Different Food Hardness Affect Memory

by Jenny Sunariani

Submission date: 11-Oct-2019 12:18PM (UTC+0800)
Submission ID: 1190592359
File name: Different_Food_Hardness_Affect_Memory.pdf (295.26K)
Word count: 2652
Character count: 13781

Different Food Hardness Affect Memory

Wahyuning Ratih Irmalia[1], *Jenny Sunariani*[2], *Christian Khoswanto*[2]

1. Graduate Student Faculty of Dental Medicine, Universitas Airlangga Surabaya.
2. Department of Oral Biology, Faculty of Dental Medicine, Universitas Airlangga Surabaya.

Abstract

Recent studies proved the role of mastication in learning and memory function. The effect of various food hardness on spatial memory in childhood is not fully understood.

The aim of this study is to analyze the role of mastication activity in spatial memory in childhood by giving food with various hardness Post-weaned rats aged 28 days were divided into three groups. Control group was fed with normal pellets diet, blended grain and seeds (soft diet) for treatment I group and whole grain and seeds (hard diet) for treatment II group. Radial eight arm maze-test was used to assess spatial memory. Data collected was analyzed using One-way Anova.

There was significant difference of spatial memory ($p<0.05$). Control group showed the best spatial memory, while treatment II showed the lowest performance.

Experimental article (J Int Dent Med Res 2017; 10(3): pp. 987-990)

Keywords: Mastication, hippocampus, spatial memory.

Received date: 31 August 2017 **Accept date:** 12 October 2017

Introduction

Mastication is rhythmic and voluntary movement of lower jaw and masticatory muscles that is the first step of digestive process.[1,2] In recent studies, mastication has been found to affect stress and cognitive function.[1,3] Hippocampus is a part of brain that belongs to limbic system that function in long-term memory and spatial navigation[4]. Previous studies using mice in growth period proved that soft diet impairs learning and memory function.[5,6] Other line of evidence showed that forced mastication improved survival and proliferation of neurons in dentate gyrus.[7] Those studies were conducted using different aged animal models, so the role of mastication in learning and memory function, especially in childhood remains unknown.

Mastication activity is an important key in learning and memory function since it is one of the sensory input towards hippocampus.[8] Reduced mastication due to masticatory disorder has been proven leading to hippocampus morphological change, characterized by reduced number of pyramidal cell, astrocyte hypertrophy, reduced dendritic spine in cornu amonis (CA)1 and reduced proliferating cell in dentate gyrus.[9] Mastication related to hippocampus through a neural pathway. Somatosensory input from masticatory system may affect hippocampus through synaptic projection from thalamus and cerebral cortex.[8]

Hippocampal-dependent spatial memory could be assessed using the Morris water maze and the radial-arm maze. Previous studies using these procedures indicated that adult rats experienced learning ability impairment between 2 and 30 months after molar teeth extraction.[10] Other studies stated that occlusal disharmony causes spatial memory impairment.[11] The same method was used to assessed spatial memory of mice after soft diet feeding for 3 weeks also proved that soft-diet could alter spatial memory.[12] Various studies to analyze the effect of mastication to hippocampal function has been conducted, yet the effect on childhood remains unknown.

The aim of this study is to analyze the role of mastication activity in learning and memory in childhood by giving food with various hardness. Mastication activity of rats begins at 12 days old, and masticatory function was fully developed at 18-21 days old.[13] Rats are omnivore that eat plants, seeds and insects naturally.[14,15] Therefore, this study was conducted using post weaned rats aged 28 days and mixed grain and seeds as food.

*Corresponding author:
Prof. Jenny Sunariani, DMD., M.Sc., PhD.
Department of Oral Biology, Faculty of Dental Medicine, Universitas Airlangga. Jl. Mayjen Prof. Dr. Moestopo 47 Surabaya 60132, Indonesia.
E-mail: jenny-s@fkg.unair.ac.id

Materials and Methods

This study was approved by Ethical Committee Faculty of Dental Medicine, Universitas Airlangga with Ethical Clearance Certificate No: 023/HRECC.FODM/II/2017.

Animal

Male Wistar Rats aged 28 days were randomly divided into control group (N=7), treatment I group (N=7) and treatment II group (N=7) immediately post-weaned. The control group was fed normal pellet (Comfeed-Gemuk A, Sidoarjo, Indonesia), treatment I group was fed soft diet that consisted of powdered grain and seeds (Hamsfood, Canada) mixed with water at a ratio 1:1, whereas treatment II group was fed hard diet containing mixed grain and seeds, the same ingredients with treatment I group for 8 weeks. The rats get free access of food and water, under a constant 12 hours light-dark circle. The body weight was measured on the beginning and at the end of the experimental period.

Radial Eight Arm Maze Test

The rats' spatial memory was assessed using an eight-arm radial maze. The maze constructed of a center part with eight arms placed radially. The diameter of inner part of the maze was 36 cm, with each arm sized 80 cm length, 6 cm width and 20 cm high. The training period was conducted in 5 days. On the 1st day of training, the rat was placed in and allowed to explore the maze without food for 10 minutes. From that day onwards, the feed was reduced by 50%, yet the rats still get free access of water. Hereafter, the rat was placed in the maze with food on the entrance of each arms on 2nd day, with food in the middle of each arms on 3rd day, and food at the end of each arms on 4th and 5th day of the training. The real maze test was held on 55th day, with 100mg food at the end of each arms. The test began as the rat was placed in the center of the maze and ended when all the food in eight arms, were empty or 10 minutes has passed.[16] The initial eight correctly chosen arms were considered as reference memory. The number of times that the rat entered arms with empty plate was considered as errors. The maze was placed in the same location and the maze-test were conducted at the same time each day.[11]

Statistical Analysis

All data obtained from this experiment were analyzed using statistical software (IBM SPSS 16, New York). Values were compared using one-way ANOVA test and LSD Tukey with level of significance was set at P<0.005.

Results

Rat Body Weight

The mean body weight of control, treatment I and treatment II group were increasing in the same manner during experimental period. Body weight of treatment I and treatment II group were slightly lower than control group, but there were no significant differences between each group at the same age (Figure 1).

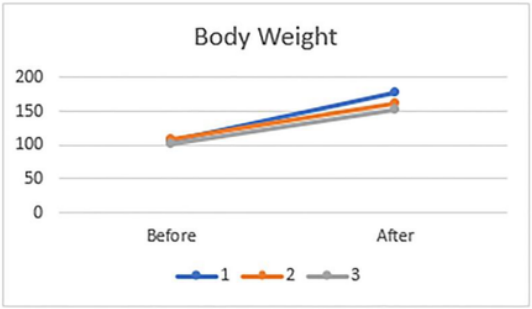

Figure 1. Body Weight of Control Group (1), Treatment I (2) and Treatment 2 (3) at the Beginning (1 = 106.43±4.756; 2 = 108.47±21.157; 3 = 102.14±9.94) and at the End of Experimental Period (1 = 177.14±37.289; 2 = 161.43±15.736; 3 = 150.71±31.149).

Radial Eight Arm-Test

To analyze the effect of mastication activity by giving various food hardness on memory function, radial eight arm-test was performed, by observing the right choices and errors taken by rats. There was significant difference in right choice (p = .001) and error (p = .000) among all groups. The right choices of the control group were significantly higher than treatment I (p = .001) and treatment II (p = .001) group, while there was no significant difference of right choice between treatment I and treatment II group (p = .893) (Figure 2). The same results were obtained from statistical analysis of error. The errors of control group were significantly lower than treatment I (p = .000) and treatment II (p = .000) group, while there was no significant difference of error between treatment I and treatment II (p = .126) group (Figure 3).

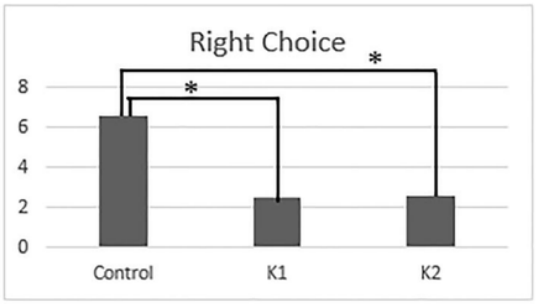

Figure 2. The right arm choice of control (6.57±1.81), treatment I (2.43±1.397) and treatment II (2.57±2.507) group. (*) indicate statistical difference.

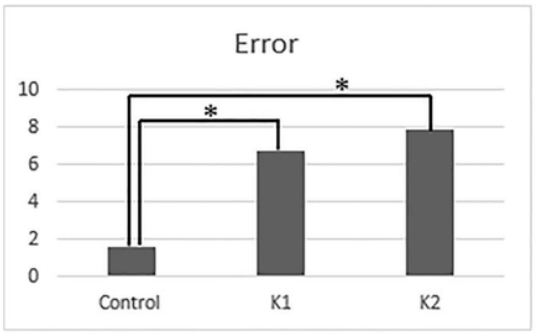

Figure 3. Error of control (1.57±1.72), treatment I (6.71±1.25) and treatment II (7.86±0.90) group. (*) indicate significant difference.

Discussion

This research was conducted using animal model that was fed with different food hardness to measure mastication intensity. Post-weaned rats were used to observe the correlation between mastication and memory as early as possible. Spatial memory assessment was done using radial eight arm maze-test. Radial eight arm maze-test can be done by two procedures, the reference memory and the working memory version. The number of arms used in radial arm maze varies from four, to the standard number of eight, and up to seventeen. The larger the number of arms, the more difficult the task. This is an assessment of working spatial memory, because the test measures depend on trial with bait on each arm, and cues from the outside of the maze to guide arm choices.[17]

In previous study, it was stated that rats are more sensitive in diet hardness, rats given hard diet could grow normally, yet showed reduced growth. The mean body weight of hard diet group was slightly but not significantly lower.[18] This study also gave the same results. From the findings of this study, it is hypothesized that diet hardness have no correlation with growth. Study by Indrasari et al. also stated that no correlation between mastication ability, loss of teeth with the body mass index[19].

There was significant difference of spatial memory among groups. This study showed that control group, with normal diet had the best spatial memory, while soft diet and hard diet groups displayed deficit in spatial memory, which is hippocampus function. Memory impairment in masticatory disorder might be caused by the reduced activity of sensory-motoric pathways.[20] Masticatory disorder due to tooth extraction, periodontal disease, occlusal disharmony leads to soft food preference.[8,9] Reduced mastication activity causes reduced activity of sensory receptors delivering afferent impulse to central nervous system, which may lead to neuroanatomical alterations.[20] These findings support the hypothesis that reduced sensory input from periodontal mechanoreceptors causes changes in hippocampus thereby impair its function.

In this study, treatment II group had the lowest spatial memory than treatment I and control group. This result contrary with the previous study which stated that hard diet mice have better memory, characterized by improved proliferation and survival neuron in dentate gyrus.[7]

The new-born rats only drink milk with no water or solid food until age of 14 days old. The weaning process started from 14 days old and completely stop nursing at 30 days age. In the weaning period, there is a change from suckling phase to chewing phase, and the jaw closing muscle activity is increasing along the period. Thus, the firing frequency of jaw closing motor neuron will increase as the rat gets older to prepare jaw closing force for chewing activity.[21] Other study stated that organs physiological adaptation is related to age. Different chewing forces may exist due to age-related muscle efficiency.[22]

We are now analyzing molecular and cellular changes associated with spatial learning alteration after being fed with different food

hardness. Further studies using older animal given various food hardness may confirm the correlation between mastication activity and hippocampus function.

Conclusions

Within the limitation of this study design, it is concluded that mastication activity affects spatial memory of rats. Reduced and forced mastication impair spatial memory in childhood. Feeding with hardness of the food that is suitable to the growth need to be considered.

Declaration of Interest

The authors report no conflict of interest and the article is not funded or supported by any research grant.

References

1. Sasaki-Otomaru A, Sakuma Y, Mochizuki Y, Ishida S, Kanoya Y, Sato C. Effect of Regular Gum Chewing on Levels of Anxiety, Mood, and Fatigue in Healthy Young Adults. *Clin Pract Epidemiol Ment Heal*. 2011;7:133-139.
2. Watanabe Y, Hirano H, Matsushita K. How masticatory function and periodontal disease relate to senile dementia. *Jpn Dent Sci Rev*. 2015;51(1):34-40.
3. Kubo K-Y, Ichihashi Y, Kurata C, et al. Masticatory function and cognitive function. *Okajimas Folia Anat Jpn*. 2010;87(3):135-40.
4. Amaral DG, Lavenex P. Hippocampus. *Oxford Univ Press*. 2007;(1587):37-114.
5. Yamamoto T. Central mechanisms of taste: Cognition, emotion and taste-elicited behaviors. *Jpn Dent Sci Rev*. 2008;44(2):91-99.
6. Okihara H, Ito J ichi, Kokai S, et al. Liquid diet induces memory impairment accompanied by a decreased number of hippocampal neurons in mice. *J Neurosci Res*. 2014;92(8):1010-1017.
7. Akazawa Y, Kitamura T, Fujihara Y, Yoshimura Y, Mitome M, Hasegawa T. Forced mastication increases survival of adult neural stem cells in the hippocampal dentate gyrus. *Int J Mol Med*. 2013;31(2):307-314.
8. Chen H, Iinuma M, Onozuka M, Kubo KY. Chewing maintains hippocampus-dependent cognitive function. *Int J Med Sci*. 2015;12(6):502-509.
9. Kubo K, Chen H, Onozuka M. The Relationship Between Mastication and Cognition. In: Zhiwei Wang HI, ed. *Senescence and Senescence-Related Disorders*. 2013:116-134.
10. Ono Y, Yamamoto T, Kubo K, Onozuka M. Occlusion and brain function: mastication as a prevention of cognitive dysfunction. *J Oral Rehabil*. 2010;37(8):624-40.
11. Ekuni D, Endo Y, Tomofuji T, et al. Effects of apoE Deficiency and Occlusal Disharmony on Amyloid-Beta Production and Spatial Memory in Rats. *PLoS One*. 2013;8(9):1-8.
12. Yamamoto T, Hirayama A, Hosoe N, Furube M, Hirano S. Soft-diet feeding inhibits adult neurogenesis in hippocampus of mice. *Bull Tokyo Dent Coll*. 2009;50(3):117-24.
13. Ferraz-Pereira KN, da Silva Aragao R, Verdier D, et al. Neonatal low-protein diet reduces the masticatory efficiency in rats. *Br J Nutr*. 2015;114(9):1515-1530.
14. Shiels AB, Flores CA, Khamsing A, Krushelnycky PD, Mosher SM, Drake DR. Dietary niche differentiation among three species of invasive rodents (Rattus rattus, R. exulans, Mus musculus). *Biol Invasions*. 2013;15(5):1037-1048.
15. Shiels AB, Pitt WC. A Review of Invasive Rodent (Rattus spp . and Mus musculus) Diets on Pacific Islands. 2014:161-165.
16. Prasetya DY, Yuliani S. Aktifitas ekstrak rimpang temulawak (Curcuma xanthorrhiza) pada radial arm maze dan pasive avoidance test tikus model demensia. *Pharmaciana*. 2014;4(2):157-164.
17. Vorhees C V., Williams MT. Assessing spatial learning and memory in rodents. *ILAR J*. 2014;55(2):310-332.
18. Fox JG. *The Mouse in Biomedical Research*. 2nd Ed. (Fox JG, Barthold SW, Newcomer CE, Quimby FW, Smith AL, eds.). Academic Press; 2007.
19. Indrasari M, Shakina T, Masulili C. Association Between Masticatory Performance and Body Mass Index (BMI). *J Int Dent Med Res*. 2016;9(Special Issue):293-299.
20. Iinuma M. Relationship between the Early Toothless Condition and Hippocampal Functional Morphology. *Anat Physiol*. 2013;4(3):8-13.
21. Walcher DN, Peters DL, Pennsylvania State University. *Early Childhood: The Development of Self-Regulatory Mechanisms*. Academic Press. 1971.
22. Leong NL, Hurng JM, Djomehri SI, Gansky SA, Ryder MI, Ho SP. Age-related adaptation of bone-PDL-tooth complex: Rattus-Norvegicus as a model system. *PLoS One*. 2012;7(4).

Different Food Hardness Affect Memory

ORIGINALITY REPORT

16%	10%	11%	3%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	journals.plos.org Internet Source	3%
2	Bushra Rashid Noaman. "Necrosis of the revascularized pulp in an immature infected maxillary second premolar following apexogenesis - a case report", Journal of Dental Health, Oral Disorders & Therapy, 2018 Publication	1%
3	Hidemasa Okihara, Jin-ichi Ito, Satoshi Kokai, Takayoshi Ishida et al. "Liquid diet induces memory impairment accompanied by a decreased number of hippocampal neurons in mice", Journal of Neuroscience Research, 2014 Publication	1%
4	www.medicinaoral.com Internet Source	1%
5	www.scielo.br Internet Source	1%
6	unair.ac.id Internet Source	1%

7	www.mdpi.com Internet Source	1%
8	Kevin C.H. Pang. "GABAergic septohippocampal neurons are not necessary for spatial memory", Hippocampus, 2001 Publication	1%
9	c4st.org Internet Source	<1%
10	www.scribd.com Internet Source	<1%
11	Gary R. Morrow. "Reduction in serum cortisol after platinum based chemotherapy for cancer: A role for the HPA axis in treatment-related nausea?", Psychophysiology, 7/2002 Publication	<1%
12	Hatice Balci Yuce, Ozkan Karatas, Humeyra Aydemir Turkal, Emine Pirim Gorgun, Seda Ocakli, Ismail Benli, Sevil Cayli. "The Effect of Melatonin on Bone Loss, Diabetic Control, and Apoptosis in Rats With Diabetes With Ligature-Induced Periodontitis", Journal of Periodontology, 2016 Publication	<1%
13	M Miyagawa. "Effects of subchronic exposure to toluene on working and reference memory in rats", Neurotoxicology and Teratology, 1995	<1%

	Publication	
14	Submitted to BPP College of Professional Studies Limited Student Paper	<1%
15	repositorio.unicamp.br Internet Source	<1%
16	www.pdk3mi.org Internet Source	<1%
17	Submitted to Universiti Teknologi MARA Student Paper	<1%
18	Clarissa Pedrini Schuch, Gustavo Balbinot, Matthew S. Jeffers, Matthew W. McDonald, Angela Dykes, Lydia M. Kuhl, Dale Corbett. "An RFID-based activity tracking system to monitor individual rodent behavior in environmental enrichment: Implications for post-stroke cognitive recovery", Journal of Neuroscience Methods, 2019 Publication	<1%
19	L.-B. Zou, K. Yamada, M. Sasa, T. Nabeshima. "Two phases of behavioral plasticity in rats following unilateral excitotoxic lesion of the hippocampus", Neuroscience, 1999 Publication	<1%
20	Galih Sampoerno, Jenny Sunariani, Kuntaman. "Expression of NaV-1.7, TNF-α and HSP-70 in	<1%

experimental flare-up post-extirpated dental pulp tissue through a neuroimmunological approach", The Saudi Dental Journal, 2019

Publication

Exclude quotes	On	Exclude matches	< 5 words
Exclude bibliography	On		

Different Food Hardness Affect Memory

GRADEMARK REPORT

FINAL GRADE

/0

GENERAL COMMENTS

Instructor

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5