

Does Nutrition Impact Brain Function?



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Scientific Idea

Investigate how nutrition impacts brain function. Different vitamins and minerals are connected to different functions in the brain. This experiment tested six different food combinations with varying levels of nutrition to determine whether having a more nutritious diet (e.g. more vitamins and minerals) impacts cognitive function.

Scientific Question

Does consuming a more balanced diet of vitamins and minerals (nutrition) impact brain function over a short period of time?

Hypothesis

If you eat more nutritious food, then your brain function will improve compared to eating less nutritious food, because a diet rich in diverse nutrients, vitamins, and minerals supports cognitive health and enhances brain function. Different nutrients have specific roles in maintaining brain health, and a variety of them can provide a range of cognitive benefits.

Prediction

Eating a more balanced and nutritious diet will improve brain function over a short period. This is because a diet rich in a variety of nutrients, such as vitamins and minerals, is essential for supporting cognitive health and enhancing brain performance.

Research - Executive Summary

What is Brain Health?

According to the World Health Organization (WHO), brain health means having a brain that works well in different areas, such as:

- Cognitive abilities: Thinking, learning, and remembering.
- Sensory skills: Senses like sight, hearing, and touch.
- Social and emotional skills: Understanding and managing emotions and relationships.
- Behavioral skills: Making decisions and controlling actions.

- Motor skills: Moving and coordinating your body.

Connection to Lifestyle

Brain health is influenced by many factors, including age, injuries, mood disorders (such as anxiety or depression), and diseases. While some of these factors cannot be changed, research shows that certain lifestyle choices may help maintain or improve brain function.

Key lifestyle factors that can support brain health include:

- Eating a balanced diet
- regular physical activity
- Staying mentally active through learning and problem-solving
- Maintaining social connections

Research has shown that nutrition plays a vital role in brain development during early childhood. However, scientists are now focusing on how diet affects cognitive function and brain health as people age. Understanding this connection is important for developing new ways to prevent or treat age-related brain disorders and to improve the quality of life for older adults.

Certain nutrients, such as B vitamins, iron, and polyphenols (plant compounds), have been found to support brain health. Specific diets are associated with a lower risk of mental decline and better overall cognitive health.

Therefore, there is a link between nutrition and how it affects the brain.

Importance of Cognitive Health

Cognitive health is about how well a person can think, learn, and remember. It includes mental abilities, acquired skills, and the ability to use these skills to complete meaningful tasks or activities. When brain health is good, people can understand their abilities, adapt their thinking, emotions, and behaviour, and cope with the challenges around them.

Nutrition and Cognitive Health

Scientific evidence shows that nutrition plays a big role in brain health. While most research has focused on brain development in children, scientists are now exploring how diet and lifestyle affect cognitive health throughout life.

A Decade of Research

Researchers reviewed studies over 10 years (2011–2021) to gather evidence about nutrition and brain health. Using over 50 chosen search terms, they studied data from observational and experimental research on humans. These studies were collected from reliable sources.

This research helps scientists understand how to prevent or manage age-related brain health problems, which can improve quality of life for people as they grow older.

Nutrition and Brain Development

Nutrition is one of the most important factors for early brain development, even more influential than some parts of a child’s environment. Without proper nutrition, the brain may not develop as it should, and deficiencies in specific nutrients can have long-term effects on how the brain works.

Key nutrients that are vital for brain development include:

- **Protein:** Supports overall brain growth and function.
- **Iron:** Helps carry oxygen to the brain.
- **Copper and Zinc:** Support brain signaling and development.
- **Iodine:** Critical for brain development during pregnancy and early childhood.
- **Folate:** Essential for brain cell growth.
- **Healthy Fats:** Important for building brain structure and supporting communication between brain cells.

How Macronutrients Affect Brain Health

Macronutrients are protein, fats, and carbohydrates and are the main components of the food we eat and play different roles in brain health.

Protein and Cognition

- A study found no strong link between overall protein intake and general brain function in older adults.
- Some studies found that higher protein intake is linked to better memory, understanding shapes, verbal fluency, and attention.
- Foods like meat, eggs, and vegetables seem to have a positive effect on brain health, according to one study.

Fats and Brain Health

- A high-fat diet, especially one with a lot of saturated fats (found in processed foods and some animal products), can negatively affect thinking and memory. For example, one study found that older women who ate a lot of saturated fats had worse memory over time.
- Healthier fats like monounsaturated fats (MUFAs, found in foods like olive oil and avocados) and polyunsaturated fats (PUFAs, like omega-3 fatty acids in fish) are beneficial for the brain.
- omega-3 fatty acids, such as EPA and DHA, are particularly important. They help reduce inflammation in the brain, improve brain cell structure, and support communication between brain cells. They also play a key role in memory, attention, and preventing brain diseases.

Carbohydrates and Cognitive Health

- Diets high in refined carbohydrates (like sugary or processed foods) are linked to poorer brain function. These foods can cause inflammation in the brain, leading to memory and thinking problems.
- Studies suggest that a balance of macronutrients is important for brain health. Too much energy from protein and fat and too little from healthy carbohydrates may contribute to cognitive decline.

The Role of Vitamins and Iron in Brain Health

Certain vitamins and minerals are essential for brain development and function. They help support important processes like memory, thinking, and learning.

Vitamin B

- Vitamin B-12 is important for brain development, especially during pregnancy and early childhood. It helps form the protective coating around nerve cells and supports brain growth.
- For older adults, the link between B-vitamins (like B12, B6, folate, and niacin) and brain function isn't clear. One study in the United States showed that higher B-vitamin intake was linked to better memory and thinking skills.

Vitamin D

- Vitamin D plays an important role in brain health, and lower levels of this vitamin have been linked to cognitive problems and diseases like Alzheimer's.
- A study found that people with low vitamin D levels had a higher risk of Alzheimer's disease (AD) 7 years later.
- In one experiment, adults who took a high dose of vitamin D3 (4,000 IU per day) for 18 weeks improved in understanding shapes and spaces, but no other brain functions were affected.

Antioxidant Vitamins (E and C)

- Vitamins E and C help protect the brain from damage caused by harmful molecules in the body.
- High vitamin E intake has been linked to better memory, faster recall, and improved language skills.
- Antioxidants, like those found in these vitamins, may reduce the risk of cognitive decline as people age.

Iron

- Iron is vital for carrying oxygen to the brain and other parts of the body because it is a key part of hemoglobin in red blood cells.
- Iron Deficiency Anemia (IDA) is when the body doesn't have enough iron and can lead to problems with thinking, memory, and motor skills in both children and adults.
- Too much iron in the brain can also cause damage. Excess iron increases damage to brain cells, leading to memory problems, slower movements, and difficulty making decisions.

Getting the right amount of vitamins and iron is essential for brain health. Deficiencies in these nutrients can harm memory, learning, and motor skills, especially during early life and as people age. Over-supplementation or high levels of certain nutrients, like iron, can also negatively affect brain function.

What are the best foods: Well there are many different foods that are good for you and your brain health, so are much more than others. Some of these are:

- Green/leafy vegetables: Kale, spinach, collards, and broccoli are right in nutrients like vitamin K & folate.
- Fatty fish: Fatty fish are abundant sources of omega-3 fatty acids, healthy unsaturated fats such as Omega-3 fatty acids which regulates neurobiological processes, cognition, improves memory, reduces inflammation in the brain, improves brain function/structure, and lastly attention.
- Berries: Flavonoids,

How Different Nutrients Impact Cognition (different brain functions and roles)

Nutrient	Impact on Cognition
Vitamin D	Supports neuron (brain cells) growth, development, and survival. Lowers risk of Alzheimer's disease. Improves understanding of shapes and space.
Iron	1. Helps nerve impulses (signals) move through the neuron (propagation) 2. Energy use in brain cells (energy metabolism) Excess iron can increase damage to brain cells which can lead to slower memory, movement, and decision-making.
Vitamin C	Neurotransmitter synthesis (the creation of chemicals in the brain that help brain cells communicate with each other). Protect the brain from damage caused by harmful molecules in the body.

Flavonoids	Improves memory
Potassium	Helps your nerves fire properly when stimulated
Calcium	Suspected link: Improves learning and memory (neurotransmitter release) and proper brain functioning and development.
B-vitamins	1. Neurotransmitter synthesis (the creation of chemicals in the brain that help brain cells communicate with each other) 2. Energy use in brain cells (energy metabolism)
Vitamin B12 (Cobalamin)	Helps nerve impulses (signals) move through the neuron (propagation). Helps brain growth and may improve memory and thinking skills.
Vitamin B6 (Pyridoxine)	Neurotransmitter binding (chemicals in the brain attaching to other brain cells to pass on signals)
Vitamin B9 (folate/folic acid)	Controls levels of homocysteine (a chemical which, if too much builds up, can damage brain cells and make it harder for them to work). Helps nerve impulses (signals) move through the neuron (propagation)
Vitamin B2 (riboflavin) and Vitamin B3 (niacin)	Controls levels of homocysteine (a chemical which, if too much builds up, can damage brain cells and make it harder for them to work).

The vitamin B complex is a group of eight vitamins that play important roles in keeping the body, including the brain and nervous system, healthy. These vitamins are:

1. B1 (Thiamine) – Helps turn food into energy and supports nerve function.
2. B2 (Riboflavin) – Important for energy production and cell growth.
3. B3 (Niacin) – Helps with energy metabolism and repairing DNA.
4. B5 (Pantothenic Acid) – Essential for making and breaking down fats and hormones.
5. B6 (Pyridoxine) – Helps in the production of neurotransmitters and red blood cells.
6. B7 (Biotin) – Supports healthy hair, skin, and nails, and helps metabolize fats, carbs, and proteins.
7. B9 (Folate/Folic Acid) – Important for cell division and making DNA.
8. B12 (Cobalamin) – Vital for nerve function and the production of red blood cells.

Proteins	Supports brain growth and function High protein - better memory, understanding of space and shapes, verbal fluency, and attention.
Fats	High saturated fat = negative effect on thinking and memory High monounsaturated and polyunsaturated fats (MUFAs, PUFAs, omega 3) = beneficial for the brain (see below).
omega-3 polyunsaturated fatty acids (PUFA) (AA, EPA, and DHA)	1. Nerve cell membrane composition (integrity) (how strong the nerve cell membrane is) 2. Regulates neurobiological processes, cognition. Improves memory Reduce inflammation in the brain, improves brain function/structure. Also improves memory and attention.

Carbohydrates	Refined carbohydrates = linked to poorer brain function. Negatively impacts memory and thinking.
By improving brain cell function and development, all cognitive functions should also improve, including memory, perception, attention/processing, and problem-solving. https://www.auctoresonline.org/article/the-impact-of-nutrition-on-peoples-cognitive-development “Adequate nutrition supports the formation of neural connections and enhances cognitive functions such as attention, memory, and problem-solving skills. Studies have shown that malnutrition, particularly protein-energy malnutrition, can lead to irreversible cognitive impairments.”	
<u>NUTRITION AND COGNITIVE FUNCTION</u>	
Link	Summary
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10083484/	If you are to change your lifestyle choices such as: Changing your diet, getting more sleep, etc. it can change your overall cognitive value.
https://www.medicalnewstoday.com/articles/324431#strawberries	How different fruits have different amounts of vitamins and which fruits have the most different vitamins.
Foods linked to better brainpower - Harvard Health	How different foods are linked to brain power.

Snacks:

Week 1 Day, 1-2

Nutritional Score Calculator (Range 1-100)										
Combined Snack Score		Maximum Value		Dunkaroos		Pilsbury Cookies		Strawberry Jell-O Cup		
Sugars (g)	36	Max Sugars (g)	25	Sugars (g)	11	Sugars (g)	9	Sugars (g)	16	
Carbs (g)	15	Max Carbs (g)	27	Carbs (g)	7	Carbs (g)	7	Carbs (g)	1	
Vitamins & Minerals (% DV)		Target % DV		Vitamins & Minerals (% DV)		Vitamins & Minerals (% DV)		Vitamins & Minerals (% DV)		
Vitamin D	0	100		Vitamin D		Vitamin D		Vitamin D		
Vitamin C	0	100		Vitamin C		Vitamin C		Vitamin C		
B Vitamins (composite)	0	100		B Vitamins (composite)		B Vitamins (composite)		B Vitamins (composite)		
Iron	10	100		Iron	6	Iron	4	Iron		
Omega-3	0	100		Omega-3		Omega-3		Omega-3		
Calcium	0	100		Calcium		Calcium		Calcium		
Potassium	2	100		Potassium	2	Potassium		Potassium		
Component Scores										
	14									
Sugar Score	4.0									
	94									
Carbs Score	.5									
Vitamins & Minerals Score	2.6									
Final Nutritional Score	1.0									

Week 1 Day, 3-4

Nutritional Score Calculator (Range 1-100)									
Combined Snack Score		Maximum Value		Pringles		Veggie Straws		No-Name Granola Bar	
Sugars (g)	6	Max Sugars (g)	25	Sugars (g)	0	Sugars (g)	0	Sugars (g)	6
Carbs (g)	41	Max Carbs (g)	275	Carbs (g)	11	Carbs (g)	17	Carbs (g)	13
Vitamins & Minerals (% DV)		Target % DV		Vitamins & Minerals (% DV)		Vitamins & Minerals (% DV)		Vitamins & Minerals (% DV)	
Vitamin D	0	100		Vitamin D		Vitamin D		Vitamin D	
Vitamin C	0	100		Vitamin C		Vitamin C		Vitamin C	
B Vitamins (composite)	0	100		B Vitamins (composite)		B Vitamins (composite)		B Vitamins (composite)	
Iron	7	100		Iron		Iron	4	Iron	3
Omega-3	0	100		Omega-3		Omega-3		Omega-3	
Calcium	8	100		Calcium		Calcium	6	Calcium	2
Potassium	5	100		Potassium		Potassium	4	Potassium	1
Component Scores									
Sugar Score	24.0								
Carbs Score	85.1								
Vitamins & Minerals Score	4.3								
Final Nutritional Score	40.4								

Week 2, Days 5-6

Nutritional Score Calculator (Range 1-100)									
Combined Snack Score		Maximum Value		Dempsters white bread		Kashi chocolate chia		IOGO Nano	
Sugars (g)	18	Max Sugars (g)	25	Sugars (g)	4	Sugars (g)	9	Sugars (g)	5
Carbs (g)	60	Max Carbs (g)	275	Carbs (g)	24	Carbs (g)	27	Carbs (g)	9
Vitamins & Minerals (% DV)		Target % DV		Vitamins & Minerals (% DV)		Vitamins & Minerals (% DV)		Vitamins & Minerals (% DV)	
Vitamin D	8	100		Vitamin D		Vitamin D		Vitamin D	8
Vitamin C	0	100		Vitamin C		Vitamin C		Vitamin C	
B Vitamins (composite)	85	100		B Vitamins (composite)	79	B Vitamins (composite)	6	B Vitamins (composite)	
Iron	21	100		Iron	13	Iron	8	Iron	
Omega-3	0	100		Omega-3		Omega-3		Omega-3	
Calcium	14	100		Calcium	6	Calcium	2	Calcium	6
Potassium	7	100		Potassium	1	Potassium	4	Potassium	2
Component Scores									
Sugar Score	72.0								
Carbs Score	78.2								
Vitamins & Minerals Score	28.9								
Final Nutritional Score	66.5								

Week 2, Days 7-8

Nutritional Score Calculator (Range 1-100)									

Combined Snack Score		Maximum Value		Cheerios (Multigrain)		Whole Wheat Dempster's		Cheese (Balderson)	
Sugars (g)	9	Max Sugars (g)	25	Sugars (g)	6	Sugars (g)	3	Sugars (g)	0
Carbs (g)	56	Max Carbs (g)	275	Carbs (g)	25	Carbs (g)	31	Carbs (g)	0
Vitamins & Minerals (% DV)		Target % DV		Vitamins & Minerals (% DV)		Vitamins & Minerals (% DV)		Vitamins & Minerals (% DV)	
Vitamin D	0	100		Vitamin D		Vitamin D		Vitamin D	
Vitamin C	0	100		Vitamin C		Vitamin C		Vitamin C	
B Vitamins (composite)	103	100		B Vitamins (composite)	55	B Vitamins (composite)	48	B Vitamins (composite)	
Iron	32	100		Iron	22	Iron	10	Iron	
Omega-3	0	100		Omega-3		Omega-3		Omega-3	
Calcium	26	100		Calcium	8	Calcium	6	Calcium	12
Potassium	5	100		Potassium	2	Potassium	3	Potassium	
Component Scores									
Sugar Score	36.0								
Carbs Score	79.6								
Vitamins & Minerals Score	35.6								
Final Nutritional Score	79.5								

Week 3, Days 9-10

Nutritional Score Calculator (Range 1-100)									
Combined Snack Score		Maximum Value		Strawberry		Broccoli		Whole grain crackers	
Sugars (g)	5.75	Max Sugars (g)	25	Sugars (g)	4.9	Sugars (g)	0.85	Sugars (g)	
Carbs (g)	25.5	Max Carbs (g)	27	Carbs (g)	8	Carbs (g)	3.5	Carbs (g)	14
Vitamins & Minerals (% DV)		Target % DV		Vitamins & Minerals (% DV)		Vitamins & Minerals (% DV)		Vitamins & Minerals (% DV)	
Vitamin D	0	100		Vitamin D		Vitamin D		Vitamin D	
Vitamin C	171	100		Vitamin C	97	Vitamin C	74	Vitamin C	
B Vitamins (composite)	5	100		B Vitamins (composite)		B Vitamins (composite)		B Vitamins (composite)	
Iron	9.5	100		Iron	2	Iron	1.5	Iron	6
Omega-3	18	100		Omega-3		Omega-3		Omega-3	18
Calcium	7	100		Calcium	1	Calcium	2	Calcium	4
Potassium	8.5	100		Potassium	4	Potassium	4.5	Potassium	
Component Scores									
Sugar Score	23.0								
Carbs Score	90.7								
Vitamins & Minerals Score	46.9								
Final Nutritional Score	84.7								

Week 3, Days 11

Combined Snack Score		Maximum Value		Whole grain bread (country harvest whole grain + protein blend)		Spinach Dip		Organika - O-Boost		Clementine Orange		Cucumber	
Sugars (g)	3.8	Max Sugars (g) 5	2	Sugars (g)	3.0	Sugars (g)	0.8	Sugars (g)		Sugars (g)	6.8	Sugars (g)	1.8
Carbs (g)	4.4	Max Carbs (g) 5	2	Carbs (g)	3.0	Carbs (g)	1.4	Carbs (g)		Carbs (g)	3.0	Carbs (g)	0.7
Vitamins & Minerals (% DV)		Target % DV		Vitamins & Minerals (% DV)		Vitamins & Minerals (% DV)		Vitamins & Minerals (% DV)		Vitamins & Minerals (% DV)		Vitamins & Minerals (% DV)	
Vitamin D	0.0	100		Vitamin D		Vitamin D		Vitamin D		Vitamin D		Vitamin D	
Vitamin C	60.3	100		Vitamin C		Vitamin C	7.0	Vitamin C		Vitamin C	55.0	Vitamin C	1.7
B Vitamins (composite)	62.0	100		B Vitamins (composite)	12.0	B Vitamins (composite)		B Vitamins (composite)		B Vitamins (composite)		B Vitamins (composite)	
Iron	15.5	100		Iron	13.0	Iron	1.3	Iron		Iron	0.6	Iron	0.6
Omega-3	18.0	100		Omega-3	18.0	Omega-3		Omega-3		Omega-3		Omega-3	
Calcium	17.3	100		Calcium	6.0	Calcium	4.4	Calcium		Calcium	1.7	Calcium	0.6
Potassium	1	100		Potassium	4.	Potassium	2	Potassium		Potassium	2.8	Potassium	1.6

	5.				0		.		3	sium		sium	
	4						7						
Component Scores													
Sugar Score	1												
	5.												
	1												
Carbs Score	8												
	7.												
	5												
Vitamins & Minerals Score	1												
	0												
	0.												
	0												
Final Nutritional Score	1												
	0												
	0.												
	0												

This nutrition calculator gives a score based on sugar, carbs, and vitamins/minerals. It lowers the score if there's a lot of sugar or carbs and raises it for more vitamins/minerals. If the vitamin score is low (under 10), it subtracts extra points. The score always stays between 1 and 100.

How It Works:

Starts at 100 points – this is like giving a perfect score to begin with.

Subtracts points for sugar and carbs – since too much sugar and carbs aren't great, we take away:

Multiplier of $0.3 \times \text{Sugar Score (B17)}$

Multiplier $0.3 \times \text{Carb Score (B18)}$

Adds points for vitamins – because vitamins are good, we add:

Multiplier of $0.4 \times \text{Vitamin Score (B19)}$

Extra penalty if vitamins are too low – if the vitamin score is less than 10, the formula takes away even more points:

$(10 - \text{the Vitamin Score}) \times 5 \rightarrow$ This means missing vitamins hurt the score a lot.

Keeps the score between 1 and 100 – so it doesn't go too high or too low.

Materials

- Pre-portioned food samples for each participant on weekly food combinations
 - 12 Jello cups
 - 12 Dunkaroos (vanilla)
 - 24 Christmas Pillsbury Cookies
 - 12 To-Go Pringle Packs
 - 12 No-name granola bars
 - Twelve 30g portions of Veggie Straws (original)
 - 12 Dempster's white bread slices
 - 12 Kashi Chocolate Chia Bars
 - 12 IOGO Nano yogurt drinks
 - Twelve 20g portions of Multigrain Cheerios
 - 12 whole wheat Dempster's bread slices
 - 12 To-Go Balderson Cheese (21g aged cheddar)
 - 48 same-sized fresh strawberries
 - 72 small broccoli florets
 - Twelve 20g whole grain crackers (Crunchmaster Multi-Grain Crackers)
 - 12 whole grain bread slices (Country Harvest Whole Grain and Protein Blend)
 - Twelve 100g servings of Spinach Dip
 - 12 Organika O-Boost packets with water
 - 12 Clementine Oranges
 - 12 mini cucumbers
- Cognitive test sheets
- Containers for food

- Bin
- Bowls
- Baking scale
- Cutting boards
- Knives
- Paper clips
- Veggie Wash
- Timer/stopwatch (personal computers)
- Pens/pencils
- Paper
- 10 participants, assigned into pairs

Variables

Controlled Variables:

- participants each week
- food pairings for each week
- amount of food given to each participant
- time of day of the experiment
- duration of tests
- duration of eating (and time between eating and completing the test)
- the types of tests
- length of tests
- participant partners

Manipulated Variable:

- Nutrition level of food

Responding Variable:

- Cognitive function (results of the tests)

Procedures

Preparation Procedure

1. Prepare the food combinations for each day based on nutritional content
 - a. Record the nutritional content of the foods given each day
2. Ensure the portions are measured and equal for each participant (see materials list for exact amounts)
3. Develop and print (12 versions each) the memory tests, reasoning tests, attention/processing tests, and problem-solving tests
4. Randomize the order of the tests each week
5. Create pairings for each week and record which versions of the tests each pair will receive each week

Procedure

1. Put each participant into their pairs (email the list to them)
2. Have participants decide who is Participant #1 and Participant #2
3. Using a computer, open a countdown timer and face it towards the participants (can put on smartboard if available)
4. Give each participant their portion of food for that week
5. Give participants 10 minutes to eat (all participants must consume all of the food given)
6. Start a timer for 10 minutes
7. Give each participant a folder of each test for that week while the timer is counting down. Give participants blank paper and a pencil.
8. Ensure the participants do not look at any of the tests early.

Order of Tests:

1. Problem-solving
2. Reasoning Test
3. Attention to detail (Spot the Difference)
4. Memory Test
5. Attention/Processing Test (Stroop Test)

The test difficulty was maintained for each week or adjusted to appropriate grade 7 levels.

Memory Test (5 minutes)

1. Participant #1 will read their list of objects to their partner (twice in a row), after the second reading, Participant #2 will write down on paper how many objects they remember from the list.
2. Repeat the procedure with the opposite participant reading the list and writing it down.

Reasoning Test (5 minutes)

1. Each participant will look at their reasoning test and be given 5 minutes to answer the question
2. Start a 5 minute timer
3. Participants will write down their answers and their names.
4. When finished with the question, record the time on the counter when finished on their paper.
5. Ensure participants stop writing when the timer ends

Attention/Processing Speed Test (5 minutes)

1. Each participant will get a version of the Stroop test
2. Participant #1 will show their Stroop test to Participant #2. Participant #2 must quickly complete the test by listing all the colours. For any colour they list incorrectly, Participant #1 must circle and mark down. Participants should complete the test as quickly as they can. They do not repeat the test.
3. Repeat the procedure but Participant #2 shows their test to Participant #1 and mark down any incorrect answers.

Problem-solving Test

1. Participants look at their test (grab it out of the folder)
2. Put on a 5-minute timer
3. The participant will complete their math problem (write name on the test)
4. When complete, write down the time they completed it (what time the counter was at)
5. All participants must stop after the time ends

Attention-to-detail Test

1. Participants look at their test
 2. Put on a 5-minute timer
 3. The participant will spot all the differences (up to 10) and the time it took to spot them
 4. If the participant did spot them all, they would take the entire 5 minutes and write that not all were spotted.
-
9. Collect all tests and folders from participants
 10. Ensure all participants throw away their garbage
 11. Repeat the procedure with the same food combination for a second day in a row.
 12. Repeat the procedure with a different food combination (higher nutrition).
 13. Complete six rounds of food combinations across three weeks (Monday/Tuesday - same foods, Wednesday/Thursday - same foods but different from M/T).

Post-Experiment Procedure

1. Data collection - collect all test sheets. Mark correct answers/accuracy and record the time taken for each test (if timed).
 - a. Memory test, write down how many objects they remember out of 5
 - b. Reasoning test, write down whether the participant got the question correct and how long it took them
 - c. Attention/Processing Speed test, look at how many colours they got incorrect out of the total amount of colours.
 - d. Problem-solving test, mark if they got the question correct and how long it took them.
 - e. Attention-to-detail test, mark how many differences were spotted correctly and the time it took

Record all this information on a Google Sheet.

2. Track the nutritional content of the foods consumed each week (list nutrients, minerals, and amounts of each)
3. Calculate the nutrition score for each day

4. Analyze the data

Tests:

Please find links to the tests below

[Memory Tests](#)

[Problem Solving](#)

[Stroop Test](#)

[Reasoning Test](#)

[Spot the Difference](#)

Additional Information

Week/Day	Foods
Week 1 - Day 1/2	• Jello cups • Dunkaroos (vanilla) • Pillsbury Cookies (boxed)

Week 1 - Day 3/4	● Pringles ● No-Name Granola Bar ● Veggie Straws
Week 2 - Day 5/6	● White bread ● Kashi Chocolate Chip Chia ● IOGO Nano Yogurt
Week 2 - Day 7/8	● Multigrain Cheerios ● Whole wheat bread ● Balderson Cheese
Week 3 - Day 9/10	● Strawberries ● Broccoli ● Whole grain crackers (Crunchmaster)
Week 3 - Day 11/12	● Whole grain bread ● Fruit/Veggie mix ● Multivitamin drink ● Spinach dip

Organika O-Boost Nutritional Data:

Turmeric (Curcuma longa, Rhizome) 50 mg, Ginger (Zingiber officinale, Rhizome) 50 mg, Grape Seed Extract (Vitis vinifera, Seed) 10 mg (Standardized to contain 85% Oligomeric Proanthocyanidins (OPC)), Green Tea Extract (Camellia sinensis, Leaf) 200 mg (Standardized to contain 1% Caffeine and 80% Catechins), Taurine 200 mg, Potassium (Potassium Bicarbonate, Potassium Carbonate, Potassium Citrate) 200 mg, Chromium (Chromium (III) Nicotinate) 17.5 mcg, Manganese (Manganese (II) Gluconate) 1.15 mg, Copper (Copper (II) Citrate) 250 mcg, Selenium (Selenomethionine) 27.5 mcg, Zinc (Zinc Amino Acid Chelate) 5.5 mg, Magnesium (Magnesium

Bisglycinate) 105 mg, Calcium (Calcium Citrate) 60 mg, Pantothenic Acid (Calcium D-pantothenate) 2.5 mg, Vitamin B12 (Cyanocobalamin) 1000 mcg, Folate (L-5-Methyltetrahydrofolate, Calcium Salt) 200 mcg, Vitamin B6 (Pyridoxal 5'-phosphate) 0.85 mg, Niacin (Niacinamide) 8 mg, Riboflavin (Riboflavin 5'-phosphate) 0.65 mg, Thiamine (Thiamine Mononitrate) 0.6 mg, Vitamin E (d-alpha Tocopheryl Acid Succinate) 7.5 mg AT1, Vitamin C (Ascorbic Acid) 500 mg., 1 AT (Alpha-Tocopherol)

Nutrient	Amount in Product	RDV	% RDV
Potassium	200 mg	4,700 mg	4.26%
Chromium	17.5 mcg	35 mcg	50%
Manganese	1.15 mg	2.3 mg	50%
Copper	250 mcg	900 mcg	27.78%
Selenium	27.5 mcg	55 mcg	50%
Zinc	5.5 mg	11 mg	50%
Magnesium	105 mg	420 mg	25%
Calcium	60 mg	1,300 mg	4.62%
Pantothenic Acid (B5)	2.5 mg	5 mg	50%
Vitamin B12	1,000 mcg	2.4 mcg	41666%
Folate (B9)	200 mcg	400 mcg	50%
Vitamin B6	0.85 mg	1.7 mg	50%
Niacin (B3)	8 mg	16 mg	50%
Riboflavin (B2)	0.65 mg	1.3 mg	50%
Thiamine (B1)	0.6 mg	1.2 mg	50%
Vitamin E	7.5 mg AT	15 mg AT	50%

Vitamin C	500 mg	90 mg	555.56%
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Homemade Spinach Dip

Nutrient	Total for Recipe	Per Serving (1/24)	%DV
Calories	~887	~37	
Protein	~76.6 g	~3.2 g	~6.4%
Carbs	~33.9 g	~1.4 g	~0.5%
Sugars	~18.5 g	~0.77 g	~1.54%
Fiber	~10 g	~0.42 g	~1.5%
Fat	~56.4 g	~2.35 g	~3%
Vitamin A	~32,700 IU	~1,362.5 IU	~45.4%
Vitamin C	~150 mg	~6.25 mg	~6.94%
Calcium	~1,365 mg	~56.9 mg	~4.38%
Iron	~5.7 mg	~0.24 mg	~1.33%
Potassium	~3,080 mg	~128.3 mg	~2.73%
Sodium	~800 mg (from cheese and salt)	~33.3 mg	~1.45%

Low-calorie: Each serving is about 37 calories, making it light and nutrient-dense.

Rich in Vitamins: High in Vitamin A, Vitamin C, and calcium, especially for such a small serving size.

Low Sugar: Most sugars come from the Greek yogurt, contributing less than 1 g per serving.

Balanced Macronutrients: Good protein source (~3.2 g/serving) with minimal carbs and fat.

[NUTRITION SCORE CALCULATOR](#)

Results & Observations

Week 1

In week 1 of the nutrition and cognition experiment, the nutrition score for days 1-2 was 1.0 and for days 3-4 was 40.4.

Observations: Days 1-2: For the first two days of week 1, the participants consumed the food within the 10-minute eating period.

For the memory test, participants appeared defocused and the participants struggled with the tests getting lower scores than expected. The processing time was very low.

For the reasoning test, participants appeared defocused and struggled with time management. This test was an individual test, the accuracy was 90% but the time in seconds was on average 170 seconds. For the attention/processing test (Stroop test), participants appeared defocused and struggled with time management. This was a partner test. The scores were the average correct was 32/36 and the average percent was 90%.

For the problem-solving test, participants appeared defocused and struggled with time management, focus, and the ability to do basic tasks. The scores were 90% on the first day and 60% on the second day. The times were 131.6 seconds on the first day and on the second day was 200.6 seconds.

For the attention-to-detail (spot the difference) test, participants appeared defocused and struggled with time management. Their time management was below average, there was a present struggle to complete basic tasks even with a timeline. The score was 96% on the first day and 85% on the second day. The time averages were 204.5 seconds on the first day and 242.0 on the second day.

Days 3-4: For days 3 and 4 of week 1, the participants consumed the food within the 10-minute eating period.

For the memory test, participants appeared slower in movements and less energized than in the previous days. They struggled to complete tasks and had poor time management. The participants appeared more focused than in

previous days. The scores were on average 5.5/10 on the first day and 6.2/10 on the second day. The accuracy on average was 55% on the first day and 62% on the second day.

For the reasoning test, participants appeared slower in movements and they were overall less energized than in the previous days. They had poor time management although their results were very good. The scores were 100% on the third day and 88% on the second day. The times were 206.6 seconds on the first day and 129.0 seconds on the second day.

For the attention/processing test (Stroop test), participants appeared slower in movements and had less energy than in previous days. Their focus was poor, also their time management was less than ideal. The scores were 35.25/36 on the third day and 34.63/36 on the second day. The percentages were 98% on the third day and 96% on the fourth day.

For the problem-solving test, participants appeared unfocused, were slower in movements and had less energy than in previous days. Their social skills were less than ideal. The scores were 89% on the third day and 86% on the second day. The processing times were 171.2 seconds on the third day and 117 seconds on the fourth day.

For the attention-to-detail (spot the difference) test, participants appeared slower in movements and appeared unfocused. The participants also had less energy than in previous days. The scores were 88% on the third day and 99% on the second day. The times were 218.8 on the third day and 193.0 seconds on the fourth day.

Data - Week 1

Table 1a. Week 1 Reasoning Test Results - Correctness.

Week 1	Day 1	Day 2	Day 3	Day 4
Participant 1	1	1	1	1
Participant 2	1	1	1	1
Participant 3	1	1		0
Participant 4	1	1	1	

Participant 5	0	0	1	1
Participant 6	1	1	1	
Participant 7	1	1	1	1
Participant 8	1	1	1	1
Participant 9	1	1	1	1
Participant 10	1	1	1	1

Score key: 0 = incorrect, 1 = correct.

Table 1b. Week 1 Reasoning Test Results - Time to complete (in seconds).

Week 1	Day 1	Day 2	Day 3	Day 4
Participant 1	145	132	8	25
Participant 2	12	130	300	300
Participant 3	54	76		134
Participant 4	300	290	300	
Participant 5	300	300	300	300
Participant 6	105	120	50	
Participant 7	300	300	300	92
Participant 8	78	75	171	106
Participant 9	60	62	165	30
Participant 10	300	298	265	45

The maximum time given for the test was 300 seconds. A score of 300 seconds indicates that the participant took all of the allotted time or did not finish within the allotted time.

Table 2. Week 1 Memory Test Results - Correctness.

Week 1	Day 1	Day 2	Day 3	Day 4
Group A - Participant 1	5	4	5	4
Group A - Participant 2	7	8	6	5
Group B - Participant 1	1	0	7	7
Group B - Participant 2	3	5	6	8
Group C - Participant 1	0	2	6	8
Group C - Participant 2	4	6	6	10
Group D - Participant 1	5	7	6	4
Group D - Participant 2	6	8	3	4
Group E - Participant 1	7	5	5	5

Group E - Participant 2	7	7	5	7
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Scores were calculated out of 10 total points (10 words).

Table 3. Week 1 Attention and Processing Speed Test Results - Correctness.

Week 1	Day 1	Day 2	Day 3	Day 4
Group A - Participant 1	29	32	36	31
Group A - Participant 2	30	33	36	35
Group B - Participant 1	32	33		32
Group B - Participant 2	33	34		
Group C - Participant 1	32	25	36	36
Group C - Participant 2	31	33	36	35
Group D - Participant 1	34	35	32	36
Group D - Participant 2	33	34	36	36
Group E - Participant 1	34	34	35	36
Group E - Participant 2	31	35	35	

Scores were calculated out of a total of 36 points (words).

Table 4a. Week 1 Problem-Solving Test - Correctness.

Week 1	Day 1	Day 2	Day 3	Day 4
Participant 1	1	1	1	1
Participant 2	1	1	1	1
Participant 3	1	0		1
Participant 4	1	0	1	1
Participant 5	0	1	1	
Participant 6	1	1	1	
Participant 7	1	1	1	
Participant 8	1	0	1	1
Participant 9	1	1	0	0
Participant 10	1	0	1	1

Score key: 0 = incorrect, 1 = correct.

Table 4b. Week 1 Problem Solving Test - Time to complete (in seconds)

Week 1	Day 1	Day 2	Day 3	Day 4
Participant 1	16	40	35	36
Participant 2	30	300	300	300
Participant 3	26	117		64
Participant 4	300	300	300	
Participant 5	300	300	300	
Participant 6	15	262	16	
Participant 7	300	300	94	33
Participant 8	29	57	31	135
Participant 9	30	60	195	27
Participant 10	270	270	270	224

The maximum time given for the test was 300 seconds. A score of 300 seconds indicates that the participant took all of the allotted time or did not finish within the allotted time.

Table 5. Week 1 Attention-to-detail Test - Correctness.

Week 1	Day 1	Day 2	Day 3	Day 4
Participant 1	10	9	9	10
Participant 2	10	10	8	10
Participant 3	10	10		10
Participant 4	10	10	10	
Participant 5	9	9	9	10
Participant 6	10	10	9	10
Participant 7	8	1	9	10
Participant 8	10	10	7	9
Participant 9	9	6	8	10
Participant 10	10	10	10	

Scores were calculated out of 10 total points (10 differences).

Table 6. Week 1 Attention-to-detail Test - Time to complete (in seconds).

Week 1	Day 1	Day 2	Day 3	Day 4
Participant 1	120	300	300	154

Participant 2	68	300	300	300
Participant 3	269	90		115
Participant 4	300	300	300	
Participant 5	300	300	300	300
Participant 6	277	224	298	150
Participant 7	300	300	188	149
Participant 8	111	96	59	150
Participant 9	120	300	90	226
Participant 10	180	210	134	

The maximum time given for the test was 300 seconds. A score of 300 seconds indicates that the participant took all of the allotted time or did not finish within the allotted time.

Week 2

In week 2 of the nutrition and cognition experiment, the nutrition score for days 5-6 was 66.5 and for days 7-8 was 79.5.

Days 1-2: For the first two days of week 2, the participants consumed the food within the 10-minute eating period.

For the memory test, participants appeared more focused in the previous week although they were less social. They completed the single-person activities/tests with ease. The scores were 6.2/10 on the first day and 5.875/10 on the second day. The percentages were 62% on the first day and 59% on the second day.

For the reasoning test, participants appeared more focused in the previous week although they were less social than in previous days. They completed the single-person tests with ease but the partner tests were completed with difficulty and they sometimes tried to get out of the group tests. The scores were 40% on the first day and 50% on the second day. The processing times were 243.3 seconds on the first day and 178.8 seconds on the second day.

For the attention/processing test (Stroop test), participants appeared more focused than in the previous week but they were less social than their normal behaviour. The participants completed the single-person tests with ease but the multi-person tests they struggled with and they would hand them in late or even forget to hand them in. The scores were 32.40/36 on the first day and 34.50/36 on the second day. The percentages were 90% on the first day and 96% on the second day.

For the problem-solving test, participants appeared more focused than in previous days but they were less social than on a normal day. The participants completed the tests and challenges with ease but struggled with completing the multi-person tests they often were distracted when completing the multi-person tests. The scores were 70% on the first day and 60% and the times were 105 seconds on the first day and 203.2 on the second day.

For the attention-to-detail (spot the difference) test, participants appeared slower in movements and they were either running around the hallways/classroom or they were being super anti-social. The participants completed the individual tests with ease but they completed the partner tests with a slowness and would try to get out of doing them. The scores were 89% on the first day and 76% on the second day. The times were 272.3 seconds on the first day and 248.5 seconds on the second day.

Days 3-4: For days 3 and 4 of week 2, the participants consumed the food within the 10-minute eating period.

For the memory test, participants appeared sad almost with the amount of bread that they had to consume for the experiment and there was lots of procrastination when it came to eating the bread and consuming the cheerios. But they greatly enjoyed the cheeses because they could spread it on the bread. The average correct was 6.2 on the third day and 5.875 on the fourth day. The average percentage correct was 62% on the third day and 59% on the fourth day.

For the reasoning test, participants appeared sad almost with the amount of bread that they had to consume for the experiment and there was lots of procrastination when it came to eating the bread and consuming the cheerios. But they greatly enjoyed the cheeses because they could spread it on the bread. It was easier for them to complete the group tests. The average percentage correct was 20% on the third day and 56% on the fourth day. The average processing time was 243.3 seconds on the third day and 178.2 seconds on the fourth day.

For the attention/processing test (Stroop test), participants appeared sad at the amount of bread that they had to consume for the experiment. There was a lot of procrastination when it came to eating the bread and consuming the cheerios. But they greatly enjoyed the cheeses because they could spread it on the bread. It was easier for them to complete the group tests because they were more social and focused on finishing their work. The average correct

was 35/36 on the third day and 34.80/36 on the fourth day. The average percentage correct was 97% on the third day and 97% on the fourth day.

For the problem-solving test, participants appeared sad at the amount of bread that they had to consume for the experiment. There was a lot of procrastination when it came to eating the bread and consuming the cheerios. But they greatly enjoyed the cheeses because they could spread it on the bread. It was easier for them to complete the group tests, because they were more social and focused on finishing their work. The average percent correct was 100% on the third day and 88% on the second day. The average processing time was 133.3 seconds on the third day and 228.75 seconds on the fourth day.

For the attention-to-detail (spot the difference) test, participants appeared sad at the amount of bread that they had to consume for the experiment. There was lots of procrastination when it came to eating the bread and consuming the cheerios. But they greatly enjoyed the cheeses because they could spread it on the bread. It was easier for them to complete the group tests, because they were more social and focused on finishing their work. The average percentage correct was 61% on the third day and 86% on the fourth day. The processing times were 223 seconds on the third day and 217.1 seconds on the fourth day.

Data - Week 2

Table 7a. Week 2 Reasoning Test Results - Correctness.

Week 2	Day 1	Day 2	Day 3	Day 4
Participant 1	0	1	0	1
Participant 2	0	0	0	0
Participant 3	0	0	1	0
Participant 4	1	0	0	1
Participant 5	1	1	1	0
Participant 6	0	1	0	1
Participant 7	0	0	0	0
Participant 8	1	0	0	1
Participant 9	0	1	0	

Participant 10	1	1	0	1
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Score key: 0 = incorrect, 1 = correct.

Table 7b. Week 2 Reasoning Test Results - Time to complete (in seconds).

Week 2	Day 1	Day 2	Day 3	Day 4
Participant 1	300	65	54	37
Participant 2	79	300	300	270
Participant 3	135	300	43	300
Participant 4	171	300	300	20
Participant 5	300	300	300	300
Participant 6	300	18	100	5
Participant 7	300	48	75	261
Participant 8	300	1	14	300
Participant 9	300	180	20	
Participant 10	248	270	240	300

The maximum time given for the test was 300 seconds. A score of 300 seconds indicates that the participant took all of the allotted time or did not finish within the allotted time.

Table 8. Week 2 Memory Test Results - Correctness.

Week 2	Day 1	Day 2	Day 3	Day 4
Group A - Participant 1	2	7	3	4
Group A - Participant 2	4	4	9	4
Group B - Participant 1	5		6	5
Group B - Participant 2	9		6	6
Group C - Participant 1	7	8	10	7
Group C - Participant 2	10	6	7	5
Group D - Participant 1	3	4	3	5
Group D - Participant 2	5	5	2	2
Group E - Participant 1	8	7	8	7
Group E - Participant 2	9	6	8	7

Scores were calculated out of 10 total points (10 words).

Table 9. Week 2 Attention and Processing Speed Test Results - Correctness.

Week 2	Day 1	Day 2	Day 3	Day 4
Group A - Participant 1	32	34	32	36
Group A - Participant 2	29	35	36	36
Group B - Participant 1	35	30	34	33
Group B - Participant 2	35	35	34	31
Group C - Participant 1	32	35	36	36
Group C - Participant 2	30	35	36	35
Group D - Participant 1	33	36	36	36
Group D - Participant 2	31	35	36	34
Group E - Participant 1	32	36	35	35
Group E - Participant 2	35	34	35	36

Scores were calculated out of a total of 36 points (words).

Table 10a. Week 2 Problem-Solving Test - Correctness.

Week 2	Day 1	Day 2	Day 3	Day 4
Participant 1	1	1	1	1
Participant 2	0	0	1	1
Participant 3	1	0	1	0
Participant 4	0	0	1	1
Participant 5	1	1	1	1
Participant 6	1	1	1	1
Participant 7	1	1	1	1
Participant 8	1	0	1	
Participant 9	0	1	1	
Participant 10	1	1	1	1

Score key: 0 = incorrect, 1 = correct.

Table 10b. Week 2 Problem Solving Test - Time to complete (in seconds)

Week 2	Day 1	Day 2	Day 3	Day 4
Participant 1	44	264	8	300
Participant 2	25	300	300	256

Participant 3	3	300	25	38
Participant 4	27	300	300	300
Participant 5	0	300	300	195
Participant 6	17	63	54	300
Participant 7	299	274	15	225
Participant 8	300	1	31	
Participant 9	300	5	10	
Participant 10	35	225	290	216

The maximum time given for the test was 300 seconds. A score of 300 seconds indicates that the participant took all of the allotted time or did not finish within the allotted time.

Table 11. Week 2 Attention-to-detail Test - Correctness.

Week 2	Day 1	Day 2	Day 3	Day 4
Participant 1	10		7	9
Participant 2	10	8	7	10
Participant 3	9	8	8	9
Participant 4	8	7	8	6
Participant 5	8	7	8	9
Participant 6	6	7	8	9
Participant 7	10		8	10
Participant 8	10	8	8	
Participant 9	8	8	8	
Participant 10	10	8	8	7

Scores were calculated out of 10 total points (10 differences).

Table 12. Week 2 Attention-to-detail Test - Time to complete (in seconds).

Week 2	Day 1	Day 2	Day 3	Day 4
Participant 1	300		70	217
Participant 2	116	137	300	300
Participant 3	300	300	300	110
Participant 4	283	300	300	300
Participant 5	300	300	300	70

Participant 6	300	300	256	140
Participant 7	300		210	300
Participant 8	300	187	74	
Participant 9	300	300	180	
Participant 10	224	164	240	300

The maximum time given for the test was 300 seconds. A score of 300 seconds indicates that the participant took all of the allotted time or did not finish within the allotted time.

Week 3

In week 3 of the nutrition and cognition experiment, the nutrition score for days 9-10 was 84.7 and for days 11-12 was 100.0.

Days 1-2: For the first two days of week 3, the participants consumed the food within the 10-minute eating period.

For the memory test, participants appeared more focused and overall they completed the tests with ease and they worked better at working in the partner groups. The work was completed faster and the tests were overall more accurate. The participants enjoyed the food more and ate the food faster than in previous weeks/days. The average correct scores were 6.5/10 on the first day and 6.2/10 on the second day. The average percent correct was 78% correct on the first day and 65% on the second day.

For the reasoning test, participants appeared more focused and overall they completed both the multi person and the single person tests with ease. The work was completed overall more accurately and they listened more over the course of the day. The participants enjoyed the food more than in previous days which also helped them consume the food faster. The average percent correct was 100% on the first day and 90% on the second day. The average processing time was 158.2 seconds on the first day and 66.9 on the second day.

For the attention/processing test (Stroop test), participants appeared more focused than in previous days. The participants overall completed both the multi person tests and single person tests with ease. The work was completed overall more accurately than in previous days which also helped them consume the food faster. The

average correct score was 32.8/36 on the first day and 35.5/36 on the second day. The average percent correct was 91% on the first day and 99% on the second day.

For the problem-solving test, participants appeared, participants appeared more focused than in previous days. The participants overall completed both the single and multi tests with ease. The work was completed overall more accurately than in previous days which also helped them consume the food faster. The average percent correct was 100% on the first day and 80% on the second day.

For the attention-to-detail (spot the difference) test, participants appeared more focused than in previous days. The participants overall completed both the single and the multi person tests with ease. The average percent correct was 96% on the first day and 98% on the second day.

Days 3-4: For day 3 of week 3 the participants consumed the food within the 10-minute eating period.

For the memory test: The participants appeared more focused than in previous days, with better communication skills and completed the tests with speed and accuracy. Both of the single and the multi person tests were completed with ease. The average correct was 5.7. The average percent correct was 57% correct.

For the reasoning test: The participants appeared more focused than in the previous days, with communication between peers. The tests were completed with more speed and accuracy than in the previous days. Both the single and multi person tests were completed with little to no bumps. The average percent correct is 70%. The average processing time in seconds is 161.7 seconds.

For the attention/processing test: The participants appeared more focused than in the previous weeks, the communication skills of the participants were better. The tests were completed with ease, speed, and accuracy then in the previous weeks. The average correct is 35.60. The average percent correct is 99% percent.

For the problem solving test: The participants appeared to be more focused than in the previous days, the communication between the peers was better than previous days/weeks. The tests were completed with ease, speed, and accuracy then in the previous weeks. The average processing time was 194.3 seconds. The average percent correct was 70%.

For the attention-to-detail test: The participants appeared to be more focused than in the previous day, the tests were completed with ease, speed, and accuracy then in the previous weeks. The average processing time 215.4 seconds. The average percent correct was 94%.

Data - Week 3

Table 13a. Week 3 Reasoning Test Results - Correctness.

Week 3	Day 1	Day 2	Day 3	Day 4
Participant 1	1	1	1	
Participant 2	1	1	1	
Participant 3	1	0	0	
Participant 4	1	1	1	
Participant 5	1	1	0	
Participant 6	1	1	1	
Participant 7	1	1	1	
Participant 8	1	1	1	
Participant 9	1	1	1	
Participant 10	1	1	0	

Score key: 0 = incorrect, 1 = correct.

Table 13b. Week 3 Reasoning Test Results - Time to complete (in seconds).

Week 3	Day 1	Day 2	Day 3	Day 4
Participant 1	300	25	5	
Participant 2	300	12	1	
Participant 3	300	300	192	
Participant 4	5	5	300	
Participant 5	45	240	300	
Participant 6	270	61	120	

Participant 7	12	7	65	
Participant 8	33	5	34	
Participant 9	17	5	300	
Participant 10	300	9	300	

The maximum time given for the test was 300 seconds. A score of 300 seconds indicates that the participants took all of the allotted time or did not finish within the allotted time.

Table 14. Week 3 Memory Test Results - Correctness.

Week 3	Day 1	Day 2	Day 3	Day 4
Group A - Participant 1	5	6	10	
Group A - Participant 2	6	10	5	
Group B - Participant 1	6	5	4	
Group B - Participant 2	10	5	8	
Group C - Participant 1	6	10	8	
Group C - Participant 2	6	6	4	
Group D - Participant 1	9	5	4	
Group D - Participant 2	7	3	5	
Group E - Participant 1	5	7	5	
Group E - Participant 2	5	5	4	

Scores were calculated out of 10 total points (10 words).

Table 15. Week 3 Attention and Processing Speed Test Results - Correctness.

Week 3	Day 1	Day 2	Day 3	Day 4
Group A - Participant 1	29	34	35	
Group A - Participant 2	34	34	36	
Group B - Participant 1	35	36	36	
Group B - Participant 2	31	36	36	
Group C - Participant 1	29	36	36	
Group C - Participant 2	36	36	36	
Group D - Participant 1	36	36	35	
Group D - Participant 2	34	36	34	
Group E - Participant 1	30	35	36	
Group E - Participant 2	34	36	36	

Scores were calculated out of a total of 36 points (words).

Table 16a. Week 3 Problem-Solving Test - Correctness.

Week 3	Day 1	Day 2	Day 3	Day 4
Participant 1	1	1	1	
Participant 2	1	1	1	
Participant 3	1	0	0	
Participant 4	1	0	0	
Participant 5	1	1	1	
Participant 6	1	1	1	
Participant 7	1	1	0	
Participant 8	1	1	1	
Participant 9	1	1	1	
Participant 10	1	1	1	

Score key: 0 = incorrect, 1 = correct.

Table 16b. Week 3 Problem Solving Test - Time to complete (in seconds)

Week 3	Day 1	Day 2	Day 3	Day 4
Participant 1	5	5	35	
Participant 2	300	5	135	
Participant 3	300	12	300	
Participant 4	5	115	300	
Participant 5	3	21	300	
Participant 6	266	41	30	
Participant 7	5	300	210	
Participant 8	14	21	33	
Participant 9	11	5	300	
Participant 10	5	7	300	

The maximum time given for the test was 300 seconds. A score of 300 seconds indicates that the participant took all of the allotted time or did not finish within the allotted time.

Table 17. Week 3 Attention-to-detail Test - Correctness.

Week 3	Day 1	Day 2	Day 3	Day 4
Participant 1	10	8	10	
Participant 2	10	8	7	
Participant 3	10	7	10	
Participant 4	9	8	10	
Participant 5	9	7	10	
Participant 6	9	8	10	
Participant 7	9	8	10	
Participant 8	10	8	8	
Participant 9	10	8	9	
Participant 10	10	8	10	

Scores were calculated out of 10 total points (10 differences).

Table 18. Week 3 Attention-to-detail Test - Time to complete (in seconds).

Week 3	Day 1	Day 2	Day 3	Day 4
Participant 1	300	300	59	
Participant 2	300	101	300	
Participant 3	300	31	240	
Participant 4	90	300	300	
Participant 5	120	236	300	
Participant 6	237	73	95	
Participant 7	250	77	195	
Participant 8	97	300	65	
Participant 9	300	300	300	
Participant 10	67	300	300	

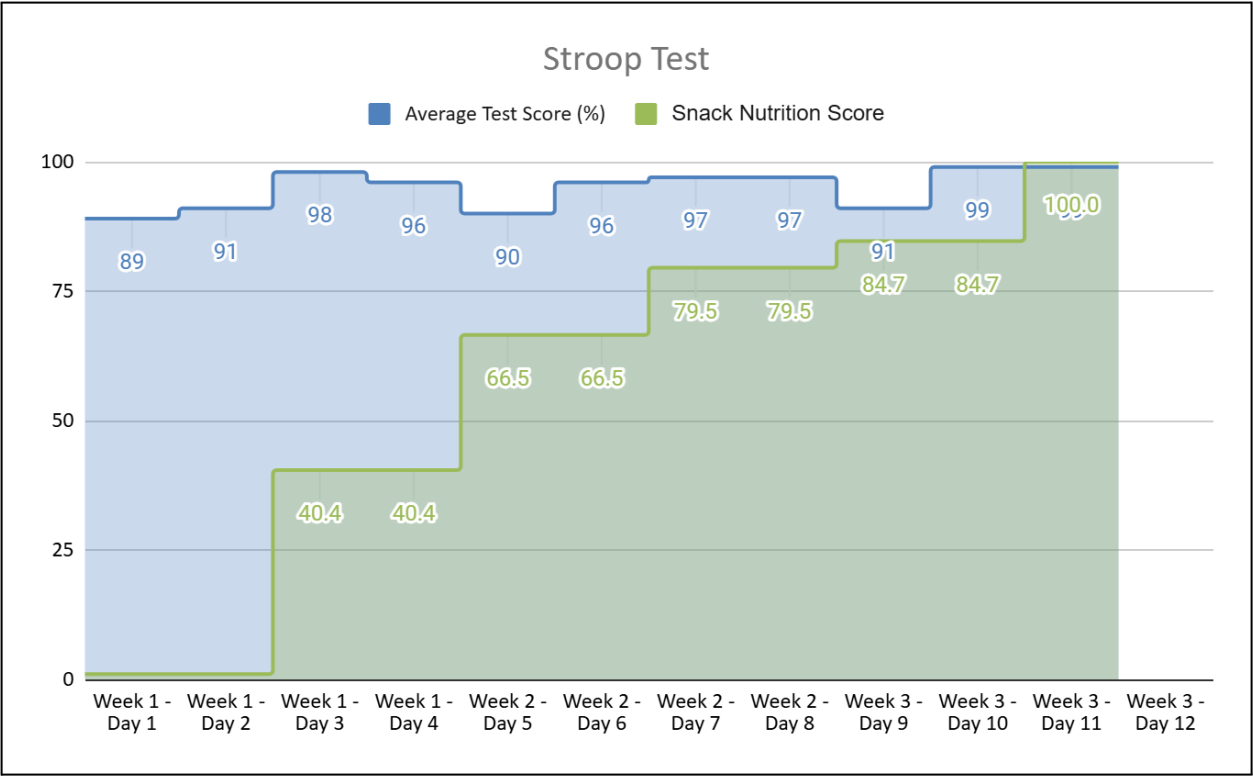
The maximum time given for the test was 300 seconds. A score of 300 seconds indicates that the participant took all of the allotted time or did not finish within the allotted time.

Analysis

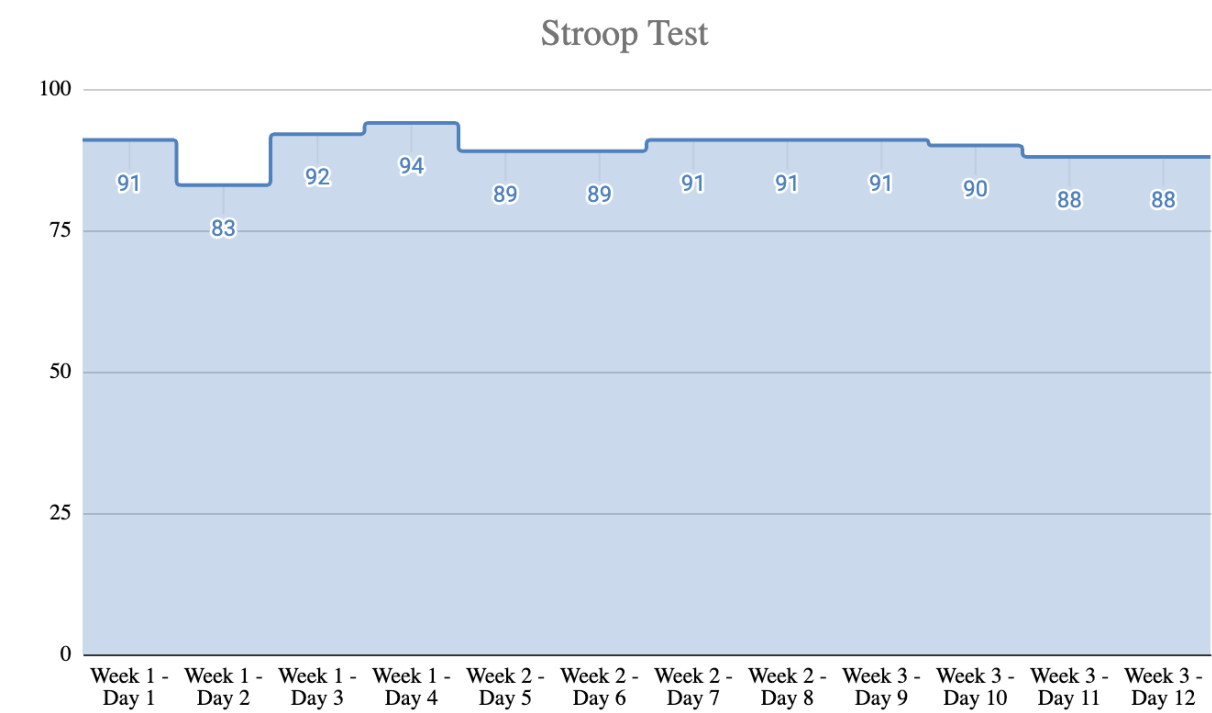
Attention/Processing Test (Stroop Test)

Based on the research, it is expected that the attention/processing results will consistently go up as the nutrition score increases. However, the results are not consistent with the research as they show variable increases and decreases as the nutrition score increases. It is possible that the presence of iron, calcium, and potassium may impact attention/processing during the Stroop test as these nutrients were seen on the days with the highest average test score, and not seen on the day with the lowest score. However, given that all the scores on the Stroop tests are relatively high and consistent throughout all the days, it is likely that the participants generally performed well on this type of test. The presence of vitamin C does not seem to have any connection to attention/processing. Further, it is possible that the nutrients that correspond to better attention/processing happened to fluctuate over the days despite the nutrition score still increasing.

Graph 1. Stroop test (attention/processing) averages in percent (%), across 11 days including the snack nutrition score of each day.



Control table:

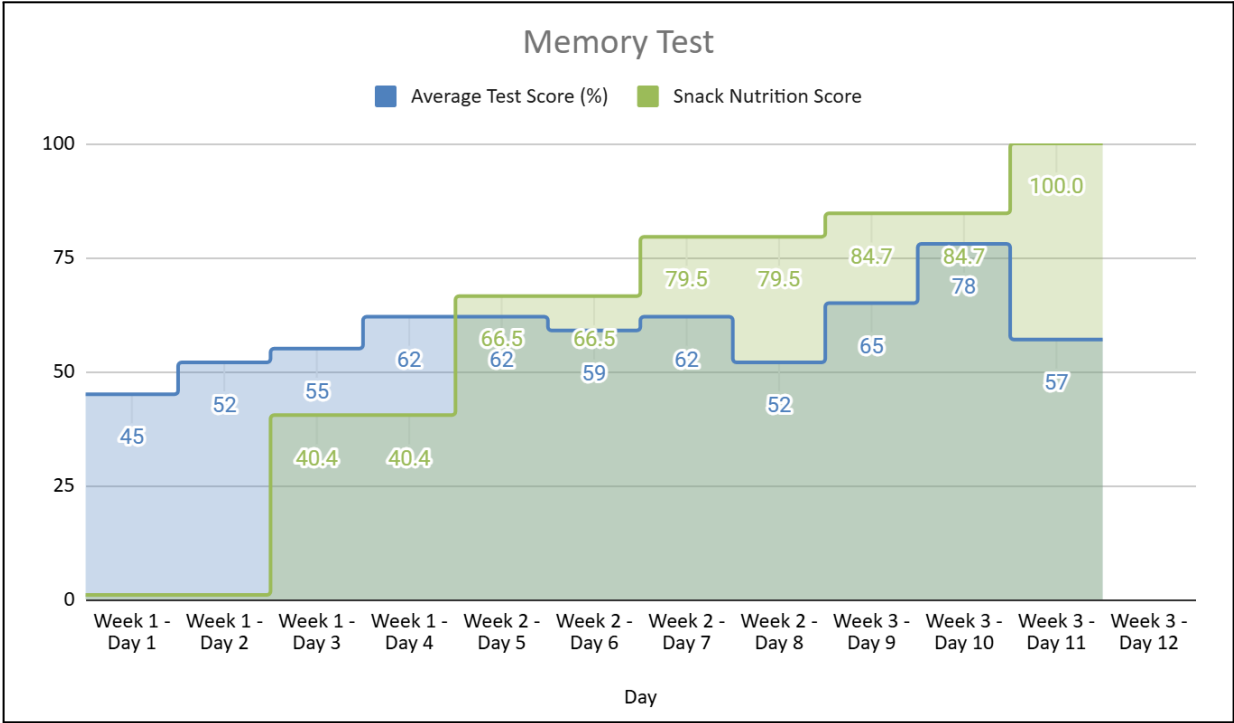


Memory Test

For the memory test, it is expected that the memory test scores will increase as the nutrition score increases. In week 1, participants performed the worst on day 1 for the memory test. Research says that being high in nutrients is beneficial for cognitive health, particularly the presence of calcium, flavonoids, and poly-unsaturated fatty acids (PUFAs) are shown to improve memory.

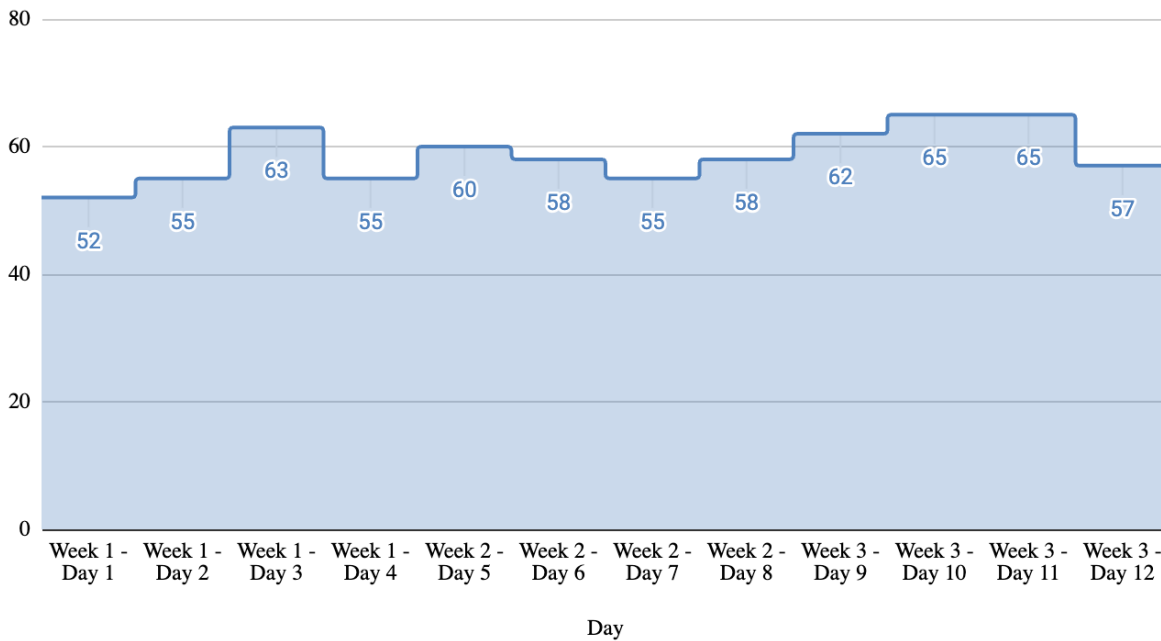
Since the participants did not consume any of these nutrients on Day 1, the results support the research on this day. On days 2-5 the memory results increased as the nutrition score also increased, however, on days 8, 9, and 11, the test scores decreased despite the nutrition score increasing. This data does not support the research and prediction. Based on the observations, it is likely that high amounts of processed sugars influenced hyper behaviour and contributed to the participants losing focus throughout the experiment which can explain the low results on days 1-2. Further analysis showed that although nutrition scores increase they are consistent. But as your can ee with the table that overall there i a difference and there is an impact.

Graph 2. Memory test averages in percent (%), across 11 days including the snack nutrition score of each day.



Control table:

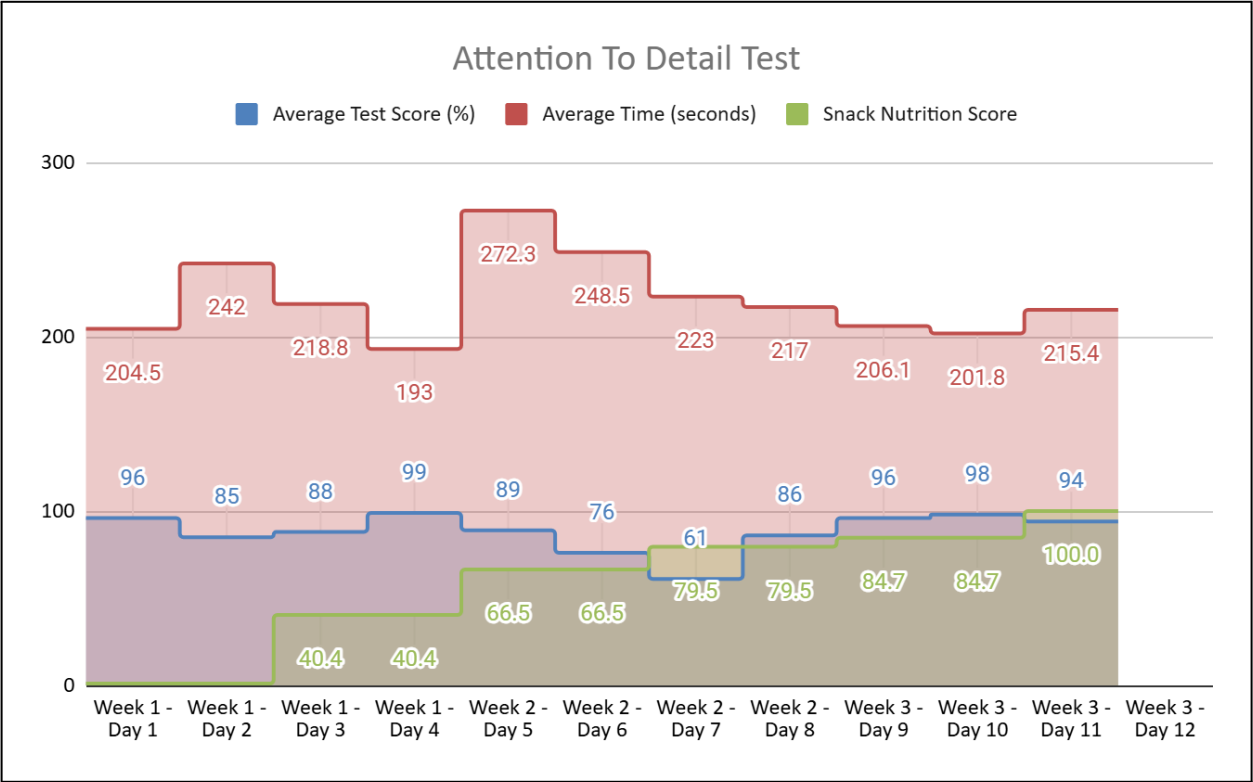
Memory Test



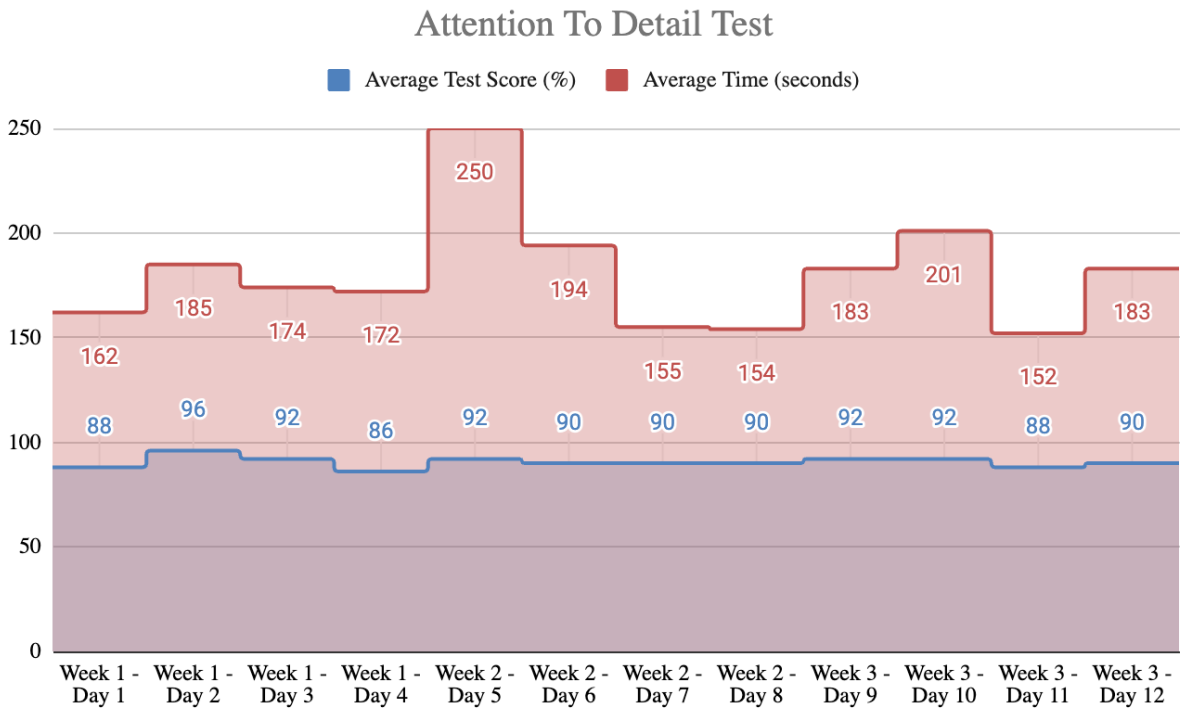
Attention-to-Detail (Spot the Difference)

For the attention-to-detail test, it is expected that the test scores will increase and the processing times will go down as the nutrition score increases. Days 6 and 7 had the lowest results, for day 6 it could be because of the large amounts of refined bread and other carbohydrates, it could also come from the fact there were omega-3 fatty acids. These results do not follow a trend because the snacks for those days were different from one another. For day 7 it could stem from the fact that there are no omega-3 fatty acids and that there is a large amount of carbohydrates. Days 1-4 the results were not as research predicted because the results should have decreased but the processing times are on par with what they should be. Day 5 results were expected to be just as they are with a large processing time and a lower score. Day 8 results are consistent with research as the score increases from previous days. Days 9 and 10 followed that pattern of the results that were expected, there was omega-3 in the food for the first time so the increase in the results are consistent with research which shows that omega-3 fatty acids are linked to improved attention. Day 11 results were expected in relation to the previous four days because there was a combination of healthy carbs and omega-3 fatty acids which contributed to improved attention. The control group shows that nutrition can have an affect on brain health.

Graph 3. Attention to detail test averages in percent (%), across 11 days including the snack nutrition score of each day.



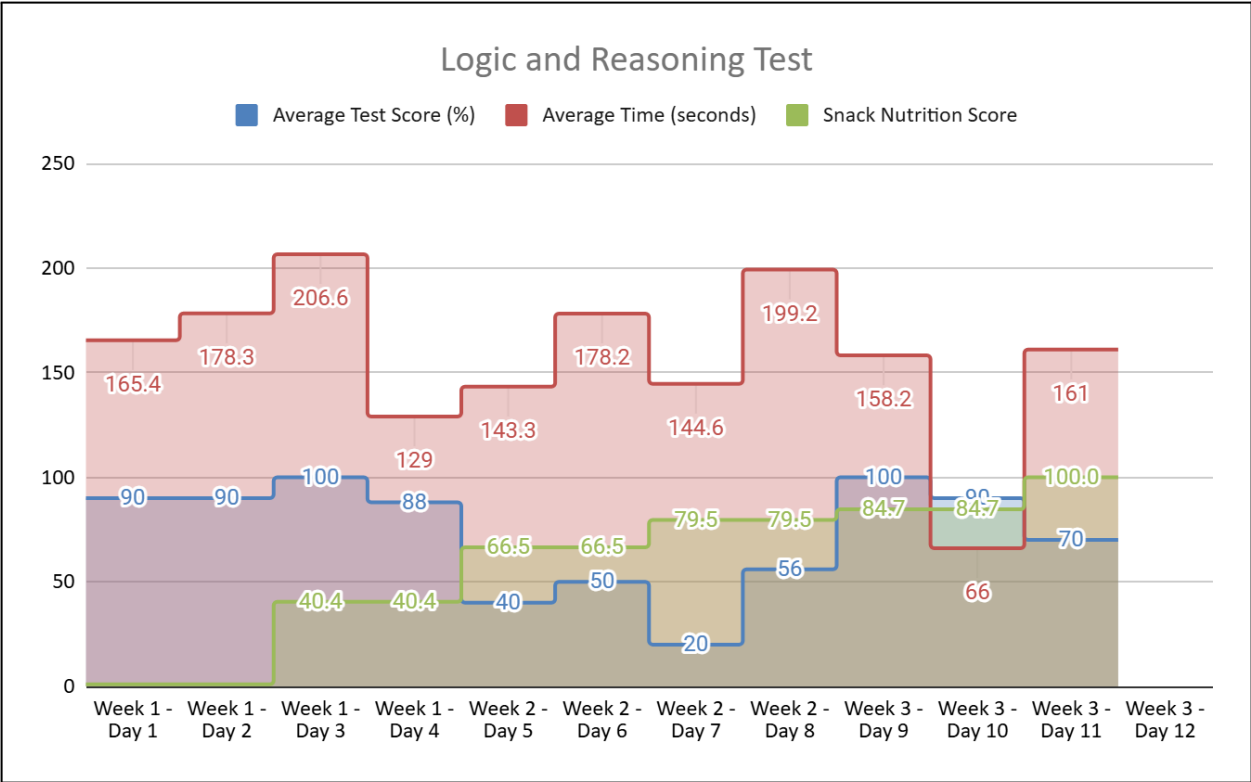
Control table:



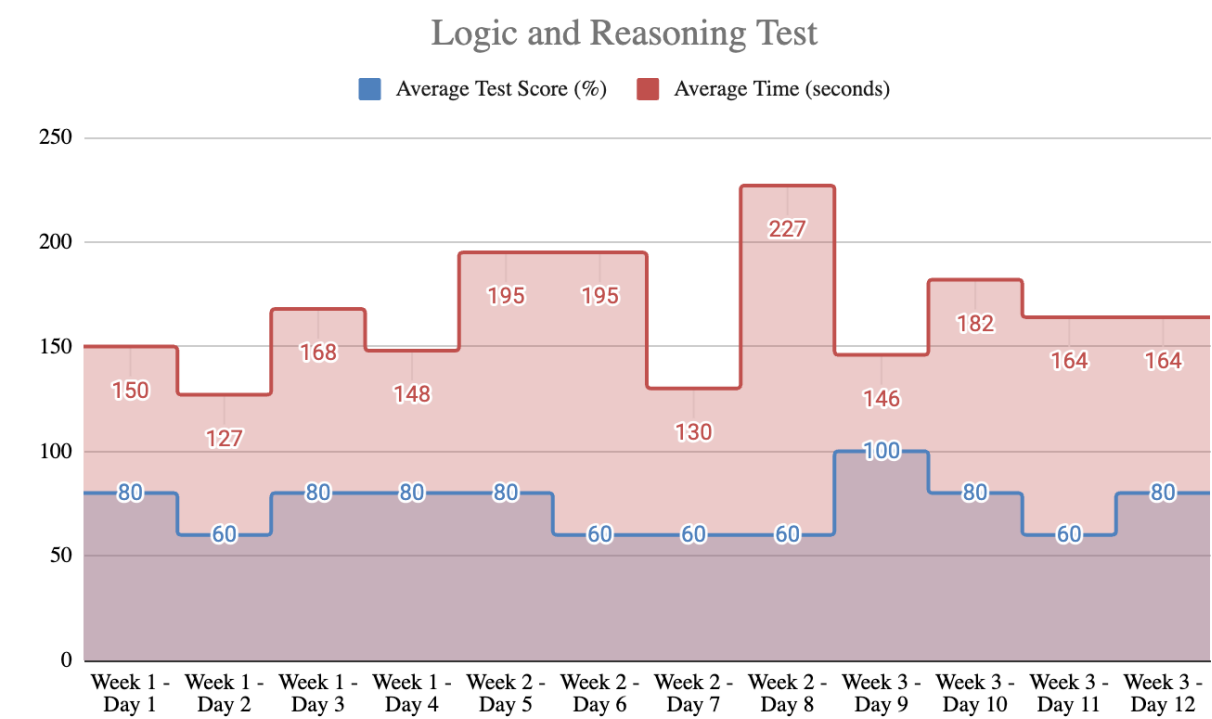
Reasoning Test

For the reasoning test, it is expected that there will be an increase in the scores and a decrease in the processing time as the nutrition score increases. The lowest results were on day 7, this was not expected based on the prediction. Again this could be because of the refined carbohydrates with zero omega-3 fatty acids. Also, it could be because this was in the upper limit of the amount of iron that you should consume. But one upside was there was lots of vitamin D. For days 1 and 2 the results followed the research because there were little carbohydrates and there was some iron. For days 3 and 4, they do not follow the research because it should be way lower because there are way more carbohydrates and lower vitamin amounts. For days 5 and 6 the results do follow the research because there were large amounts of carbohydrates and there was more iron than in previous days, with no omega-3 fatty acids. For days 7 and 8 the results are very mixed and do not follow the research and prediction. On days 9 and 10 the results follow the research. There are large amounts of omega-3 fatty acids and there were less carbohydrates than in previous days. For days 11 and 12 the results do not follow the research because it was expected that it would increase from the previous two days.

Graph 4. Logic and reasoning test averages in percent (%), across 11 days including the snack nutrition score of each day



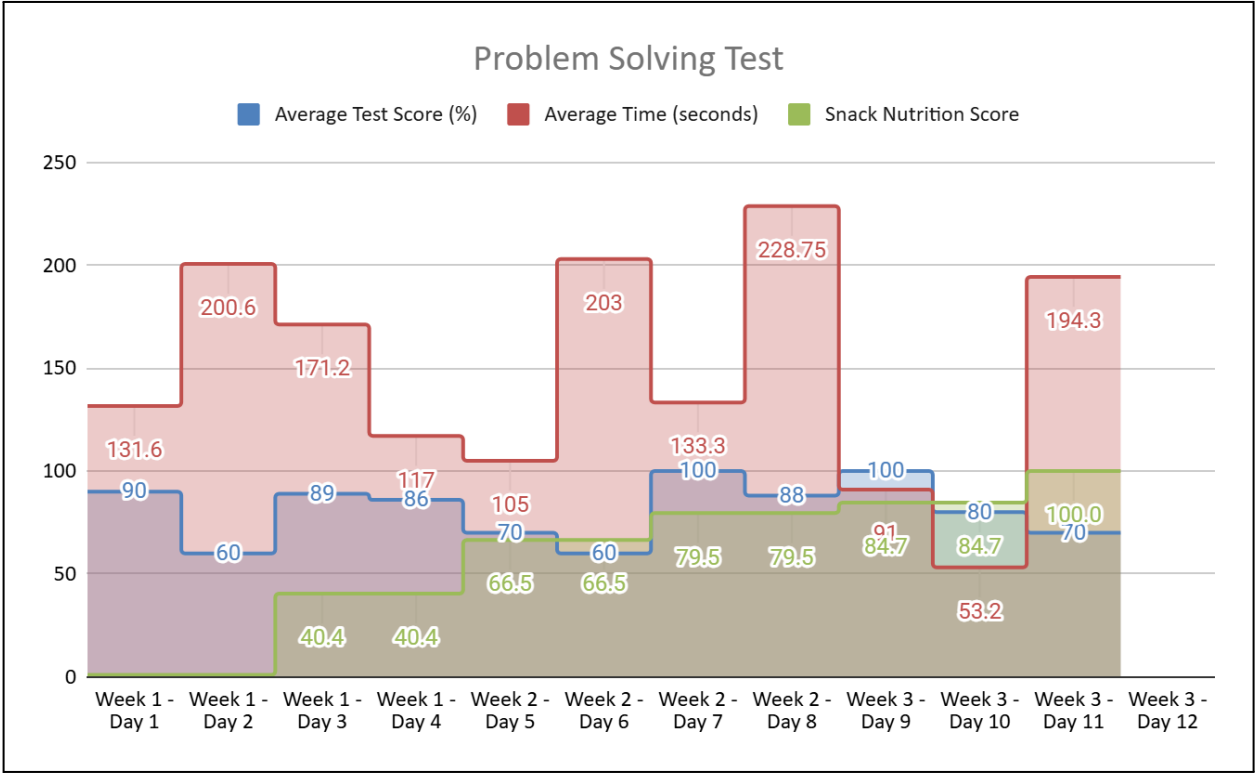
Control table:



Problem-solving

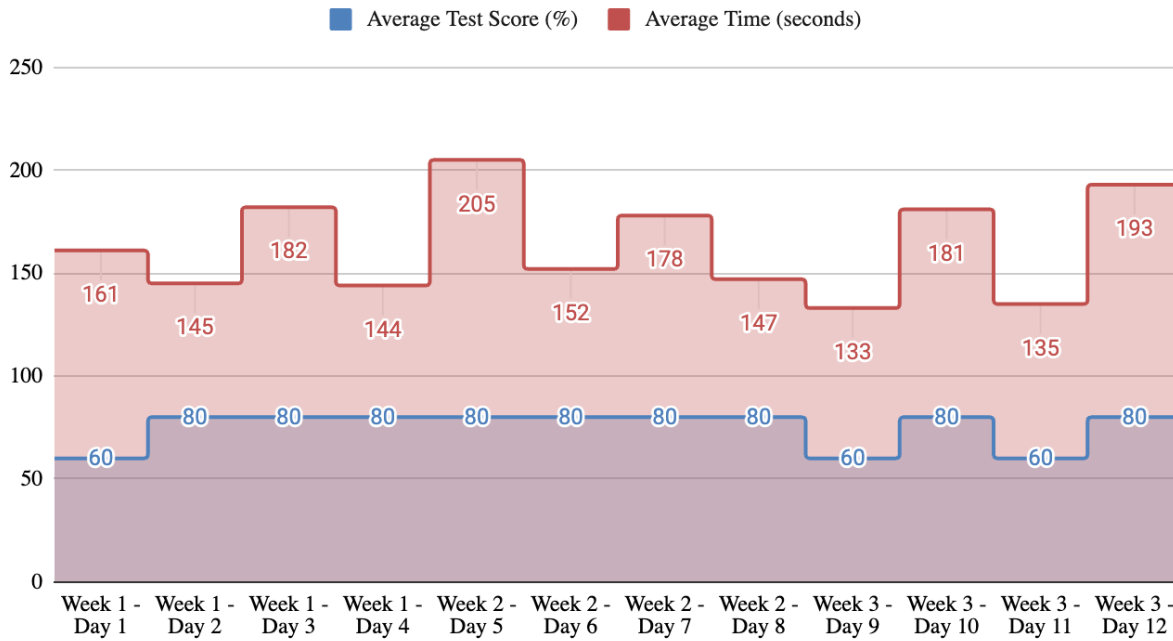
For the problem-solving test, it is expected that the test scores will increase and the processing time will decrease as the nutrition scores go up. The worst day was day 2 for the problem-solving test. This could be from the large amounts of sugar and because there are no omega-3 fatty acids. For days 1 and 2 did not follow the research because it fluxes a lot. This could be because different nutrients do different things and they will change how the experimental results. Since omega-3/PUFAs are very good for problem-solving while refined carbohydrates are bad, this could change how the experiment results from what is expected. Overall this test did not follow the research because it never followed any form of a pattern which was abnormal.

Graph 5. Problem-solving tests average in percent (%), across 11 days including the snack nutrition score of each day.



Control table:

Problem Solving Test



Sources of Error

The following sources of error can contribute to changes in the results from the prediction.

Purposefully Going Slow on the Stroop Test: Some participants might have intentionally slowed down while completing the Stroop test, which could have impacted their performance in terms of speed, skewing results for processing speed.

Non-compliance with Instructions: If participants did not fully listen to instructions, such as starting the test at the wrong time or not completing it within the set period, it could have led to inaccurate or inconsistent data collection.

What They Ate for Breakfast: The participants' breakfast choices could have affected their performance on the cognitive tests. For example, if a participant consumed a high-sugar breakfast, it might have resulted in energy crashes during testing, affecting memory, attention, and problem-solving abilities.

Amount of Sleep: Sleep quality and quantity can have a significant impact on cognitive function. If participants had varying amounts of sleep, this could have caused inconsistencies in performance on the tests.

Eating Speed: If participants consumed the food too quickly or too slowly, it could have influenced their cognitive test performance, as eating speed could affect digestion and nutrient absorption rates. Additionally, it could have influenced their focus or energy levels during the tests.

Limited Exposure to Last Food Combination: There was only one day of the last food combination (the most nutritious). Having more time with this diet would have provided better insights into its long-term impact on cognitive function.

Environmental Factors: Distractions or environmental factors (e.g., noise, temperature, or interruptions during testing) could have affected participants' ability to focus and perform on the tests.

Cognitive Variability: Participants might have had different baseline cognitive abilities, and some may have had better or worse focus, memory, or problem-solving skills regardless of the nutrition they consumed. This could have contributed to variability in the results.

Test Fatigue: Since participants were taking multiple tests each day, they could have experienced fatigue, which might have affected their performance, particularly on tests requiring attention and processing speed.

Limitations of this study include a small sample size and the short duration of each nutrition level diet (two days each). Future studies could explore longer exposure to a balanced diet, include a larger and more diverse sample, and assess how varying nutrient combinations specifically influence different cognitive domains.

Conclusions

This experiment aimed to explore the impact of nutrition on brain function by testing various food combinations over three weeks and measuring cognitive function through tasks that tested memory, attention, reasoning,

problem-solving, and processing. While the results showed some variability, there were trends suggesting that certain nutrients, like omega-2 fatty acids, iron, and calcium had observable effects on cognitive performance.

The memory test, in particular, demonstrated that higher nutritional scores led to improvements in recall, but also revealed inconsistencies in results, especially on days when high sugar or processed foods were consumed. This aligns with existing research that suggests nutrient-rich diets, particularly those containing essential vitamins and minerals, can enhance cognitive abilities. However, participants also struggled with focus and time management during the tests, possibly due to factors like sleep deprivation or distractions during the experiment, which introduced errors in the results.

The Stroop test and attention-to-detail tasks reflected improvements with more nutritious food, particularly when omega-3s and polyunsaturated fats were present, reinforcing research indicating that these nutrients play a role in cognitive function. However, the problem-solving test did not follow a clear trend, suggesting that other external factors may have affected the results more significantly.

Overall, while the experiment provided valuable insights into the connection between nutrition and cognition, further research is needed to draw conclusions about specific nutrients being beneficial. Further research could benefit from controlling more variables such as sleep and from longer exposure to the different nutrition score levels.

These findings show the importance of a balanced diet rich in a variety of nutrients to support cognition.

Application

Education: Based on the results, schools could implement nutrition programs that provide students with foods high in omega-3 fatty acids, iron, and other cognitive-enhancing nutrients. This could be especially important in developing countries or areas where malnutrition may be more prevalent.

Sports: Professional athletes could combine physical training with cognitive training supported by proper nutrition to enhance overall mental agility and decision-making during competition. They could create better diets and make their performance better.

But this is just the tip of the surface. This can affect many different people and fields of study.

Dedication

Thank you to my parents for supporting me through this great process. I am grateful to have the support of my mentor Cynthia Do for helping perfect my processes and making my work the best it can be. Thank you to Jojo for inspiring me to do the best project I possibly could do. Thank you to my friends Sage & Victoria for supporting me every step of the way. Thank you to all my other friends for giving me the advice I needed. Thank you to Westmount Charter school and to the science fair coordinator Ms.Lai making this possible. Last but not least, thank you to all the participants for completing all my tests and eating the food that could not have been done without you.

Resources

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