AUCTORES
Globalize your Research
Journal of Neuroscience and Neurological Surgery
Raed Mualem *
Open Access
Research Article

The Effect of Dietary Preferences on Academic Performance Among Kindergarten-Aged Children

Raed Mualem [1]*, Nibal Jadon [2], Shir Shance [1], Rania Hussein Farraj [1], Riham Mansour [2], Sapir Cohen [1], Yusra Zbedat [3], Calixto Machado [4]

[1] Econeurobiology Research Group, Research Authority, Oranim Academic College, Israel.

[2] The Institute for Brain and Rehabilitation Sciences, Israel.

[3] Ramat Zebulon high school, Israel.

[4] The University of the Medical Sciences of Havana, Cuba.

***Corresponding Author:** Raed Mualem., Econeurobiology Research Group, Research Authority, Oranim Academic College, Israel.

Received date: August 08, 2023; Accepted date: August 24, 2023; Published date: August 31, 2023

Citation: Raed Mualem, Nibal Jadon, Shir Shance, Rania Hussein Farraj, Riham Mansou, et al, (2023), The Effect of Dietary Preferences on Academic Performance Among Kindergarten-Aged Children, *J. Neuroscience and Neurological Surgery,* 13(3); DOI:**10.31579/2578-8868/277**

Abstract

This study examines the impact of kindergarten children's dietary preferences on their cognitive performance and social relationships, with a focus on traditional foods versus processed foods. The research demonstrates that a child's choice of breakfast can significantly affect their cognitive abilities, including memory and concentration, as well as their interpersonal relationships. Traditional foods like salads and olive oil are found to increase cognitive abilities, while processed foods like hot dogs and chocolate sandwiches can be detrimental to academic performance and social behavior. The study utilized puzzle games and card games to evaluate cognitive abilities and found that a processed diet can lead to decreased focus, hyperactivity, and impaired social relationships.

QEEG analysis contributes to the existing body of evidence indicating that a traditional diet can enhance academic performance. The study highlights the importance of educating parents about the advantages of a traditional diet and encourages them to prepare breakfast together with their children using traditional foods like olive oil and salad to enhance academic performance and social relationships.

The findings offer valuable insights into the importance of a traditional diet for young children's education and highlight the need for greater attention to be given to diet as an important factor in children's academic success.
Key words: nutrition; educational achievement; cognition; gut-brain axis; early childhood

1. Introduction

The human body obtains its energy through the digestive system via a complex process of digestion and absorption. Within the digestive system, the digestive processes occur along various organs and are aided by the participation of microorganisms in the large intestine, where fermentation and the breakdown of plant cellular wall take place to produce SCFA short chain fatty acid [1]. The composition of these microorganisms is subject to change due to a variety of factors, such as daily diet, diarrhea, and the administration of antibiotics, although their quantity remains relatively constant. The microorganisms that reside in our intestines, particularly in the large intestine, can be categorized as either beneficial or pathogenic (“good” and “bad” bacteria). Consumption of high-fat foods can provoke inflammation on the surface of the intestines, potentially leading to the development of a "leaky gut" syndrome. This condition allows toxic substances to enter the bloodstream, which may trigger an immune response. The hazards of such toxic substances are significant, as they are capable of penetrating the blood-brain barrier. [2-4]

Recent research has elucidated the capacity of various bacteria, including commensal, probiotic, and pathogenic ones, residing in the gastrointestinal tract to activate neural pathways and signaling systems of the central nervous system. [2, 4]. Therefore, it has been suggested that the digestive system may act as a "second brain”. It has been established that the composition of the intestinal microbiota can exert a profound influence on numerous physiological parameters, including cognitive functions like learning, memory, and decision-making. The connection between dietary intake, medication use, and emotional behavior has been demonstrated, with the advent of some untreatable illnesses. Preclinical investigations have identified a significant role for the gut microbiota in these brain interactions. In rodents reared under germ-free conditions, the gut microbiota appears to impact the development of emotional behavior, stress, and pain modulation systems, as well as neurotransmitter systems in the brain. Disturbances to the microbiota through interventions such as probiotics and antibiotics can also impact these indicators in adult animals. Recent evidence suggests that numerous mechanisms, such as endocrine and neurocrine pathways, contribute to gut-to-brain signaling and that the autonomic nervous system facilitates bidirectional alterations to both behavior and microbes in the brain. Clearly, the gut-brain axis plays a substantial role in the pathogenesis of conditions like irritable bowel syndrome, autism, anxiety, depression, and Parkinson's disease [3].

The epidemiological evidence substantiates the hypothesis that modifiable lifestyle factors are correlated with cognitive decline, hence paving the way for novel preventive strategies.

Certain dietary patterns, such as the Mediterranean diet, may confer more favorable outcomes than elevated consumption of individual nutrients or particular food items. The evidence strongly suggests a link between vascular risk factors and dementia, and the association between diet and several vascular and metabolic disorders is widely recognized. Additionally, plausible mechanisms underlying the connection between nutrition and cognitive decline have been postulated, including inflammation and oxidative stress. (Figure. 1). [5]

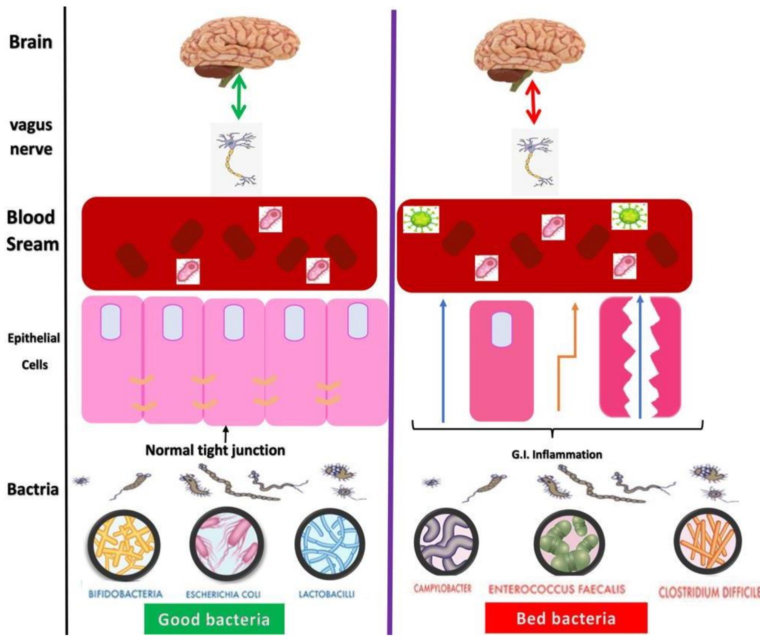

Figure 1: The gut-brain connection

Figure drawn by Roaa Mohamed

The microbiota's composition represents one of the primary regulators of gut function in the brain and has instigated an evaluation of the gut-brain axis' significance. The axis's importance revolves around investigating the biological and physiological foundation of psychiatric, neurodevelopmental, age-related, and degenerative disorders. The communication between the microbiota and the brain occurs through diverse pathways, such as the immune system, tryptophan metabolism, the vagus nerve, and the enteric nervous system, which encompasses microbial metabolites like short chain fatty acids, branched chain amino acids, and peptidoglycans. Numerous factors can influence the microbiota's composition early in life, including infection, mode, antibiotic use, nature of nutrition, environmental stressors, and host genetics. In contrast, microbial diversity decreases with aging. Stress, in particular, can significantly impact the microbiota-gut axis throughout all stages of life. Recent research has linked gut bacteria to a myriad of conditions, including autism, anxiety, obesity, schizophrenia, Parkinson's disease, and Alzheimer's disease. [2-6]

In conclusion, in recent years researchers have uncovered links between pathology in the digestive system and psychiatric neurological conditions, including anxiety, depression, autism, schizophrenia, and neurodegenerative disorders [7-8]. Various studies have shown that there is a relationship between the intestines and the brain, as well as the impact of the microbiota composition on brain functioning, distinguishing the positive effects of beneficial bacteria that contribute to the fermentation processes of polysaccharides and the synthesis of short-chain fatty acids, primarily in the colon [1]. These substances are essential sources of energy and vitamins for the body's functions, especially in omnivorous and ruminant animals. Therefore, a high-fiber, plant-based diet enhances the link between the intestines and the brain, resulting in better health, human well-being, and normative cognitive function. Conversely, a diet high in fats and processed foods can cause a shift in the bacterial population's composition, leading to an imbalance in favor of detrimental bacteria. Such an unhealthy diet can result in disorders such as a "leaky gut," which increases the epithelial tissue's permeability, causing inflammation on the epithelium's surface. This inflammation, in turn, enables toxic substances and compounds such as complex sugars, fats, and "LPS" to penetrate the bloodstream, causing an elevation in cytokines levels that stimulate the immune system's response, leading to immune dysfunction and autoimmune diseases. Moreover, this toxicity can cross the blood-brain barrier, and lead to neurological disorders that manifest in cognitive and behavioral function impairment [2-8].

The traditional society around the world is usually based on a healthy diet rich in plants. However, during the last few years, there has been a transition to an industrialized diet that is high in fat, in light of socio-economic development. This change in food preference among children has far-reaching consequences for their health and brain functions. The current study examines the effect of this transition from a preference for traditional food to industrialized food on the cognitive functions of preschool children. Preschool is a critical age in the overwhelming stages of development when the brain architecture takes shape, and the realization of intellectual potential begins.

2. Materials and Methods

This research is presented in three parts: (1) 90 minutes after consuming traditional and processed food, memory and concentration were tested through computer games. (2) 90 minutes after consuming traditional and processed food, children's observed behavior was recorded through non-participant observation. (3) 90 minutes after consuming traditional and processed food, brain activity was investigated using QEEG in school children in Cuba.

2.1 Participants

The study's participants consisted of 68 preschool kindergarten children aged 5-6 years from two Arab villages located in the eastern Lower Galilee region of Israel. After obtaining informed consent forms signed by their parents, the kindergarten children who participated in the study did so voluntarily. The meetings were scheduled on their free days, outside of the regular education system. The current investigation focuses on the "10AM meal" that is prepared at home, while the mid-day meal is provided by a licensed vendor on behalf of the Ministry of Education. IRB approval was obtained from the institute for brain and rehabilitation sciences, Israel.

The children participated voluntarily in an extracurricular activity with the approval of their parents, and only after the parents had given their informed consent by filling and signing the Consent form for research participation.

2.1.1 Children Characteristics

The first kindergarten comprises 35 children, 46% are male and 54% are female. All the children belong to the Arabs Muslim community, and their families exhibit a range of socioeconomic levels from low to medium. The occupations of the children's fathers are distributed among several categories, 80% being manual laborers, 5.7% being unemployed, and a mere 14.3% occupying clerical positions. With regard to the mothers, 52% are homemakers, 26% are manual laborers, and 22% are clerks. The second kindergarten comprises 33 children, 64% are male and 36% are female. All the children also belong to the Arab Muslim community, and their families exhibit a range of socioeconomic levels from medium to high. The occupations of the children's fathers are also distributed among several categories, with 81.5% being manual laborers, 6% being unemployed, and only 12.5% occupying clerical positions. With regard to the mothers, 43% are homemakers, 9.3% are manual laborers, and 47.7% are clerks.

2.2 Measurement instruments

The present study is a quantitative study with the aim of elucidating phenomena through causal relationships. The fundamental premise underlying the quantitative approach is objectivity, wherein the researcher's identity does not affect the research findings (9). Two tools have been utilized to achieve this objective:

I. The first tool entails the use of two computer games to measure memory and concentration. An eight-piece puzzle game in the *Jigsaw Planet* app and a seven-card memory game in the *LearningApps* app. In the puzzle game, the children were required to solve 8-piece puzzle. In the memory game, the children were required to match identity cards, when the pictures on the cards were taken from the children's natural environment. In both games, the time taken to complete the games was measured individually for each child in minutes and converted into seconds to enable accurate statistical analysis. This tool was employed at all stages of the research.

II. The second tool involves non-participant observation, in which an assistant observer looks and observes the children's behavior during natural activities, without initiating any intervention that may affect the course of the event. The observation is focused on the description of overt behaviors (10). The observation was carried out throughout the curriculum week during the study. Each participant's behavior was rated on a scale of 1 to 5, where 1 signifies "not at all," and 5 represents "always." The results were recorded in a questionnaire comprising 10 statements selected from a Social Skills Rating System - SSRS - (11), which were suitable for the present study. The statements have been categorized into positive and negative. This mapping was conducted throughout the study and will be utilized to test the research hypotheses. (Table.1)

Statement	Positive / Negative
Finishes class assignments within time limits	Positive
Responds appropriately to teasing	Positive
Initiates conversations with peers	Positive
Follows instructions	Positive
Disturbs activities	Negative
Doesn't listen to what other say	Negative
Answers impudently to adults when reprimanded	Negative
Has temper tantrums	Negative
Likes to be alone	Negative
Fidgets or moves excessively	Negative

Table 1: Ten statements selected from a Social Skills Rating System – SSRS.

Source: Greesham & Elliot, 1990

2.3 Definitions of independent and dependent variables

The present study's independent variable is the diet preference - "10AM meal", which comprises four distinct values, namely:

1. Chocolate sandwich.
2. Olive oil and Za'atar* sandwich with a side salad.
3. Sausage sandwich.
4. Labneh (strained yogurt) and olive sandwich.

* Za'atar is a Middle Eastern herb and spice mixture that includes herbs such as oregano, basil thyme, thyme, and savory, as well as toasted sesame seeds, dried sumac, and salt.

The dependent variables, on the other hand, include:

1. The cognitive capacity of the children in terms of memory.
2. The level of concentration exhibited by the children.
3. The observed behavior of the children.

2.4 Research design

This study is a quantitative inquiry that aims to ascertain the impact of processed food on children's memory, concentration, and observed behavior. Employing the research instruments expounded upon in section

2.2, the statistical analysis was conducted via t-tests to substantiate the research hypotheses and draw inferences with broader applicability.

Prior to the commencement of the research project, the researchers apprised the educational teams in both kindergartens of the study and explicated all its stages, while addressing any inquiries or reservations that they might have had. Furthermore, they elucidated the study's aim, as well as its near and far-reaching advantageous effects on the well-being of the children.

2.5 Procedure

The study was conducted over a period of one month and consisted of two distinct stages: During the first stage, each child from the two participating kindergartens was engaged in a memory game, individually, following an average interval of an hour and a half after consuming their "10AM meal" that was supplied from home. The duration of the game was measured in minutes and subsequently converted to seconds to facilitate accurate statistical computation. The resultant findings were manually recorded based on the type of meal that was consumed by each child. Simultaneously, a non-participant observation of the children was undertaken by an assistant, who observed seven children per day for four hours and recorded a score for each child in each category. The scores were rated on a scale of five levels, with 1 indicating "not at all" and 5 indicating "always." The recorded findings were manually entered into a table, classified based on the type of meal.

The second stage of the study involved the participation of children from both kindergartens in a puzzle game, following a similar procedure as the first stage.

2.6 Statistical analysis

Paired t-test comparisons were performed between traditional and processed food as each participant served as his or her own control.

2.7 Cuba

Brain activity after consuming different types of diets was investigated using Quantitative EEG, after same methodology that was used in Israel. QEEG is a rapidly evolving technology. Because the brain undergoes continuous and dynamic changes, QEEG was considered to be an effective method for real-time monitoring of functional brain changes after the children have their 10AM meal.

2.7.1 Participants

Fifteen school children in the third grade (aged 4 to 5) of "Gonzalo de Quezada" Havana School underwent Quantitative EEG analysis with IRB approval of the Institute of Neurology and Neurosurgery, Havana, Cuba.

2.7.2 Procedure

QEEG analysis was performed in the laboratory of the Institute of Neurology and Neurosurgery, Havana, Cuba under conditions of controlled room temperature (from 24 to 26O Celsius), noise attenuation and dimmed lighting. QEEG recording was performed from 19 standard locations over the scalp according to the 10-20 system: Fp1, Fp2, F3, F4, F7, F8, T3, T4, C3, C4, P3, P4, T5, T6, O1, O2, Fz, Cz, and Pz.

After careful cleansing of the skin, disc EEG tin electrodes were fixed using a conductor paste and connected to the input box of the digital Quantitative EEG Monitoring system (Neuronic, S.A.). Monopolar leads were recorded using linked ears as a reference. Technical parameters for EEG were: gain 20,000; pass-band filters 0.1 -70 Hz; "notch" filter at 60 Hz; noise level of 2 μV (root mean squared); sampling frequency 200 Hz; and electrode-skin impedance never higher than 5 KΩ. For monitoring purposes, a 7 bipolar chest electrocardiogram (ECG) lead was simultaneously recorded with 0.5 to 30 Hz EEG filters. QEEG was recorded 90 min after a meal that included a different food preference of traditional food and processed food.

2.8 Results

The present study examined the association between dietary preference and cognitive abilities, among children in two kindergartens situated in two Arab villages located in the eastern Lower Galilee region in Israel. The results obtained, which pertain to the cognitive capacities of memory and concentration, concerning the comparison between processed and traditional food, are shown in Table. 2.

Type of diet	Diet preferences	Solving the task Memory)time in seconds(	Solving the task Concentration)time in seconds(
Processed food	Chocolate sandwich.	125.69+6.12	149.81+7.17
	Sausage sandwich.	137.18+6.49	135.74+6.2
	Average of Processed food	131.44+6.31	142.78+6.69
Traditional food	Olive oil and Za'atar sandwich with a side salad.	90.10±4.37	104.66±5.60
	Labneh and olive sandwich.	78.40+3.44	79.91+3.81
	Average of Traditional food	84.25+3.91	92.29+4.71
% of Change From Processed food to Traditional food		-35.9%	-35.4%
P Value		P<0.001	P<0.001

Table 2: The cognitive ability of memory and concentration in the preference of traditional food and processed food among kindergarten children. The duration, measured in seconds.

As part of the study, the proficiency of children's memory was evaluated using a computerized memory game.

According to the research findings, the duration of time needed for children to complete the memory game after consuming processed food based on chocolate was 125.69±6.12 seconds. In contrast, the time required to finish the game significantly decreased by 28.3% after consuming traditional food based on olive oil, compared to the time needed after consuming processed food. Moreover, switching from processed food based on sausage to traditional Labneh-based food led to a 42.8% decrease in the time required to complete the game. Therefore, it can be concluded that traditional food resulted in a noteworthy 30%-40% decrease in the time required to complete the memory game, demonstrating a significant and observable increase in memory proficiency.

In the other part of the study, the proficiency of children's concentration was evaluated using a computerized 8-pieces puzzle game. According to the research findings, the duration of time needed for children to assemble an 8-pieces puzzle was an average of 149.81±7.17 seconds. however, when the kindergarten children consumed a breakfast that included traditional food, based on olive oil, it was found that the time required to assemble it decreased by 30%.

This reduction in the time required to assemble the puzzle is noteworthy as it indicates a substantial decrease. Similar results were obtained with the diet preference of processed food containing sausage to that of a traditional meal containing Labneh. In this case, the mean time taken to complete the task, which serves as an indicator of concentration level, was 104.66±5.60 seconds. The adoption of a traditional diet led to a decrease in the time required to assemble the puzzle, amounting to a reduction of 23.5%. This reduction was explicit and significant.

In light of these observations, it can be inferred that a 10Am meal composed of traditional food significantly reduces the duration of completing the memory game by 35.9% and assembling the puzzle, as compared to the period needed after consuming processed food by 35.4%.

The present study also examined the behavioral aspect of the children, for this purpose a test was carried out using a professional questionnaire for measuring behaviors, based on the Social Skills Rating System - SSRS - (Greesham & Elliot, 1990). The research findings are presented in Tab.3 and Table. 4.

The research findings show that all the values of the positive statements in processed food, which consisted of a chocolate sandwich or a sausage, increased when switched to traditional food, which consisted of a sandwich with za'atar and olive oil or a sandwich with labneh. At the same time, the findings indicate that all the values of the negative statements in processed food, consisting of chocolate or sausage, decreased significantly when switched to traditional food, consisting of a sandwich with za'atar and olive oil or labneh (Table.3).

Diet Preference / Statement	Processed food Chocolate sandwich	Traditional food Olive oil and Za'atar sandwich with a side salad	t	P	Processed food Sausage sandwich	Traditional food Labneh and olive sandwich	t	P
Finishes class assignments within time limits **Positive**	**2.94±1.00**	**4.47±0.78**	**12.08**	**P < 0.001**	**2.38±1.03**	**4.13±1.03**	**8.69**	**P < 0.001**
Responds appropriately to teasing **Positive**	**1.91±1.08**	**4.33±0.84**	**16.49**	**P < 0.001**	**2.14±0.98**	**3.98±0.92**	**10.29**	**P < 0.001**
Initiates conversations with peers **Positive**	**2.17±1.18**	**4.45±0.72**	**17.68**	**P < 0.001**	**2.04±1.07**	**4.00±0.99**	**9.65**	**P < 0.001**
Follows instructions **Positive**	**2.33±1.04**	**4.39±0.73**	**19.81**	**P < 0.001**	**2.14±0.95**	**3.77±1.06**	**11.14**	**P < 0.001**
Disturbs activities **Negative**	**2.75±1.23**	**1.29±0.45**	**11.51**	**P < 0.001**	**3.32±1.04**	**1.73±0.84**	**8.57**	**P < 0.001**
Doesn't listen to what other say **Negative**	**2.58±0.98**	**1.76±1.16**	**4.07**	**P < 0.001**	**3.14±1.23**	**2.51±1.38**	**3.09**	**P < 0.001**
Answers impudently to adults when reprimanded **Negative**	**2.17±0.96**	**1.10±0.30**	**10.18**	**P < 0.001**	**3.33±1.43**	**1.61±0.94**	**7.29**	**P < 0.001**
Has temper tantrums **Negative**	**3.13±0.89**	**1.29±0.49**	**21.50**	**P < 0.001**	**3.75±0.98**	**1.73±0.87**	**8.77**	**P < 0.001**
Likes to be alone **Negative**	**2.80±1.34**	**1.33±0.47**	**9.34**	**P < 0.001**	**3.13±1.45**	**1.76±0.93**	**5.70**	**P < 0.001**
Fidgets or moves excessively **Negative**	**3.38±1.28**	**1.42±0.55**	**15.46**	**P < 0.001**	**3.83±1.03**	**1.85±0.90**	**10.78**	**P < 0.001**

Table 3: A comparative analysis of statements that examine the impact of different dietary preferences on the behavior of children. The results are presented on a scale of 1 to 5, where 1 indicates "not at all" and 5 represents "always".

Children who consumed processed food received a sum of values of 9.04 ± 3.31 based on positive statements, each of which was rated on a scale of 1-5, where 1 represents "not at all" and 5 represents "always". This suggests that the children did not carry out tasks such as starting conversations, communicating appropriately, and adhering to instructions. In contrast, the study found that children who consumed traditional food had a significantly increased sum of values by 46.12%, which included initiating conversations, speaking appropriately, and following instructions, indicating that they performed these tasks effectively (Tab.4).

Furthermore, the study also measured negative statements, which described negative behavioral situations such as tantrums, disruption of activities, listlessness, preference for being alone, and hyperactivity. The results show that children who consumed processed food had a sum of values recorded as 18.68 ± 4.87 for these negative behaviors, indicating a high tendency towards negative behavior. Interestingly, transitioning from processed food to traditional food led to a significant decrease in negative behavior by 48.02%, including tantrums, disruption of activities, lack of listening, rude responses, preference for solitude, and hyperactivity (Tab.4).

Diet Preference	The sum of the values of positive behavior statements (Maximum 4X5=20)	The sum of the values of negative behavior statements (Maximum 6X5= 30)
Traditional food	**16.78 + 3.02**	**9.71 + 3.77**
Processed food	**9.04 + 3.31**	**18.68 + 4.87**
% of change	**46.12%**	**-48.02%**
t	**20.52**	**17.04**
P	**P<0.0001**	**P<0.0001**

Table 4: Total values of positive and negative behavior statements. The results are presented on a scale of 1 to 5, where 1 indicates "not at all" and 5 represents "always".

2.8.1 Results from Cuba

In Fig. 2 and Fig. 3, we show representative subjects. It was a clear and statistically significant increment of the alpha absolute power comparing consuming of traditional & processed. Regarding gamma absolute power there was also a significant increment when consuming traditional food, but less than alpha absolute power. Concluding when comparing consuming of traditional & processed food we found significant increments in both alpha and gamma absolute power, although for the alpha band the augmentation was greater.

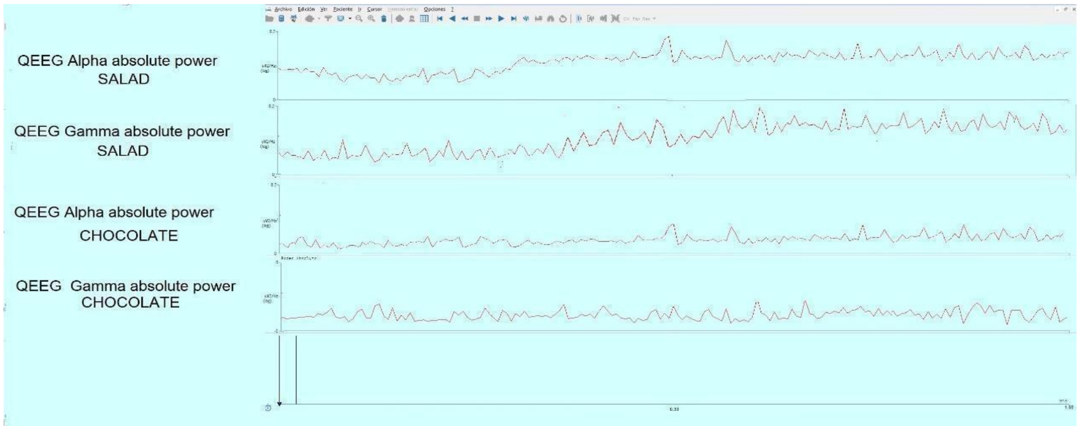

Figure 2: There is an increment of all absolute powers. It was found a clear increment of alpha and gamma absolute powers when children consumed traditional food over processed food.

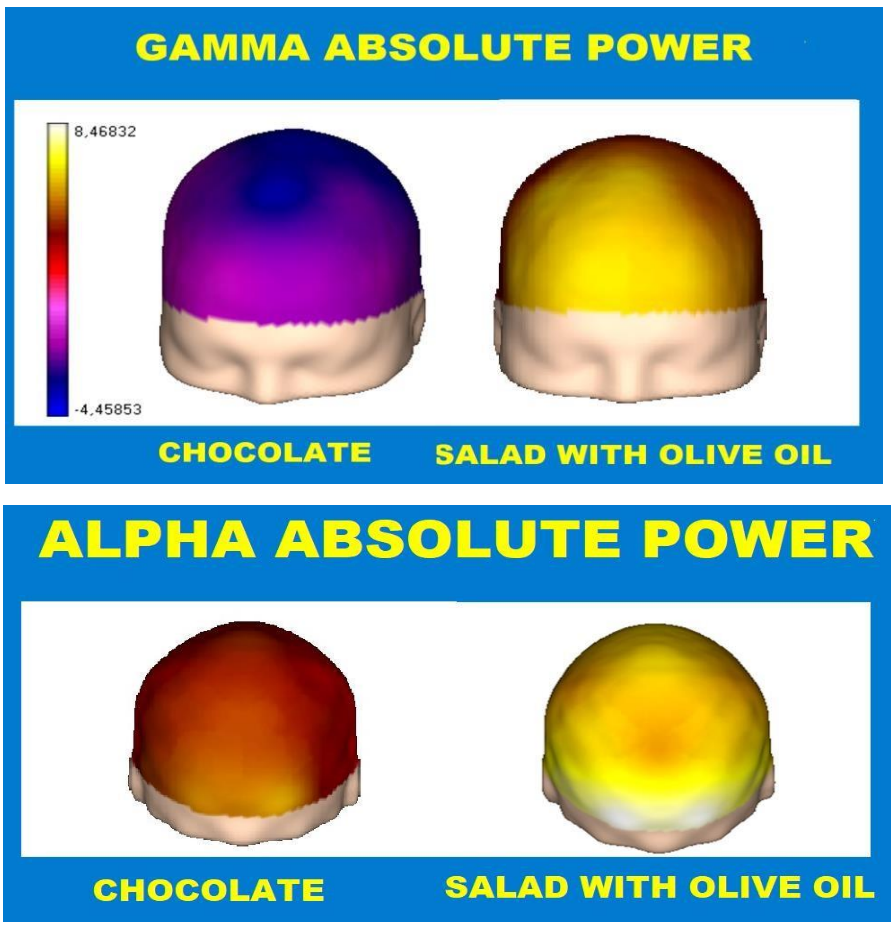

Figure 3: Comparing Gamma & Alpha waves of consuming traditional vs. processed food, there are clear increments in both alpha and gamma absolute powers.

3. Discussion & Conclusions

Food preference affects the composition of bacteria in the digestive system, and the level of balance between the beneficial bacteria and the level of pathogenic bacteria, which can affect the children's health, mood and cognitive abilities. [2-8]

The consumption of processed foods high in fats and sugars can lead to inflammation on the intestinal membrane, and the metabolic activity of pathogenic bacteria may disrupt the connections between neurons in the brain, resulting in a decrease in alpha and gamma wave strength. These changes can impact mood, cognitive abilities, and problem-solving skills, as demonstrated by this study.

This present study investigated the impact of diet preferences on cognitive abilities and electro-physiology within the brains of children. The research findings strongly suggest that the type of diet children consume can have a far-reaching influence on these particular parameters.

The study's conclusion highlights that a diet primarily based on processed food is linked to a marked decrease in the strength of brain waves associated with mood, cognitive abilities, and learning, which are crucial for children to concentrate and engage in academic activities. These outcomes further suggest that such a diet can have significant implications for the development of the brain's architecture and design, including brain flexibility, which can shape the mental and educational abilities of children.

We propose a mechanism by which this improvement in cognition may have been achieved. QEEG analysis comparing traditional vs processed food demonstrated an increment mainly in the alpha and gamma bands. Thus, the results of QEEG analysis in this research support the hypothesis that consuming traditional food over processed food increases cognitive abilities such as memory and concentration as well as positive observed behavior (stimulation of the limbic pathway) which in turn primes the frontal and prefrontal areas for improved learning and cognition through stimulation of connecting neural networks.

The academic literature emphasizes the harmful effects of a processed food and underscores the significance of a high-fiber and traditional diet. The biological basis for this may be to due to the fact that a processed diet can provoke inflammation on the surface of the intestinal lining and lead to an increase in antibody levels. This can potentially harm normal brain activity, resulting in reduced cognitive abilities and aberrant behavior characterized by hyperactivity, violence, and rebellion. [2-4].

It is noteworthy that one of the conclusions drawn from the current study is that a high-fiber diet can enhance the electro-physiology of the brain and improve cognitive performance, as manifested by greater efficiency and effectiveness in tackling cognitive challenges. The significant impact of food preference on these crucial parameters calls for a comprehensive discussion to devise effective strategies and policies concerning the type of diet children should receive during their formative years. This is because any damage to the neurobiology of the brain can have far-reaching changes and effects on the development of human capital within society.

We strongly recommend the establishment of control and regulation mechanism for the nutrition children consume. It is vital to educate parents on the significance of plant-based nutrition and its profound effects on their children's health and cognitive development.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Author Contributions

Raed Mualem developed the research concept. Nibal Jadon, Shir Shance, Rania Hussein Farraj, Riham Mansour, Yusra Zbedat, Calixto Machado were involved in manuscript drafting and revision for intellectual content.

Acknowledgment

This work was supported in part by Oranim Academic College, Israel.

References

1. Mualem, R., & Choshniak, I. (1995). Modulation of water and solute transport following food restriction in the colons of the Levant vole (Microtus guenteri) and the mouse (Mus musculus). Physiological Zoology, 68(3), 524-538.
2. Foster, J. A., & McVey Neufeld, K. A. (2013). Gut-brain axis: how the microbiome influences anxiety and depression. Trends in neurosciences, 36(5), 305–312.
3. Mayer, E. A., Tillisch, K., & Gupta, A. (2015). Gut/brain axis and the microbiota. The Journal of clinical investigation, 125(3), 926–938.
4. Montiel-Castro, A. J., González-Cervantes, R. M., Bravo-Ruiseco, G., & Pacheco-López, G. (2013). The microbiota-gut-brain axis: Neurobehavioral correlates, health and sociality. Frontiers in Integrative Neuroscience, 7, 70.
5. Caracciolo, B., Xu, W., Collins, S., & Fratiglioni, L. (2014). Cognitive decline, dietary factors and gut-brain interactions. Mechanisms of ageing and development, 136-137, 59–69.
6. Cryan, J. F., O'Riordan, K. J., Cowan, C. S. M., Sandhu, K. V., Bastiaanssen, T. F. S., Boehme, M., Codagnone, M. G., Cussotto, S., Fulling, C., Golubeva, A. V., Guzzetta, K. E., Jaggar, M., Long-Smith, C. M., Lyte, J. M., Martin, J. A., Molinero-Perez, A., Moloney, G., Morelli, E., Morillas, E., O'Connor, R., … Dinan, T. G. (2019). The Microbiota-Gut-Brain Axis. Physiological reviews, 99(4), 1877–2013.
7. Smith, P. A. (2015). Brain, meet gut: Neuroscientists are probing the connections between intestinal microbes and brain development. Nature, 526(7573), 312–313.
8. Wang, H. X., & Wang, Y. P. (2016). Gut Microbiota-brain Axis. Chinese medical journal, 129(19), 2373–2380.
9. Antonovsky, A. (2006). Research Methods in Education: A Study Guide. The Open University, Israel.
10. Toren, Z. (2001), Early childhood ethnography research methods. Darna, 35, 148-159.
11. Gresham, F. K., & Elliot, S. N. (1990). Social Skills Rating System. Social skills
questionnaire, teacher elementary level. American Guidance Service, Inc.

Notes

1. Memory game – *LearningApps*, Michael Hielscher, 2012 https://learningapps.org/display?v=pjkz2efin21
2. Puzzle game – *jigsawplanet*, Tibo Software, 2003 https://www.jigsawplanet.com/?rc=play&pid=1cba94fd0160

DOI: 10.31579/2578-8868/277