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.
- Behavioural skills: Making decisions and controlling actions.
- Motor skills: Moving and coordinating your body.

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

Nutrition and Brain Development

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.

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.”

NUTRITION AND COGNITIVE FUNCTION

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.

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
- Knifes
- 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.

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

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