



Effect of Breakfast Consumption on Verbal Fluency and Verbal Working Memory Performance in Seven-Year-Old Children

Jalal Bakhtiyari ¹, Mahdi Shadnough ², Hooshang Dadgar ³, Masoomeh Salmani ^{1,4,*}, Fatemeh Argha ⁴, Masoomeh Khani ⁴ and Atefe Rahmati ⁵

¹Speech Therapy Department, Neuromuscular Rehabilitation Research Center, Semnan University of Medical Sciences, Semnan, Iran

²Department of Clinical Nutrition, Faculty of Nutrition & Food Technology, Shahid Beheshti University of Medical Sciences, Tehran, Iran

³School of Rehabilitation, Tehran University of Medical Sciences, Tehran, Iran

⁴Student Research Committee, Semnan University of Medical Sciences, Semnan, Iran

⁵Department of Speech Therapy, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran

*Corresponding author: Neuromuscular Rehabilitation Research Center, Semnan University of Medical Sciences, Semnan, Iran. Email: salmani_masooome@yahoo.com

Received 2019 November 05; Revised 2020 January 14; Accepted 2020 January 21.

Abstract

Background: Studies have indicated that failure to eat breakfast did not affect children's performance in general cognitive tests; however, skipping breakfast might have effects on the specific aspects of cognition such as memory. Hypothetically, language as a higher cognitive function may be influenced by breakfast consumption routines.

Objectives: This study aimed to compare students' verbal fluency and working memory according to their breakfast routines.

Methods: We selected 60 seven-year-old children from three primary schools in the central regions of Tehran in 2017. Their parents were invited to a structured interview to fill out questionnaires consisting of information related to the child, parent, and breakfast routines. Based on the family's breakfast habits, two groups were identified: Group 1 with a full, regular breakfast routine and Group 2 with no breakfast or incomplete breakfast routine. An experienced speech therapist administered the verbal fluency task (phonemic and semantic fluency) and verbal working memory task (forward and backward digit numbers) for each student.

Results: The mean scores of students with a full breakfast routine on verbal fluency tasks were at least three units more than those of students without breakfast. These differences were all significant ($P = 0.001$). In working memory tasks, students with a full breakfast routine had seven digits and one digit in their responses more than students without breakfast in forward and backward digit tasks, in sequence. These differences were significant ($P = 0.001$).

Conclusions: The findings of the present study provide information on the positive effects of a regular breakfast routine on the specific cognitive functions related to language processing.

Keywords: Breakfast, Working Memory, Verbal Fluency

1. Background

Breakfast has been regarded as the main meal of the day that has a substantial role in providing daily energy needs (1). Breakfast, as studies indicated, can have positive effects on different areas such as health, mood (2), cognition, and academic achievement (3). Cognitive functions such as problem-solving (4), short-term memory, attention, and logical reasoning have been the focus of studies in different age groups (1, 5, 6). In a systematic review, the authors found out a lack of research comparing the breakfast types, precluding advice for the size and composition of full and ideal breakfast for children's cognitive function (7).

Studies in other cultures have indicated that skipped breakfast or partial breakfast in students could have neg-

ative effects on general cognitive skills (8). Liu et al. (9) in 2013 showed that from 1,269 children, 72 skipped breakfast and their scores in the IQ tests were significantly lower than those children with often/always breakfast. The findings of their study supported studies that had been done before such as Wesnes et al.'s study (10). Recent studies have repeated these findings and emphasized the importance of breakfast for children, especially at the school-age (11, 12) since students with skipped or partial breakfast are in danger of learning problems (13). A few studies, however, have focused on verbal fluency skills and language-related tasks (8, 14).

There is fair coverage in the matter of breakfast among Iranian studies although not all of them related to the subject of the present study. These studies indicated that 90%

of children in one study (15) and 80% of children in other studies (16, 17) had breakfast before going to school. Conversely, the professionals should be concerned about what would happen for the other 10% - 20% of children who did not have their breakfast. Because of the close relationship between academic achievements and verbal language skills (18, 19) and cognitive functions (19), the problem is the effects of skipped breakfast on cognitive processes related to language skills.

The number of Iranian studies is limited to a few studies that investigated the relationship between breakfast and cognitive functions. Two of these studies searched for the effects of breakfast types on children's function (20, 21) and reached different conclusions. The other two studies looked for the effects of breakfast consumption on children's attention and memory (5), as well as cognitive performance and academic achievements (22). Baghdadchi et al. evaluated the effects of a standard breakfast before and one hour after breakfast consumption on children's functions on standardized tests of attention and memory (5). In this randomized controlled trial study, children who had breakfast scored significantly higher than children who did not. The design of the study was crossover and similar results were achieved for the second time. Soleimani and Khani investigated the relationship of breakfast routines with cognitive function and academic achievements (22). Their findings indicated that those students who had breakfast in their routines scored higher on intelligence quotient tests than students who did not; likewise, students with breakfast routines had significantly better academic achievements than students who did not. These studies focused on general cognitive performance while working memory or specifically verbal fluency abilities that are related to language skills have not been from the perspective of these studies. Grantham-McGregor et al. (14) in 1998 used the categorical fluency to find out the effects of a school feeding program on students' cognitive function at schools. Their results indicated that the un-nourished students' scores significantly increased after they received breakfast or orange juice while these scores did not change for nourished students. Their results did not support the findings presented by the previous studies regarding the positive effects of nutritional status on the students' functions on cognitive tests. This study is one of the few studies that look at language processing tasks in methodology and not only regarding the breakfast routines.

In summary, different studies did not reach a common point about the differences between students who always ate breakfast and those students who did not in the matter of cognitive functions. In addition, there is a limited number of studies that looked at cognitive processing re-

lated to language skills. This is while professionals who work with children and students should be aware of the effects of breakfast and nutrition on cognitive and language skills.

2. Objectives

The present study aimed to compare the students' functions in both verbal fluency tasks and working memory tasks to support the claim that everyday breakfast can help students with their cognitive abilities related to language processing.

3. Methods

3.1. Participants

The target population included all children in the first grade of all public schools in Tehran. Three regions (four, eight, and 12) were selected from 22 regions of Tehran. The total number of seven-year-old students was 627 in these three regions. Three public schools were chosen randomly in these three regions. A pack of information sheets and consent forms was sent off to the schools' principals. Then, they allowed the researcher to contact the families through their health advisors. All the parents were invited to a meeting at the school halls to be informed about the study and its possible consequences. At the end of the meetings, a second pack including information sheets and consent forms written in simple language was passed to the families. They had three working days to decide on contribution. In the end, only 60 signed consent forms were returned. This study was approved by the Ethics Committee in Research of Semnan University of Medical Sciences (reference number: IR.SEMUMS.REC.1396.69).

3.2. Measurements

All the 60 parents were visited at schools by a speech and language therapist. In a structured interview, parents responded to a series of questions that provided information on the child's age, parents' information (age, education, and occupation), childbirth order, dinnertime, breakfast frequency, breakfast items, and breakfast time.

Based on the family's breakfast habits, children were divided into two groups. Group 1 had a breakfast meal every day, which means this group of children had proteins (e.g. egg or cheese), carbohydrate (e.g. wheat bread), and fruits (e.g. an apple). Group 2 had two features: (a) no routines for breakfast and (b) not having all these three elements (proteins, carbohydrates and fruits or juice unit) in their breakfast. All the 60 participants were in mainstream

schools, without any speech, language, and nutrition problems, and with appropriate academic achievement. These data were collected from the schools, health advisors, and nutritionists.

Tasks were run in a quiet, comfortable room at students' schools by a speech and language therapist between 9 and 10 a.m. Some practice items were provided to familiarize children with test materials and those parts without practice items were explained. Although the fluency and working memory tasks were taken place in a really short time, the examiner defined a 5-minute break time to avoid any mental fatigue or overlap between the tasks (23). The validity and reliability of the verbal working memory task were provided in a study by Delfani et al. in 2018 (24). This task had 100% face validity and the reliability was 0.9 in the test-retest.

3.2.1. Verbal Fluency Tasks

Two different tasks were used to evaluate the children's verbal fluency: "Phonemic Fluency" and "Semantic Fluency". To perform the phonemic fluency task, students should say as many words as possible beginning with specific phonemes in a minute. Three different phonemes consisting of two consonants (*/f/* and */s/*) and a vowel (*/a/*) were administered. There was a 5-minute break time and then the test continued with the semantic fluency assessment. In this task, students should say items from two semantic categories (fruits and animals) in one minute. To calculate the verbal fluency scores for each task, the examiner counted the number of words per each phoneme and each semantic category in 60 seconds. The mean and standard deviation were calculated for each group and the results were compared.

3.2.2. Verbal Working Memory Tasks

The working memory test was performed after a 5-minute break. The examiner read a series of random single-digit numbers and the subjects should repeat the numbers in the same order and reverse (forward and backward digit numbers). The strings of numbers increased from two to eight digits. The test stopped when the subject repeated the strings of numbers with the wrong order twice. No feedback was given to the student during the test. The mean and standard deviation of correct scores in this task were calculated and then compared between the two groups.

3.2.3. Statistical Analysis

Analyses were performed using SPSS V. 19. The significance level was set at 0.05. The normal distribution of data was assessed by the One-Sample Kolmogorov-Smirnov test and the scores of the two groups on different tests were

compared with the Independent Samples *t*-test. The chi-square test was applied to analyze the demographic data. The three schools were from moderate socioeconomic status (SES) regions, so, analyses were not adjusted for SES differences (25).

4. Results

Children's characteristics are presented in Table 1. The Kolmogorov-Smirnov test revealed that data had normal distribution ($z = 0.793$, $P = 0.06$). Parents were in a similar age range and had a similar education level and job positions. These findings confirm that children were matched according to SES backgrounds. Table 1 summarizes the characteristics of students and their parents.

All 60 students attended an evaluation session at their schools. These students were divided into two groups based on breakfast consumption. Only had 46.7% ($n = 28$) of the participants full breakfast routines and 53.3% ($n = 32$) had no breakfast or partial one.

There were no significant differences between those who had a regular full breakfast and those who had no

Table 1. Demographic Characteristic of Children with and Without Breakfast^a

Demographic Characteristic	Breakfast (N = 28)	No Breakfast (N = 32)	P Value
Gender			0.51
Male	64.21	68.71	
Female	35.79	31.29	
Father's age	42.25 ± 6.89	40.25 ± 6.51	0.88
Mother's age	37.46 ± 5.93	37.28 ± 6.32	0.73
Father's years of education			0.08
< 12	14	10	
12	78.5	88	
> 12	7.5	2	
Mother's years of education			0.61
< 12	0	0	
12	88	96	
> 12	12	4	
Mother's job			0.33
Housewife	97	93	
Employee	3	7	
Father's job			0.39
Private job	26	21	
Employee	74	79	

^aValues are expressed as mean ± SD or percentage.

breakfast in terms of demographic variables such as age, gender, and parental education, job, and age ($P = 0.001$).

4.1. Verbal Fluency

Children who ate full breakfast regularly had significantly higher scores on the verbal fluency test (both sections) than those who did not ($P = 0.001$) (Table 2). These differences were more obvious in the semantic task than the phoneme task. The difference between the groups in naming according to the phonemes was three units while the difference between the groups in the semantic task was approximately six units. Such differences were reported for children with learning disabilities (26).

Table 2. Verbal Fluency Scores of Children with and Without Breakfast^a

Verbal Fluency Tasks	Breakfast (N = 28)	No Breakfast (N = 32)	P Value
Phonemic Fluency /f/	10.12 ± 1.94	6.91 ± 2.23	0.001
Phonemic Fluency /s/	11.08 ± 2.92	7.11 ± 2.35	0.001
Phonemic Fluency /a/	10.08 ± 1.23	6.71 ± 2.11	0.001
Semantic Fluency (animals)	13.54 ± 3.05	7.33 ± 2.41	0.001
Semantic Fluency (fruits)	11.14 ± 2.88	6.40 ± 1.92	0.001

^aValues are expressed as mean ± SD.

4.2. Verbal Working Memory

Table 3 indicates the participants' scores on working memory tasks. There were significant differences between children who had regular, full breakfast and children who did not ($P = 0.001$).

Table 3. Verbal Working Memory Scores of Children with and Without Breakfast^a

Working Memory	Breakfast (N = 28)	No Breakfast (N = 32)	P Value
Working memory (forward)	15.54 ± 3.51	8.61 ± 1.79	0.001
Working memory (backward)	3.79 ± 1.23	2.4 ± 0.49	0.001

^aValues are expressed as mean ± SD.

5. Discussion

The results of the present study indicate that the consumption of breakfast can play an important role to optimize children's performance in verbal fluency and working memory tasks in schools.

The significant differences in cognitive performance between children who ate breakfast and children who skipped breakfast in the present study are in agreement

with the findings from previous studies (1, 5). Similar to Mahoney et al., the present study confirmed the previous findings that the consumption of breakfast can increase children's cognitive performance. Zipp and Eissing in a study evaluated the influence of breakfast on information processing, memory, and concentration of 1,181 children and adolescents aged 8 to 18 years; they concluded that breakfast consumption had a significant role in the improvement of mental performance (11). Although the cognitive domains they assessed differed from those assessed in our study, their overall results are consistent with the results of the present study.

The verbal fluency skills of children with full breakfast in the present study were significantly better than children who skipped breakfast. Chandler et al. found that un-nourished children in their study had a significantly improved performance on a verbal fluency test (a specified semantic category) after they received breakfast for a few weeks. However, nourished children did not show a significant change in their fluency scores (26).

In this study, to evaluate the role of breakfast consumption in children's cognitive performance, verbal fluency and working memory tasks were administered. Researchers and clinicians often use verbal fluency tasks as a neuropsychological assessment tool to measure verbal ability including lexical knowledge and lexical retrieval ability. Such tasks require the brain's higher executive function that is related to the function of the dorsolateral prefrontal cortex. Working memory is also part of the executive function that is taken place in the prefrontal cortex. These cognitive functions are crucial to organize children's behavior, children's academic achievement, and language performance. Suitable nutrition is one of the important factors for the growth and optimal performance of the human brain. Children's brains require higher levels of brain glucose metabolism than adults, and thus they need more 'fuel' to feed their brains and therefore require more glucose than adults (8).

Overall, the key finding of the present study support the assumption that breakfast consumption can have positive effects on the cognitive and language skills of children; however, because of the study design, the authors cannot present a mechanistic explanation.

5.1. Limitations

This study was not designed to measure specific blood glucose levels; thus, the interpretation and use of its findings should be cautious. Besides, the type of breakfast and the number of elements in the breakfast routine were not matched between children in each group. Future studies may result in different findings if they control such factors.

5.2. Conclusions

An everyday breakfast consumption consisting of proteins, carbohydrates, and fruits was associated with better cognitive functions related to language processing in primary school children in Iran. It would be ideal if families or schools could provide opportunities that all students be persuaded to eat breakfast before going to school.

Acknowledgments

The authors are grateful to the Student Research Committee of Semnan University of Medical Sciences for financial support (grant number: 1259). The authors wish to thank all children and their families for their contribution to the present study.

Footnotes

Authors' Contribution: Study design: Jalal Bakhtiyari and Mahdi Shadnoosh; manuscript writing: Jalal Bakhtiyari, Mahdi Shadnoosh, Mahdi Shadnoosh, Hooshang Dadgar, and Masoomeh Salmani; data interpretation: Jalal Bakhtiyari; study conception: Mahdi Shadnoosh; data interpretation: Hooshang Dadgar and Masoomeh Salmani; acquisition of data: Masoomeh Khani, Fatemeh Argha, and Atefe Rahmati; All authors approved the final version of the article for submission.

Conflict of Interests: None of the authors of the present study had any conflict of interest.

Ethical Approval: This study was approved by the Ethics Committee in Research of Semnan University of Medical Sciences (Reference number was IR.SEMUMS.REC.1396.69).

Funding/Support: The authors are grateful the Student Research Committee in Semnan University of Medical Sciences for their financial supports (grant number: 1259).

Patient Consent: A pack of information sheet and consent form was sent off to the schools' principals. Then they allowed the researcher to contact family through their health advisors. All the parents were invited to a meeting at the school halls to be informed about the study and its possible consequences. At the end of the meetings, a second pack including information sheet and consent form written in simple language was passed to the families. They had three working days to decide about contribution. At the end, only 60 signed consent forms were returned.

References

- Mahoney CR, Taylor HA, Kanarek RB, Samuel P. Effect of breakfast composition on cognitive processes in elementary school children. *Physiol Behav.* 2005;85(5):635-45. doi: [10.1016/j.physbeh.2005.06.023](https://doi.org/10.1016/j.physbeh.2005.06.023). [PubMed: [16085130](https://pubmed.ncbi.nlm.nih.gov/16085130/)].
- Veasey RC, Gonzalez JT, Kennedy DO, Haskell CF, Stevenson EJ. Breakfast consumption and exercise interact to affect cognitive performance and mood later in the day. A randomized controlled trial. *Appetite.* 2013;68:38-44. doi: [10.1016/j.appet.2013.04.011](https://doi.org/10.1016/j.appet.2013.04.011). [PubMed: [23608698](https://pubmed.ncbi.nlm.nih.gov/23608698/)].
- Adolphus K, Lawton CL, Champ CL, Dye L. The effects of breakfast and breakfast composition on cognition in children and adolescents: A systematic review. *Adv Nutr.* 2016;7(3):590S-612S. doi: [10.3945/an.115.010256](https://doi.org/10.3945/an.115.010256). [PubMed: [27184287](https://pubmed.ncbi.nlm.nih.gov/27184287/)]. [PubMed Central: [PMC4863264](https://pubmed.ncbi.nlm.nih.gov/PMC4863264/)].
- Pollitt E, Lewis NL, Garza C, Shulman RJ. Fasting and cognitive function. *J Psychiatr Res.* 1982;17(2):169-74. doi: [10.1016/0022-3956\(82\)90018-8](https://doi.org/10.1016/0022-3956(82)90018-8). [PubMed: [6764933](https://pubmed.ncbi.nlm.nih.gov/6764933/)].
- Baghdadchi J, Amani R, Khajeh Mughani N. [Assessment of the effects of breakfast on attention and short-term memory of school children]. *Razi J Med Sci (RJMS).* 2001;27:535-40. Persian.
- Ingwersen J, Defeyter MA, Kennedy DO, Wesnes KA, Scholey AB. Influence of breakfast composition on children's attention and memory. *Appetite.* 2007;47(2):267. doi: [10.1016/j.appet.2006.07.035](https://doi.org/10.1016/j.appet.2006.07.035).
- Edefonti V, Bravi F, Ferraroni M. Breakfast and behavior in morning tasks: Facts or fads? *J Affect Disord.* 2017;224:16-26. doi: [10.1016/j.jad.2016.12.028](https://doi.org/10.1016/j.jad.2016.12.028). [PubMed: [28062077](https://pubmed.ncbi.nlm.nih.gov/28062077/)].
- Pollitt E, Mathews R. Breakfast and cognition: An integrative summary. *Am J Clin Nutr.* 1998;67(4):804S-13S. doi: [10.1093/ajcn/67.4.804S](https://doi.org/10.1093/ajcn/67.4.804S). [PubMed: [9537633](https://pubmed.ncbi.nlm.nih.gov/9537633/)].
- Liu J, Hwang WT, Dickerman B, Compher C. Regular breakfast consumption is associated with increased IQ in kindergarten children. *Early Hum Dev.* 2013;89(4):257-62. doi: [10.1016/j.earlhumdev.2013.01.006](https://doi.org/10.1016/j.earlhumdev.2013.01.006). [PubMed: [23395328](https://pubmed.ncbi.nlm.nih.gov/23395328/)]. [PubMed Central: [PMC3606659](https://pubmed.ncbi.nlm.nih.gov/PMC3606659/)].
- Wesnes KA, Pincock C, Scholey A. Breakfast is associated with enhanced cognitive function in schoolchildren. An internet based study. *Appetite.* 2012;59(3):646-9. doi: [10.1016/j.appet.2012.08.008](https://doi.org/10.1016/j.appet.2012.08.008). [PubMed: [22902600](https://pubmed.ncbi.nlm.nih.gov/22902600/)].
- Zipp A, Eissing G. Studies on the influence of breakfast on the mental performance of school children and adolescents. *J Public Health.* 2019;27(1):103-10. doi: [10.1007/s10389-018-0926-4](https://doi.org/10.1007/s10389-018-0926-4).
- Lundqvist M, Vogel NE, Levin LA. Effects of eating breakfast on children and adolescents: A systematic review of potentially relevant outcomes in economic evaluations. *Food Nutr Res.* 2019;63. doi: [10.29219/fnr.v63.1618](https://doi.org/10.29219/fnr.v63.1618). [PubMed: [31548838](https://pubmed.ncbi.nlm.nih.gov/31548838/)]. [PubMed Central: [PMC6744840](https://pubmed.ncbi.nlm.nih.gov/PMC6744840/)].
- Adolphus K, Lawton CL, Dye L. The effects of breakfast on behavior and academic performance in children and adolescents. *Front Hum Neurosci.* 2013;7:425. doi: [10.3389/fnhum.2013.00425](https://doi.org/10.3389/fnhum.2013.00425). [PubMed: [23964220](https://pubmed.ncbi.nlm.nih.gov/23964220/)]. [PubMed Central: [PMC3737458](https://pubmed.ncbi.nlm.nih.gov/PMC3737458/)].
- Grantham-McGregor SM, Chang S, Walker SP. Evaluation of school feeding programs: some Jamaican examples. *Am J Clin Nutr.* 1998;67(4):785S-9S. doi: [10.1093/ajcn/67.4.785S](https://doi.org/10.1093/ajcn/67.4.785S). [PubMed: [9537629](https://pubmed.ncbi.nlm.nih.gov/9537629/)].
- Vaghari G, Keshtkaran A, Shomali L, Aslani H, Moradiyan H, Kazemi S. [The study of breakfast consumption in elementary school students]. *Payesh.* 2011;11(3):327-36. Persian.
- Nemati A, Sagha M, Nozad Charudeh H, Dehghan M. [An evaluation of breakfast consumption in female students, Ardabil]. *Res Sci J Ardabil Univ.* 2003;2(7):39-46. Persian.
- Motlagh ME, Taheri M, Ghadimi R, Nasrohhalpour Shirvani SD. [Breakfast and snack status among students of Iranian ethnicities]. *Iran J Nutr Sci Food Tech.* 2017;12(1):29-36. Persian.
- Kastner JW, May W, Hildman L. Relationship between language skills and academic achievement in first grade. *Percept Mot Skills.* 2001;92(2):381-90. doi: [10.2466/pms.2001.92.2.381](https://doi.org/10.2466/pms.2001.92.2.381). [PubMed: [11361297](https://pubmed.ncbi.nlm.nih.gov/11361297/)].
- Puerta Morales L. [Relationship between cognitive processes and academic performance in high school students]. *Psychol Avance Discipline.* 2015;9:85-100. Spanish.

20. Amiri F, Amani R, Rashidkhani B, Khajemogahi N, Wesnes KA, Saxby B. [Effect of breakfast composition on memory of primary school children in Ahvaz]. *Iran J Endocrinol Metabol.* 2008;**10**(3):247-92. Persian.
21. Amiri F, Amani R, Khajeh Mugahi N, Rashidkhani B. [Effect of two Iranian breakfast types (full of carbohydrate vs. Full of protein) on cognitive function in students aged between 9 and 11 years old]. *Iran J Nutr Sci Food Technol.* 2008;**3**(2):23-32. Persian.
22. Soleimani N, Khani S. [Effect of breakfast eating on the cognitive performance and educational achievement of the fourth grade students of elementary schools of Garmsar in the academic year of 2010-2011]. *Res Curriculum Plan.* 2014;**11**(13):139-50. Persian.
23. Jones KJ. *Neurological assessment: A clinician's guide.* Edinburgh: Churchill Livingstone, Elsevier; 2011.
24. Delfani S, Hadavi S, Maleki Shahmahmood T, Khoramian S, Soleymani Z. [Developing a working memory scale and assessment of working memory in children with cochlear implant]. *J Mazandaran Univ Med Sci.* 2018;**28**(166):96-107. Persian.
25. Sadeghi R, Zanjari N. [The spatial inequality of development in the 22 districts of Tehran metropolis]. *Social Welfare.* 2017;**17**(66):149-84. Persian.
26. Chandler AMK, Walker SP, Connolly K, Grantham-McGregor SM. School breakfast improves verbal fluency in undernourished Jamaican children. *J Nutr.* 1995;**125**(4):894-900. doi: [10.1093/jn/125.4.894](https://doi.org/10.1093/jn/125.4.894).