What Affects the Memory

Etleva Beliu, Ermira Pajaj

Abstract: ***Physical exercise affects our body on multiple fronts. It increases heart rate, which means more blood pumped to the brain. It also helps the body release some hormones, that participate in aiding and providing a nourishing environment for the growth of brain cells. Physical exercise training can modify hippocampal and medial temporal lobe volumes. Both of these regions are involved in memorization. The aim of this study is to analyze the effect of physical exercise, of smoking, and using alcohol on the memorizing ability. By using the questionnaires and face-to-face interviews, data is collected from around 300 people of both genders. They have an age range of 15 – 20 years old and are from different schools in Albania ; namely in Tirana and the outskirts of Tirana, in Durres, in Shkodra, Gjirokastra and Vlora. They are asked to read 40 words in 5 minutes and then are tested to see how many of them they can memorize. The questionaire includes demographic information such as age, gender and birth city and questions to measure their lifestyle. In the lifestyle area it is asked about the smoking habbit, alcohol consumption, eating and exercise frequency. The data is analized using SPSS. A normalization of number of memorized words is done. Then, this modified variabel is analized using stepwise multiple regression. The most important independent variables of this model are exercise frequency and alcohol consumption. Exercise frequency is organized in three groups: those who train 0-2 days a week, Level Group 1 (LG1); those who train 3-4 days a week (LG2); and the ones that train more than 4 days a week (LG3). The method of MANOVA shows that there is a statistically obvious increase between two consecutive levelgroups. But there is a very significant difference between the number of memorized words of LG1 and LG2. This research provides evidence that physical exercise and alcohol consumation affect memory.***

Index Terms: ***memory, BDNF molecule, hippocampus, exercise frequency, alcohol consumption, stepwise multiple regression, and MANOVA.***

I. INTRODUCTION

These days, more and more people are choosing the gym as a way to stay fit in the lack of everyday activity. They see it as a way of body salvation from obesity and overweight, both very common problems. Also everybody knows that if you do not work out, your muscles get flaccid. But, what most people don't realize, is that your brain also stays in better shape when you exercise. So, aerobic exercise has been associated with increased cognitive ability, including benefits to learning and memory. This has been shown through over a decade of research in animals and people. One of the earliest clues about exercise-induced changes in the brain came in the late 1990s. It was known that the brain affects behaviour but nobody before asked for the contrary, which came out to be true.

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Indeed, when a group of scientists leaded from Fred Gage, a neuroscientist at the Salk Institute for Biological Studies decided to compare the brains of mice given unlimited access to an exercise wheel (runners) to those of mice without exercise wheels in their cages (non-runners), they discovered that compared to the non-runners, the physically fit mice had double the number of new nerve cells in the region of the hippocampus. As hippocampus is known as a brain area envolved in learning and memory, scientist checked the performance of these mice in tests for learning and memory. The experiments showed that physically fit mice performed better in learning and remembering tests. [1]
Given these results, Judy Cameron[1] , a neuroscientist at the University of Pittsburgh, asked whether these results would have been relevant to increased fitness activity in apes. In her lab, they trained a group of middle-aged and older monkeys to run on a treadmill for one hour each day, five days per week for five months, meanwhile, a second group of monkeys sat on the treadmills. This experimental model tried to simulate the human physical activity, which is different from the mice activity, as mice are continous runners. The results showed that the monkeys on the running regimen learned new things twice as fast as the sedentary animals.
Studies in humans, like the ones performed by Art Kramer, who studies how fitness can change the aging brain at the University of Illinois at Urbana-Champaign, have shown a noticible association between physical activity and improved cognitive performance across the lifespan. According to recent human studies, even people who hold off on regular aerobic activity until later in life may still be able to gain from exercise in their senior years.

A. What Causes Such An Increase In Memory?

Exercise training increases the cerebral blood volume, increasing the amount of oxygen pumped to the brain cells.
Moreover studies have shown that increased exercise is associated with higher levels of BDNF molecule [2] (a molecule known for its brain trophic properties). A higher number of growing cells in the hippocampus and higher volume of hippocampus have been detected in exercise performing subjects. [1, 4]
As a study made in Ireland[2] revealed through blood analyzis, after strenuous activity, significantly higher levels of a protein known as brain-derived neurotrophic factor, or BDNF, were present in our body.
BDNF is a molecule of the neurotrophine family. This protein family is important for survival, development and function of neurons. The first molecule of this family, NGF (Nerve Growth Factor) has been discovered from the Nobel Prize winner Levi Montalcini and Hamburger in 1950. BDNF, the second member of this family, was discovered on 1982. Other members have been reported later on. [3]
BDNF, the most studied molecule of the family, is encoded by BDNF gene. This protein is important for brain development during

embriogenesis and childhood, and adult brain function. This protein promotes the survival of nerve cells (neurons) by playing a role in the growth, maturation, and maintenance of these cells. In the brain, the BDNF protein is active at the connections between nerve cells (synapses), where cell-to-cell communication occurs. The synapses can change and adapt over time in response to experience, a characteristic called synaptic plasticity. The BDNF protein helps regulate synaptic plasticity, which is important for learning and memory. [3]

Given the high level of BDNF in the blood of people undergoing a healthy lifestyle [3] scientists believe that physical exercise improves memory and attention by increasing BDNF effect on the brain. [3, 4]

A research published online in January 31 in Proceedings of the National Academy of Sciences[4] , found exercise increase the volume of hippocampus of adults from 55 to 80 years old, respectively 2.12 percent in the left part and 1.97 percent in the right part, and after memory test it also showed that together with the beefing up of this region of the brain, also the memorizing ability was improved [5,6]

Altogether, exercise increases blood flow in the brain increasing oxygen pumped in the neurons. In the presence of this sufficient amount of oxygen, more neurons are grown, especially in the area of hippocampus. An increase in BDNF production, particularly in hippocampus is induced by exercise.

Based on the above researches, that show that exercise effect memory of adults, in this project, it is aimed to prove that the same thing can be said about young adults and teenagers. So, it is hypothesed that the more physical training the body gets regularly, the better the memorizing ability is**.**

II. MATERIALS AND METHODS

There were interviewed about 300 people of both genders with an age range of 15 – 20 years old from different schools in Albania; namely in Tirana and the outskirts of Tirana, in Durres, in Shkodra, Gjirokastra, and Vlora.

Pririor to the experiment the subjects were explained the study and the procedure. Those who had a history of any mental disorder, recent weight loss, significant medical illness were exculded.

The questionaire includes demographic information such as age, gender and birth city and questions to measure their lifestyle. It contained the lifestyle area on smoking habbit, alcohol consumation, eating habbit such as diets rich with high fat food or fruit.

To test the intermediate term memory, word recall memory quiz is used. Subjects were given a wordlist which contained 40 words of mainly different topics, and read it for 5 minutes. Then they were asked to write down all the words they could memorize. The aim was the total number of memorized words.

Exercise quantity was difficult to measure, because different physical exercises take different time and different energy consumation. So, for example playing tennis and playing football have different intesities, but they were measured both as one time a week. This means that the exercise frequency contains the number of 30 minutes exercise done by the subjects during a week.

'Eating healthy' was difficult to quantify too, because the amount of fruit intake couldnt be precisely measured as most of the subjects eat fruit with their family members after dinner, cutting them into pieces and sharing them. So they had difficulty in recalling the number of fruits eaten. Because of this, it is considered as a binary variable.

III. PROCEDURE

In this database, the variable *nrwords* determines the number of words memorized by each person. It was noticed that the lowest *nrwords* value was 1.000 and the highest was 30.000. Using SPSS the histogram of *nrwords* is designed with a chosen scale of 2 (see Fig.1). Testing of normality of data, using Shapiro-Wilky

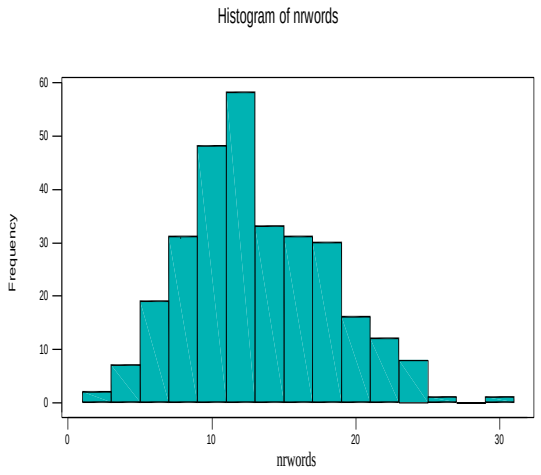

Figure 1: Histogram of number of memorized words

demostrate nonormality. The sample size of 300 is considered as large enough[7].

Transformation of *nrwords* in *sqrtnrwords*, fulfilled the assumption of normality. Values of Skewness .018 and Kurtosis -.058 are closed to 0. Result of Shapiro-Wilky, tells that the transformed variable is normally distributed, that's why it substitutes *nrwords* in this analysis (see Table I).

Table I. Descriptives statistics of *sqrtnrwords*

Descriptives

		Statistic	Std. Error
Sqrt nrword	Mean	3.6981	.03971
	95% Confidence Interval for Mean	3.6199 3.7762	
	5% Trimmed Mean	3.6990	
	Median	3.6056	
	Variance	.470	
	Std. Deviation	.68555	
	Minimum	1.41	
	Maximum	5.74	
	Range	4.33	

	Interquartile Range	.93	
	Skewness	.018	.141
	Kurtosis	-.058	.281

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Sqrtnword	.074	298	.000	.993	298	.154

a. Lilliefors Significance Correction

Some lifestyle variables, such as *smoking* habit, *gender*, *alcohol* habit, the number of exercise days during the week as *exercise frequence*, were used in the statistical analysis as independent variables, after the correlation analysis.

To study the role of *smoking*, and *eating* habit and *exercise frequence* in the *sqrtnrwords*, the stepwise regresion is used [8]. The results of Table II indicate the effect of *exercise frequence* and *smoking* habit .

The mean of *nrwords* value of subjects who don't use alcohol is 13.270, while the mean of *nrwords* value of people who use alcohol is lower 11.714. These value are 12.701 and 12.506 respectivily for healthy and non healthy eating groups. But the other variables are removed. This indicates that there is no influence of healthy eating and *alcohol* habit in the *sqrtnrwords*, based on these data.

However the two last results of this investigations are in contrast with the research "Relationship of serum brain-derived neurotrophic factor (BDNF) and health-related lifestyle in healthy human subjects" by Ka Lok Chan, which reports higher BDNF level when the subjects eat healthy and when they smoke. Studying the role of smoking habit in the *nrwords*, it is concluded that 212 subjects who don't smoke, have the mean of *nrwords* value of 13.182. While 85 people who smoke have a lower mean of *nrwords* value of 11.667. The coefficient of the stepwise multiple regression analysis -.202 indicates the negative role of *smoking* habit.

Table II: Result of stepwise regression

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	exercise frequence	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
2	smoking	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a. Dependent Variable: sqrtnrword

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.624[a]	.389	.387	.53684
2	.639[b]	.409	.405	.52887

a. Predictors: (Constant), exercise frequence

b. Predictors: (Constant), exercise frequence, smoking

While the other coefficient of regression .230 behind *exercise frequence* indicates that on average the number of memorized words increases slightly as the number of exercise days increases.

If this frequence is increased from two times a week (as usually is done in all schools of our country) to three, than the number of memorized words will change by 11.7 to 13.6.

The study is concentrated in 3 variables: *gender*, the number of exercise days during the week and *sqrtnrword*s.

In this database gender is coded 1= female and 2= male. So we have about 300 people of both genders; 178 females (coded 1), and 119 males (coded 2).

Based on the the fact that all the teenagers in Albania usually do 2 times physical exercise in weeks, the subjects were grouped into 3 main groups:

Level Group 1 (LG1) 0-2 times in a week physical exercise

Level Group 2 (LG2) 3-4 times per week

Level Group 3 (LG3) more than 4 times a week

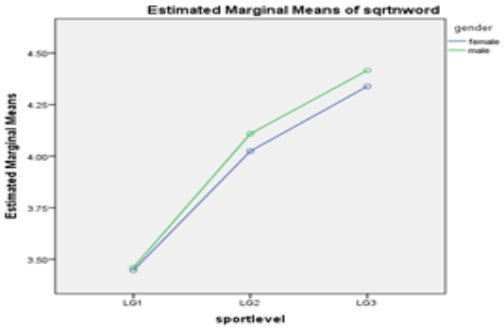

Figure 2. Plot of means of sqrtnrwords variable for gender and levelgroup

Two-way ANOVA[9] is used based on *gender*s, males and females, and three *levelgroup*s of physical exercise(LG1, LG2, and LG3). The plot of results, Fig. 2, tells us that the mean of male is higher than the female's mean of three levelgroups.

But the result of Table III (F .333 and Sig .565) help us to get a good idea that *gender* brings no difference on *sqrtnrwords* of each *levelgroup*.

Looking at the levelgroups (F=42.256 and Sig. 7.62 E-17), it is easily understandable that *sqrtnrwords* depend on *Levelgroups.*

There is no interfered effect between these factors (F =.103 and Sig.902).

The percentage of three created groups of exercise according to gender tells that females display 73.91 % of LG1 and males display 72.34% of LG3. The conclusion that the mean of male is higher than the female's mean, is connected with the fact that male do more physical exercise.

By looking at this point, it is not necessary to study the relationship between the variable *gender* and *sqrtnrwords*,

but only the effectiveness of number of exercise days on *sqrnrwords*.

It is concluded by Pairwise Comparision a statistically obvious increase between two consecutive *levelgroup*s. But the increase is statistically more obvious between first and second levelgroup (Sig 3.8 E-12). While the difference between two last subgroups is not significant at α=0.01. (Sig. .023)

There is no more reason not to accept that an increase of physical exercise causes an increase of the number of memorized word. Furthermore if the teenagers do one more hour of physical exercise, they pass from LG1 to LG2 and have a statistically better memorizing ability.

Table III: Result of Two-way ANOVA

Tests of Between-Subjects Effects						
Dependent Variable: sqrtnrword						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	37.779[a]	5	7.556	21.672	.000	.271
Intercept	2148.261	1	2148.261	6161.623	.000	.955
gender	.116	1	.116	.333	.565	.001
sportlevel	29.465	2	14.733	42.256	.000	.224
gender *sportlevel	.072	2	.036	.103	.902	.001
Error	101.806	292	.349			
Total	4215.000	298				
Corrected Total	139.585	297				
a. R Squared = .271 (Adjusted R Squared = .258)						

IV.CONCLUSION

Based on presented results it is concluded that:

- There is an effect of physical exercise on memory for teenagers. The increase in the amount of physical exercise per week, improves memorizing ability.
- There is not any statistical difference in the memorizing ability of males and females.
- There is an influence of smoking habit on memorizing ability.
- But, based on this study, it can't be said that eating healthy or alcohol effects memory.

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