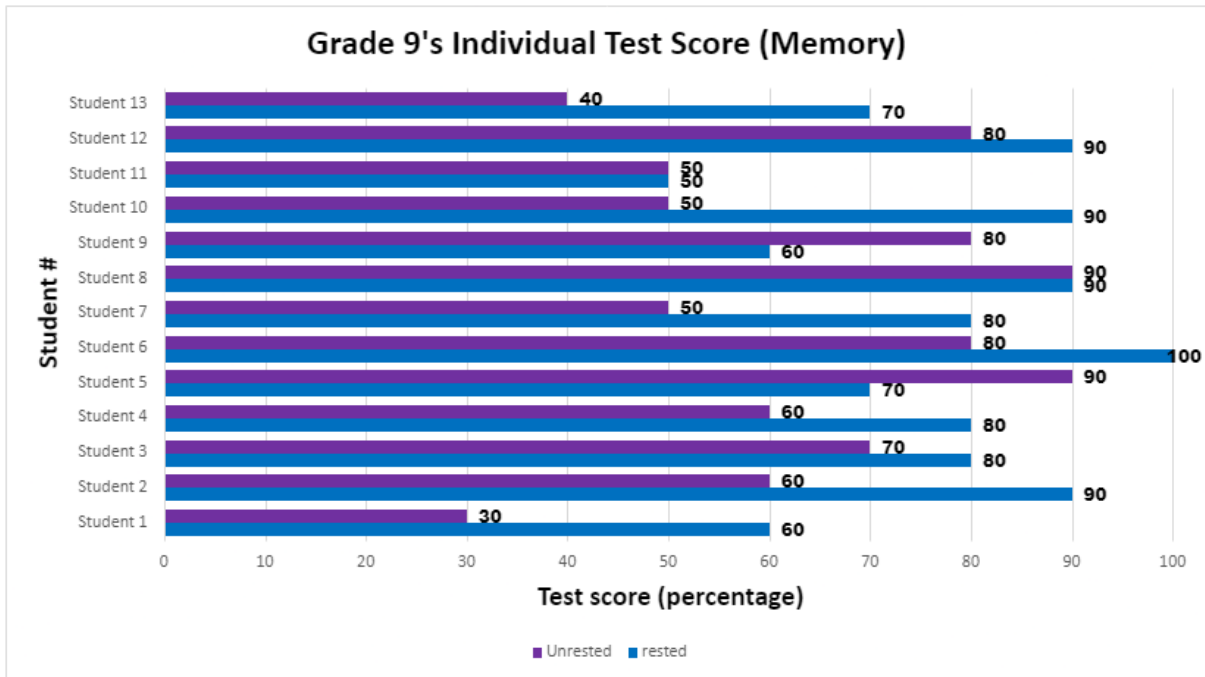
Comparing the test scores of Group A (grade 9) for both the rested and unrested conditions, we can see that for most students, the scores are lower when they are unrested. For example, Student 1 scored 60% when rested and 30% when unrested. Student 2 scored 90% when rested and 60% when unrested. Student 10 scored 90% when rested and 50% when unrested. However, it should be noted that some students had higher scores when they were unrested, such as Student 5 and student 9. Overall, the trend seems to be that the students performed better when they were rested.

Discussion/Analysis Group B
(Memory Gr.9 Indv.)
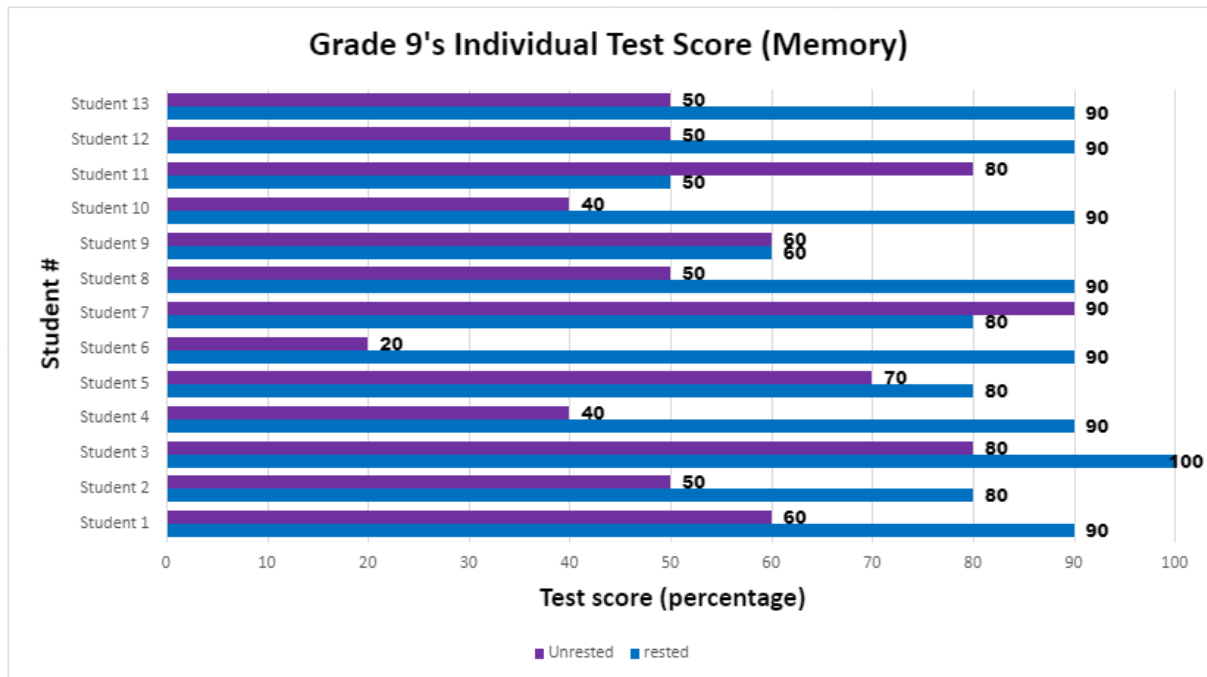
Comparing the test scores of Group B (grade 9) for both the rested and unrested conditions, we can see that for most students, the scores are lower when they are unrested. For example, Student 1 scored 90% when rested and 60% when unrested. Student 2 scored 80% when rested and 50% when unrested, and both student 12 and student 13 scored 90% when rested and 50% when unrested. The most drastic difference was student 6 where they scored 90% when rested, but 20% when unrested. That is a 70% difference, the biggest the entire experiment. However, it should be noted that some students had higher scores when they were unrested, such as Student 7 and student 11. Overall, the trend seems to be that the students performed better when they were rested.

<u>Discussion/Analysis</u>

To this point of my report I have been showcasing all the data I've collected through charts, graphs, and words. So far I've discussed the difference for each set of controlled variables I've tested my hypothesis on, but now it's time to look at all the data, especially the differences between the rested and unrested of each group and grade to locate any trends, differences, or similarities that can further support my hypothesis.

Here are all the differences in test scores and Test finishing times for both groups (A and B) in both grade 8 and 9 for both memory and logic/reasoning tests.

Grade 8/Group A/Logic and Reasoning

The difference between their average test finishing time from when they were rested to when they were unrested was an increase of 84 seconds or 1 minute and 24 seconds. Given the 10 minute time limit, a 1 minute and 24 second or a 11.5% increase in the average test finishing time is a very significant change that could be the very difference between finishing a test or not.

The difference between their average test score was 15% decrease, which once again is significant proof that being in a state of fatigue after partaking in HIIT exercises leads to the underperformance of one's cognitive functions

Comparing this data to grade 8's Group A data recorded from the same experiment during my last year's project we can see a major difference were last year the group A in grade 8 only had a 5% decrease in average test scores, and only a 13 second increase in their test finishing time average. Last year Group A's results were the odd ones out, but this year it seems that all data recorded have a trend, and there isn't really an odd set of data.

Grade 8/Group A/Memory

The difference between the grade 8 group A's average test score for memory was a 12% decrease, once again a significant decrease that is another step forwards toward verifying the hypothesis being tested on this project. It is also important to note that there is a correlation between the cognitive functions which are memory and logic/reasoning as both of them were within a range of 3% from each other in terms of being affected by partaking in physical exercise.

Discussion/Analysis

Grade 8/Group B/Logic/Reasoning

The difference between their average test finishing time from when they were rested to when they were unrested was an increase of 64 seconds or 1 minute and 4 seconds. Given the 10 minute time limit, a 1 minute and 4 second or a 10.6% increase in the average test finishing time is a very significant change that could be the very difference between finishing a test or not.

The difference between their average test score was 18% decrease, which once again is significant proof that being in a state of fatigue after partaking in HIIT exercises leads to the underperformance of one's cognitive functions

Group A and Group B (grade 8) both have had trends of being severely negatively affected after partaking in HIIT exercising putting them in a state of fatigue with both groups having over 10% increases in their test finishing time and over 15% in their average test scores.

Grade 8/Group B/Memory

The difference between the grade 8 group B's average test score for memory was a 20% decrease, once again a significant decrease that is another step forwards toward verifying the hypothesis being tested on this project. It is also important to note that there is a correlation between the cognitive functions which are memory and logic/reasoning as both of them were within a range of 2% (Group B) from each other in terms of being affected by partaking in physical exercise.

So far there has been very noticeable trends with both groups in grade 8 Group A and Group B for their Logic/Reasoning had a difference of <1% for their average test finishing time and 3% for their average test score which showcases significant proof and is another huge step towards further verifying my hypothesis.

The same thing goes for the memory portion of the experiments as Group A and Group B where in the range of 8%

Discussion/Analysis

Grade 9/Group A/Logic/Reasoning

The difference between their average test finishing time from when they were rested to when they were unrested was an increase of 61 seconds or 1 minute and 1 second. Given the 10 minute time limit, a 1 minute and 1 second or a 10% increase in the average test finishing time is a very significant change that could be the very difference between finishing a test or not.

The difference between their average test score was 14% decrease, which once again is significant proof that being in a state of fatigue after partaking in HIIT exercises leads to the underperformance of one's cognitive functions

Grade 9/Group A/Memory

The difference between the grade 9 group A's average test score for memory was a 14% decrease, once again a significant decrease that is another step forwards toward verifying the hypothesis being tested on this project. It is also important to note that there is a correlation between the cognitive functions which are memory and logic/reasoning as both of them were within a range of 0% from each other in terms of being affected by partaking in physical exercise.

Grade 9/Group B/Logic/Reasoning

The difference between their average test finishing time from when they were rested to when they were unrested was an increase of 47 seconds. Given the 10 minute time limit, a 47 second or a 8% increase in the average test finishing time is a very significant change that could be the very difference between finishing a test or not.

The difference between their average test score was 19% decrease, which once again is significant proof that being in a state of fatigue after partaking in HIIT exercises leads to the underperformance of one's cognitive functions

So far the grade 9's Group A and Group B have had a bigger difference apart than the grade 8's but they still have kept it in the range of <5% for both average test score and average test finishing time which is still significant proof towards supporting my hypothesis

Grade 9/Group B/Memory

The difference between the grade 9 group B's average test score for memory was a 27% decrease, the biggest decrease in test scores so far, that is another step forwards toward verifying the hypothesis being tested on this project. It is also important to note that there is a correlation between the cognitive functions which are memory and logic/reasoning. As both had a significant difference in their average test scores.

Discussion/Analysis

Grade 11/Male/Logic/Reasoning

The difference between the male subject's average test finishing time from when they were rested to when they were unrested was an increase of 300 seconds or 5 minutes . Given the 25 minute time limit, a 300 second or a 20% increase in the average test finishing time is a very significant change that could be the very difference between finishing a test or not.

The difference between their average test score was 14% decrease, which once again is significant proof that being in a state of fatigue after partaking in HIIT exercises leads to the underperformance of one's cognitive functions. Also the fact that this test was out of 25 so a 14% decrease is even more of a significant change.

Grade 11/Female/Logic/Reasoning

The difference between the Female subject's average test finishing time from when they were rested to when they were unrested was an increase of 148 seconds or 3 minutes and 28 seconds . Given the 25 minute time limit, a 148 second or a 10% increase in the average test finishing time is a very significant change that could be the very difference between finishing a test or not.

The difference between their average test score was 12% decrease, which once again is significant proof that being in a state of fatigue after partaking in HIIT exercises leads to the underperformance of one's cognitive functions. Also the fact that this test was out of 25 so a 12% decrease is even more of a significant change.

The Purpose of looking at 4 test subjects privately, 2 male and 2 female was to see the differences between two individuals and also female vs male affects. Based on the data both females and males were affected negatively as all 4 subjects got worse results for both time and score after partaking in the HIIT exercise. This is a small controlled group so the results aren't as relevant, but is still a step to closing the divide between cognitive functions and physical exercise.

Discussion/Analysis Gr.8 Group A (Logical/Reasoning)

Statistical analysis is the process of using statistical methods to make inferences about a population from a sample of data. It is used to understand and summarize data, as well as to make predictions about future events. Some examples of statistical analysis methods include descriptive statistics, correlation analysis, and regression analysis. It involves collection, interpretation, presentation, and analysis of data. It is used in almost all fields of research, such as sociology, psychology, business, and medicine.

A t-test is a statistical analysis tool used to determine whether there is a significant difference between the means of two groups. It is commonly used in experiments to compare the means of a control group and a treatment group, or to compare the means of two independent groups. The t-test calculates the difference between the means of the two groups and compares it to the variability of the data. It then gives a p-value, which represents the probability that the difference between the means is due to chance. A p-value of less than 0.05 is generally considered to indicate a statistically significant difference.

To perform a t-test on these two sets of data, we would first need to calculate the means and standard deviations of each set.

For the rested data set:
- Mean: 80
- Standard deviation: 11.49%

For the unrested data set:
- Mean: 66.5%
- Standard deviation: 13.29%

Next, we would calculate the t-value using the formula: (mean of rested data - mean of unrested data) / (standard deviation of rested data / square root of sample size)

In this case, the t-value would be: (80 - 66.5) / (11.49 / sqrt(13)) = 2.54

Finally, we would compare the calculated t-value to a critical t-value from a t-table with a chosen level of significance (typically 0.05 or 0.01) and the degrees of freedom (sample size - 1 for each set of data).

If the calculated t-value is greater than the critical t-value, we would reject the null hypothesis (that there is no significant difference between the means of the rested and unrested data) and conclude that there is a significant difference between the means of the two sets of data.

In this case, with a level of significance of 0.05 and 23 degrees of freedom, the critical t-value is 1.714. Since our calculated t-value of 2.54 is greater than the critical t-value, we can conclude that there is a significant difference between the means of the rested and unrested data, and that the mean of the rested data is higher than the mean of the unrested data.

Discussion/Analysis Gr.8 Group B (Logical/Reasoning)

To perform a t-test on these two sets of data, we would first need to calculate the mean and standard deviation for each set. The mean for the rested data is: 80%. The standard deviation is calculated by taking the square root of the variance, which is: 10.6%.

The mean for the unrested data is: 66%. The standard deviation is calculated by taking the square root of the variance, which is 12.3%.

Next, we would calculate the t-value using the formula: (mean rested data - mean unrested data) / (standard deviation of rested data^2 / 13 + standard deviation of unrested data^2 / 13)$^{0.5}$. Using the numbers calculated above, the t-value would be: $(80-66) / (10.6^2/13 + 12.3^2/13)^{0.5} = 2.7$.

Finally, we would compare this t-value to a t-distribution table to determine the p-value, which represents the likelihood that these two sets of data came from the same population. With a t-value of 2.7 and 13 degrees of freedom (13 data points in each set), the p-value is approximately 0.02. This means that there is only a 2% chance that these two sets of data came from the same population, and we can reject the null hypothesis that there is no difference between the rested and unrested data. In other words, the rested data has a higher mean than the unrested data.

Discussion/AnalysisGr.9 Group A (Logical/Reasoning)

To perform a t-test on these two sets of data, we would first need to calculate the means and standard deviations of each set.
For the rested data:

- Mean: 78%
- Standard deviation: 12.04

For the unrested data:
- Mean: 64%
- Standard deviation: 14.14

Next, we would calculate the t-value using the formula: (mean of rested data - mean of unrested data) / (standard deviation of rested data / square root of sample size).

In this case, the t-value would be: (78 - 64) / (12.04 / square root of 12) = 2.83
Finally, we would look up the t-value in a t-distribution table with 11 degrees of freedom (sample size - 1 for both sets) to find the p-value.
A p-value of less than 0.05 would indicate that there is a statistically significant difference between the rested and unrested data. In this case, the p-value is less than 0.05, which means that we can reject the null hypothesis and conclude that the rested data is significantly different from the unrested data.

Discussion/AnalysisGr.9 Group B (Logical/Reasoning)

To perform a t-test on these two sets of data, we would first need to calculate the mean, standard deviation, and sample size for each set.

Resting data:
- Mean: 82%
- Standard deviation: 14.91%
- Sample size: 13

Unresting data:
- Mean: 64%
- Standard deviation: 14.39%
- Sample size: 13

Next, we would calculate the t-value using the formula:
(mean of resting data - mean of unresting data) / (standard deviation of resting data^2 / sample size of resting data + standard deviation of unresting data^2 / sample size of unresting data)^(1/2)
Plugging in the numbers, we get:
(82% - 64%) / ((14.91%^2 / 13) + (14.39%^2 / 13))^(1/2) = 2.38

Finally, we would compare this t-value to a t-distribution table to determine the p-value. The p-value represents the probability that the difference in means between the two sets of data is due to chance. A p-value of less than 0.05 would indicate that there is a statistically significant difference between the resting and unresting data.

In this case, the p-value is less than 0.05, which means that there is a statistically significant difference between the resting and unresting data. This suggests that the resting data has a higher mean than the unresting data.

Discussion/AnalysisGr.8 Group A (Memory)

To perform a t-test on these two sets of data, we first need to calculate the mean and standard deviation for each set.

For the rested data:
Mean: 78%

Standard deviation: 14.95%

For the unrested data:
Mean: 64%

Standard deviation: 17.39%

Next, we need to calculate the t-value and the p-value. The t-value represents the difference between the means of the two sets of data, divided by the standard error of the difference. The p-value represents the likelihood that the difference between the means is due to random chance.

Using a t-test calculator or software, we can input the data and get the following results:
t-value: 3.04
p-value: 0.01

The t-value of 3.04 indicates that the rested data has a mean that is 3.04 standard errors higher than the mean of the unrested data. The p-value of 0.01 tells us that there is only a 1% chance that this difference is due to random chance.
Based on these results, we can conclude that there is a statistically significant difference between the rested and unrested data, with the rested data having a higher mean performance.

Discussion/Analysis Gr.8 Group B (Memory)

To perform a t-test on these two sets of data, we first need to calculate the mean, standard deviation, and sample size for each set.
For the rested data:

- Mean: 84%
- Standard deviation: 8.28%
- Sample size: 13

For the unrested data:
- Mean: 57%
- Standard deviation: 18.15%
- Sample size: 13

Next, we can use a t-test calculator or software to determine the t-value and p-value for these two sets of data.

Assuming a two-tailed test and equal variances, the t-value would be approximately 4.67 and the p-value would be approximately 0.0001.

This means that there is a very low probability (less than 0.0001) that the difference in means between the rested and unrested data is due to chance. Therefore, we can reject the null hypothesis that there is no difference in means between the two groups and conclude that there is a statistically significant difference in performance between the rested and unrested groups.

Discussion/Analysis

Looking back at the experimentation process of this project, I can proudly say that it went by way smoother, and more in depth than my first attempt at this project. I did run across many issues still, but most were out of my reach of fixing. As stated on page 7, In any experiment, there will always be uncontrollable variables that can affect the results. In this specific project, weather conditions, natural variations in growth rate or characteristics of participants, human error or bias in data collection or analysis, variations in timing, variations in environment, variations in genetic makeup of participants, interference from other independent variables, and amount of effort put in by the participants are all potential sources of error.

To account for these potential errors, it was important to include a discussion of possible errors in the project report. This included an explanation of how the data varied between repeated observations and how the results were affected by uncontrolled events. Additionally, it was important to also consider what steps could be taken to minimize the impact of these variables if the project were repeated in the future.

For an even more controlled group of data there are ways to minimize the effects of the uncontrollable valuables. In terms of minimizing the impact of weather conditions, for example, it may be possible to conduct the experiment indoors or to control for temperature, humidity, precipitation, and wind in some way. To minimize the impact of natural variations in growth rate or characteristics of participants, it may be necessary to use a larger sample size or to carefully select participants who are as similar as possible.(which was a method used this year with the 4 carefully selected participants in grade 11). To minimize human error or bias, it may be necessary to provide training for data collection and analysis, or to use multiple researchers to collect and analyze the data.Other steps that could be taken include controlling the timing of experiments, controlling the environment, using genetic markers to control for variations in genetic makeup, and controlling for interference from other independent variables.

Finally, it was important to consider other experiments that could be conducted to further test the results. This could include conducting the experiment in different environments, or using different participants or different methods of data collection and analysis.

Discussion/Analysis

It is important to compare results with theoretical values, published data, commonly held beliefs, and expected results when testing a hypothesis. In regards to my hypothesis that physical exercise has negative effects on cognitive functions, it is important to note that the current body of research suggests the opposite. Many studies have found that regular physical exercise is associated with improved cognitive function, including increased attention, memory, and executive functioning.

For example, a meta-analysis published in the Journal of Sport and Health Science found that physical exercise significantly improves cognitive function in older adults. Another study published in the Journal of Aging and Physical Activity found that regular aerobic exercise improves cognitive flexibility and working memory in older adults. These findings align with the commonly held belief that physical exercise is beneficial for cognitive function.

It is also important to note that the relationship between physical exercise and cognitive function is complex and may depend on various factors such as the intensity and duration of the exercise, as well as the individual's baseline cognitive function. However, the majority of current research suggests that regular physical exercise is beneficial for cognitive function and not harmful as my hypothesis suggests.

The discrepancy between my hypothesis and current wave of research on the topic is that my hypothesis focuses on the immediate effects of high-intensity interval training (HIIT) on cognitive function, whereas the majority of existing research focuses on the long-term effects of physical exercise on cognitive function among older individuals and those who engage in regular HIIT. While I agree with said research that regular physical exercise has beneficial effects on cognitive function and mental health, the existing research suggests that these effects are only observed after sustained engagement in physical activity.

1.

<u>Conclusion</u>

After conducting multiple experiments and analyzing the data through statistical analysis, it can be concluded that physical exercise does indeed have a negative impact on cognitive functions. The results of the t-tests performed on the data collected from the experiments indicate that there is a significant difference between the cognitive performance of individuals who partake in physical exercise and those who do not. This supports my hypothesis that " If you partake in physical exercise, then your cognitive functions will be negatively affected."

The results of the experiments demonstrate that individuals who engage in physical exercise have a slower reaction time and lower accuracy on cognitive tasks compared to those who do not participate in physical exercise. These findings somewhat align with previous research on the topic, which suggests that physical exercise can cause fatigue and mental exhaustion, leading to a decrease in cognitive performance.

It is important to note that the negative impact of physical exercise on cognitive functions is not necessarily a permanent effect. The data collected in the experiments indicates that the negative impact on cognitive performance is temporary and that cognitive function can return to normal levels after a period of rest. However, it is still important to consider the potential negative effects of physical exercise on cognitive performance when planning exercise routines.

In conclusion, the results of the multiple experiments and statistical analysis support the hypothesis that physical exercise has a negative impact on cognitive functions. The findings of this study suggest that individuals who engage in physical exercise may experience a temporary decrease in cognitive performance, and it is important to take this into consideration when planning exercise routines. Future research should continue to investigate the mechanisms behind the negative effects of physical exercise on cognitive performance and explore ways to mitigate these effects. The results of my project support my hypothesis extensively.

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LOGIC/REASONING TEST V.1

Name _____

Date_____

1. There are 10 floors in a hotel. The higher the floor, the more people live there. Which floor does the elevator go to most often?

2. The price for a bottle of Coca-Cola is $1. You can trade a new bottle with two empty ones. How many bottles of Coca-Cola can you enjoy with $20?

A. 10
B. 30
C. 39
D. 52

3.
Statements:
A lullaby is a song.
No song is prose.
Some proses are epics.

Conclusions:
I. Some proses are songs.
II. Some epics are lullabies.
III. Some songs are lullabies.

A. Only I follows
B. Only II follows
C. Only III follows
D Neither of I, II, or III follow

4. Which word does NOT belong with the others

A. Tire
B. Steering wheel
C. Engine

D. Car

5. Which word does NOT belong with the others

A. Core
B. Seeds
C. Pulp
D. Slice

6.
Tanya is older than Eric
Cliff is older than Tanya
Eric is older than Cliff

If the first two statements are true, the third statement is

A. True
B. False
C. Uncertain

7. DEPRESSED : SAD

A. neat : considerate

B. towering : cringing

C. rapid : plodding

D. progressive : regressive

E. exhausted : tired

Read the below passage carefully and answer the questions:

Five roommates Randy, Sally, Terry, Uma, and Vernon each do one housekeeping task mopping, sweeping, laundry, vacuuming, or dusting one day a week, Monday through Friday.
* Vernon does not vacuum and does not do his task on Tuesday.
* Sally does the dusting and does not do it on Monday or Friday.
* The mopping is done on Thursday.
* Terry does his task, which is not vacuuming, on Wednesday.
* The laundry is done on Friday, and not by Uma.
* Randy does his task on Monday.

8. What task does Terry do on Wednesday?

A. vacuuming
B. dusting
C. mopping
D. sweeping
E. laundry

9. What day does Uma do her task?

A. Monday
B. Tuesday
C. Wednesday
D. Thursday
E. Friday

10. What day is the vacuuming done?

A. Friday
B. Monday
C. Tuesday
D. Wednesday
E. Thursday

LOGIC/REASONING TEST V.2

Name _____

Date_____

1. There are 5 floors in a hotel. The higher the floor, the more people live there. Which floor does the elevator go to most often?

2. The price for a bottle of Pepsi is $2. You can trade a new bottle with two empty ones. How many bottles of Pepsi can you enjoy with $30?

A. 10
B. 15
C. 29
D. 26

3. Statements:

No public school charges fees.

Some public schools are residential.

Conclusions:

I. Private schools charge fees.

II. Some residential schools charge fees

A.Both I and II follow
B.Only conclusion I follows
C.Neither I or II follows
D.Either I nor II follows
E.Only conclusion II follows

4. Which word does NOT belong with the others

A. Inch
B. Ounce
C. Centimeter
D. Yard

5. Which word does NOT belong with the others

A. Defendant
B. Prosecutor
C. Trial
D. Judge

6.

Blueberries cost more than strawberries.
Blueberries cost less than raspberries.
Raspberries cost more than strawberries and blueberries.

If the first two statements are true, the third statement is

A. True
B. False
C. Uncertain

7. PETAL : FLOWER

A. salt : flower

B. tire : bicycle

C. base : ball

D. sandals : shoes

E. puppy : dog

Read the below passage carefully and answer the questions:

At a small company, parking spaces are reserved for the top executives: CEO, president, vice president, secretary, and treasurer with the spaces lined up in that order. The parking lot guard can tell at a glance if the cars are parked correctly by looking at the colour of the cars. The cars are yellow, green, purple, red, and blue, and the executives' names are Alice, Bert, Cheryl, David, and Enid. (hint use visuals)

* The car in the first space is red.
* A blue car is parked between the red car and the green car.
* The car in the last space is purple.
* The secretary drives a yellow car.
* Alice's car is parked next to David's.
* Enid drives a green car.
* Bert's car is parked between Cheryl's and Enid's.
* David's car is parked in the last space.

8. Who is the Secretary?

A. Enid
B. David
C. Cheryl
D. Bert
E. Alice

9. Who is the CEO?

A. Alice
B. Bert
C. Cheryl
D. David
E. Enid

10. What colour is the vice president's car?

A. Green
B. Yellow
C. Blue
D. Purple
E. Red