



Effect of Neurofeedback Training on male Swimmers' Stress Tolerance

R L Udrishna Deori¹, Chanderkant Dhiman², Dr. Binayak Kumar Dubey³, Dr. M. K. Singh⁴, Dr. B. C. Kapri⁵

¹Assistant professor, Department of Physical Education Pedagogy, LNIPE, Gwalior, 474002 (M. P.) India, ²Research Scholar, Department of Physical Education, Banaras Hindu University, Varanasi, 221005 (U.P.) India, ³Asst. Professor, Department of Physical Education, Banaras Hindu University, Varanasi, 221005 (U.P.) INDIA, ⁴Professor (Head), Department of Sport Psychology, LNIPE, Gwalior, 474002 (M. P.) India, ⁵Professor, Department of Physical Education, Banaras Hindu University, Varanasi, 221005 (U.P.) India

Corresponding Author: Chanderkant Dhiman, Research Scholar, Department of Physical Education, Banaras Hindu University, Varanasi, 221005 (U.P.) India, Email: dhimanchandu@bhu.ac.in

Abstract

This study aimed to analyze the effect of eight weeks of neurofeedback training to increase the stress tolerance level of swimmers the current researchers examined six all-India inter-university male swimmers. For the pre-test and post-test data on stress tolerance of swimmers, the current author used the computer-based, pre-designed "Determination Test" on the Schuhfried "Vienna Test System", and the alpha and beta training was provided by the pre-designed Med-Life biofeedback/neurofeedback system. Swimmers go-through under rigorous training cycle and at the time of the race, and to reduce that stress, the current author conducted this study on swimmers and found the difference in the mean of the pre-test, i.e., 27.67, while the post-test mean was 59.5; hence, the value of the t-statistic(5.338) is also significant to its corresponding p-value, i.e., 0.003, which is less than 0.05, which shows the significant difference between the pre-test and post-test, thus leading the current authors conclude that there was a significant improvement in the swimmers' perception of their stress tolerance level and, it shows that the 21 tutelage sessions were effective in increasing the swimmers' stress tolerance level, which can help the swimmers maintain an optimal state at the time of the race.

Keywords: Neurofeedback, Alpha training, Beta training, Vienna Test System.

DOI Number: 10.48047/nq.2023.21.5.NQ222141

NeuroQuantology 2023;21(5):1501-1509

Introduction

What is Neurofeedback?

Neurofeedback is a type of biofeedback used to assess the real time electrical activity of the brain through electroencephalography (EEG). Neurofeedback therapy is classified into two types: passive and active treatment. The difference is the level of patient engagement in

the procedure, although they are both as successful.

Passive neurofeedback involves sending low-energy radio waves to the brain and measuring the waves that return. When there is a break in signal processing, the brain automatically readjusts waves to take more suitable and efficient courses. To measure the EEG and discover the parameters that offer the



optimal therapy for each patient, many sessions are necessary [19].

Active neurofeedback employs a range of particular stimuli to assist patients in controlling their brain waves and breaking bad habits. These stimuli can be sound or light signals, or even video games, and they are used by the therapist to provide positive reinforcement when the patient's brain waves reach the required frequency [19].

What is NFB training?

One of the methods to control the brain activity is through neurofeedback training. Alpha waves are intermediate frequencies that occur when we are fully awake but not actively thinking or engaging with our surroundings [19]. Beta waves are the fastest waves, which indicate complete focus on thinking and problem-solving [19].

How NFB Training works?

There are two stages to neurofeedback training. Alpha training enhances the calmness of the mind and body, while beta training helps to maintain alertness or attentiveness.

What are the benefits of NFB training?

Neurofeedback training has been shown to be effective in the treatment of epilepsy [2], [6], gymnastics [3], Attention-deficit/hyperactivity disorder [11], [18], [7], [8] anxiety, depression, and temptation (stress tolerance) [13]. Neurofeedback has the potential to retrain all of an individual's brainwave activities in order to improve an athlete's performance during competition [10]. It teaches an athlete how to control different types of muscular tension, arousal, anxiety, and other unpleasant effects of stress. Neurofeedback training is also used to achieve the top level performance in professional games and sports through proper training [15].

What are the disadvantages of stress in sports competition?

Too much or bad stress can produce performance anxiety, which is harmful to your health and prevents you from playing comfortable, confident, and focused in

competition. When you face mental challenges like fear or worry, your body responds by physically stiffening up, which can lead to issues with sports performance [20].

What is stress tolerance?

Stress tolerance is the ability to be relaxed and composed when faced with difficulties. Having a positive stress tolerance means being able to stay calm without getting carried away by strong emotions of helplessness and hopelessness [21].

How NFB and stress tolerance is related?

The experimental investigation revealed the influence of post-traumatic stress disorder (PTSD) on generating symptoms of stress and decreasing attention levels [5]. The substantial improvements in PTSD symptoms, i.e., a decrease in sadness and stress and an increase in attentiveness after 30 sessions of neurofeedback training [5], Neurofeedback may be a promising addition to existing treatments for PTSD. It alleviated PTSD symptoms as well as affect deregulation symptoms [14].

How NFB Training will be helpful to overcome stress?

Former United States Olympic swimmer Michael Phelps shared his struggle with mental health at a Kennedy Forum conference in Chicago, saying that he has suffered from depression and suicidal thoughts, i.e., "I didn't want to be in the sport anymore... I didn't want to be alive anymore." Phelps noted he could also feel some patterns of emotion: "Really, after every Olympics, I think I fell into a major state of depression" [16]. This happened because of the stress that he was facing in his personal life, and that stress can be reduced with the help of neurofeedback training, in which brainwaves, which occur at various frequencies and may be measured in cycles per second or hertz (Hz) using electroencephalography (EEG) techniques, influence mental processes [9].

Why swimmers are very prone to mental stress?

1502



According to studies, swimmers actually feel worse throughout a rigorous training cycle. This makes sense—there is less time for friends, family, or any form of balance, which leads to melancholy, anxiety, mood swings, and aggression—the major mental states that clearly illustrate the need to develop stress tolerance during training and competition. Swimming in the winter, leisure swimming, competitive swimming, and aquatic aerobics, in particular—might be a viable conservative therapy for mental health management [22], [23], [24].

How NFB training can be helpful to swimmers to overcome the stress?

Internal factors such as a person's norms, motivations, skills, or stress tolerance may play a dominant role in determining coping strategies. For example, people who have successfully dealt with adversity in the past may be better equipped to deal with similar problems in the future [4]. Environmental conditions such as extreme social pressure and frustration can also come to the fore. Some things work together, but they all work together to make a person respond in a certain way or to environmental and social circumstances that are out of our control or beyond our resources. Treat stress as an internal condition that can be viewed as potentially harmful. On the one hand, stress can trigger many physical reactions. On the other hand, psychological reactions such as fear, despair, depression, irritability, and a general feeling of being overwhelmed by the world can result from stressful conditions. Stress is a big problem in our society. About 75% of physical illnesses are said to be related to stress [12].

What is the role of breathing in stress tolerance?

The primary purpose of breathing is to inhale oxygen and exhale carbon dioxide through the movement of the lungs. The movement of the lungs is controlled by the diaphragm (a strip of muscle beneath the lungs) and the muscles between the ribs. When people are agitated,

their respiratory rhythm changes an anxious person frequently takes short, shallow breaths, allowing air to enter and exit their lungs through their shoulders rather than their diaphragm. This breathing habit disrupts the body's gas balance. Shallow over-breathing, often known as hyperventilation, can prolong anxiety by worsening physical stress symptoms. Controlling your breathing might help lessen some of these symptoms [25].

Why the present scholar is interested to do this research?

The current authors attempted to find out the effect of alpha and beta training on the stress tolerance level or temperament level of all Indian interuniversity male swimmers. The primary goal of this study is to investigate the outcomes and effects of eight weeks (21 tutoring sessions) of neurofeedback training (Alpha and Beta training three times a week for 20 minutes) on the stress tolerance level of all India inter-university male swimmers. This research primarily focuses on improving swimmers' ideal mental relaxation during a race or competition.

Methods

Participants

For the purpose of the study, six male swimmers from an all-India inter-university team from the Lakshmibai National Institute of Physical Education, Gwalior, Madhya Pradesh, India, were selected just after the COVID-19 lockdown opened. All subjects were between the ages of 19 and 22 years. The subjects were then coded as participants A, B, C, D, E, and F to maintain confidentiality and ethical standards in the study. The conditions of all participants were homogenous, i.e., living conditions, training set-ups, diets, and educational backgrounds. The investigator was well acquainted with the subjects. There is no inconvenience in getting the students to come regularly for this specific purpose of the study. A purposive sampling method was used to draw the samples to maintain the authenticity of the

1503



study, and training was provided prior to the competition for better results.

Selection of variable

The researcher had gone through the scientific literature available in books, magazines, journals, and periodicals, as well as the literature available on electronic media (the Internet) in the form of journals, articles, etc. Keeping the feasibility criterion in mind, especially in the case of the availability of instruments, the following were selected:

1. Training variable (neuro-feedback).
 - A. Alpha training (frequency range, 8–12 Hz)
 - B. Beta training (frequency range, 12-38 Hz)
2. Testing variable (Vienna Test System)
 - A. Determination Test (DT-S1)

Research Procedure

The study was divided into three stages. The first phase entails gathering pre-test data, which was then examined by a computer-based Determination Test (DT, S-1) on the Schuhfried Vienna Test System. The test was carried out in the evening under conditions of some work load or stress in order to try to overcome the stress while performing the task.

The second phase consists of 21 tutelage sessions held every other day. A tutelage session lasted for 20 minutes. The group's basic training protocol (shown in Table No. 1) was alpha or beta training. The aim was to boost stress tolerance and achieve a very high level of stress tolerance.

Table no.1: Training Protocol

Days	Monday	Tuesday	Wednesday	Thursday	Friday
Subjects	A	B	C	D	E
	F	A	B	C	D
		E		F	
Training	ALPHA Training	BETA Training	ALPHA Training	BETA Training	ALPHA Training
Time Duration	20 MINUTES WITH BREATHING				

During the training, with EEG having three reference leads, the participants were asked to perform the following tasks: remain seated with eyes open for six minutes; remain seated with eyes closed for eight minutes; and remain

seated with eyes open for six minutes, for a total of twenty minutes. While doing training or a diagnosis, a total of three electrodes were placed on the subject's body, which were as follows:

S. No.	Name of electrode	Placement
1.	Reference electrode	Earlobe
2.	Ground electrode	PO ₄
3.	Active electrode	C ₃

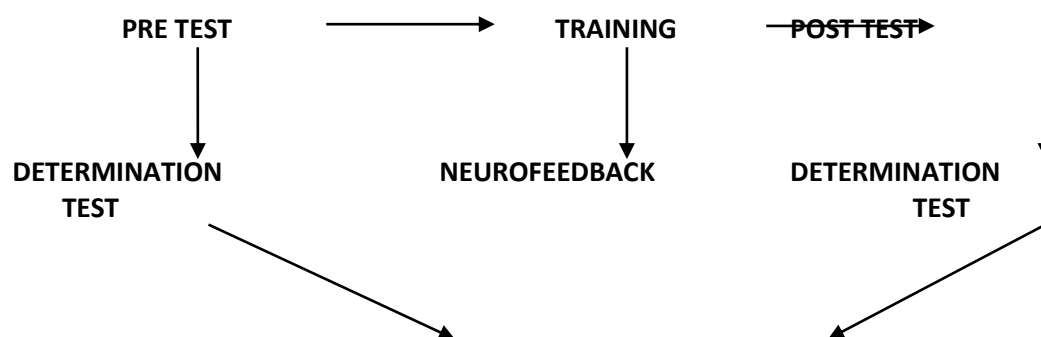
These electrodes were placed according to the 10-20 system of electrode placement. The final phase was to analyze the outcomes, and the effect of neurofeedback training on the stress tolerance of swimmers was examined by a computer-based determination test on the Schuhfried Vienna Test System (VTS). The test was held in the evening under the same conditions as the pre-test.

Which experimental design was used for training?

According to the pre-experimental research design, only one group will be tested for the pre-test and post-test for the whole investigation.

1504





VIENNA TEST SYSTEM

Statistical Technique

The dependent t-test was used to analyze the collected data for the stress tolerance level for male swimmers, and the level of significance was set at 0.05. The descriptive statistics were used to summarize the data so that it could be easily understood. IBM SPSS 20 full version was used to analyze the data.

Result

To formulate the result of the total sample that was selected for the study, the analysis of their descriptive statistics of Determination Test has been described in the form of table;

Table no.2: shows the normality of the pre-test and post-test data from two test Kolmogorov-Smirnov^a and Shapiro Wilk , significant value 0.20 & 0.338 and 0.20 & 0.988 respectively. As the Sig. values are greater than 0.05, data is normal.

1505

Table no. 2:Test of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Pre Test	.268	5	.200*	.894	5	.338
Post Test	.141	5	.200*	.989	5	.988

Table no. 3

Table no. 3: shows mean and standard deviation of sum of correct factor during pre-test and post-test are 27.66±14.09 and 59.50±20.89 respectively .It shows that the mean of determination test has increased from pre-test to post –test in general.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre Test	27.66	6	14.09	5.75
	Post Test	59.5	6	20.89	8.53



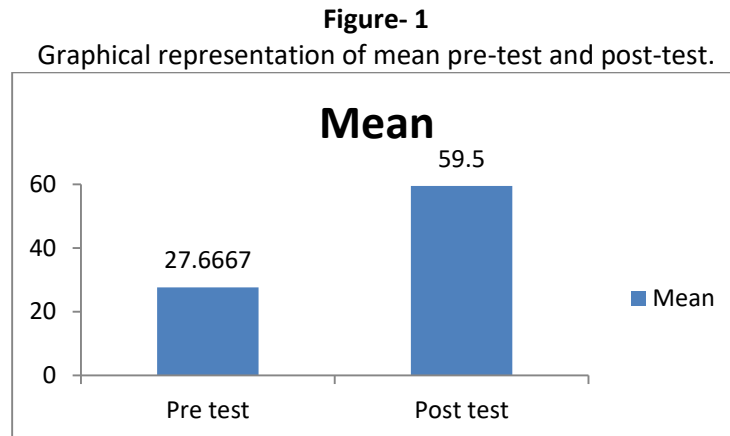


Table no. 4

Table no. 4 shows the significant difference between pre-test and post-test as value of t-statistics is 5.338. This t-statistics is significant as it corresponding p value is 0.003 which is less than 0.05.

Paired Samples Test

		Mean Diff.	t-value	Df.	p-value
Pair 1	Post Test - Pre Test	31.83	5.34	5	.003

There was a significant difference in perception of stress tolerance level of all India Interuniversity male swimmers ($M = 27.66$, $SD = 14.09$) compared after providing the eight weeks Neurofeedback training ($M = 59.50$, $SD = 20.89$), $t(5) = 5.34$, $p = 0.003$.

Discussion

The neurofeedback training has the potential to modify athletes' EEG power and substantially improve sports performance. The control group design influenced the effect of neurofeedback training on sport performance; that is, when studies were confined to active or placebo controls, the efficacy of neurofeedback training applied to sport performance might be quite modest. Future efforts should concentrate on standardizing neurofeedback training techniques and conducting better-organized trials [17]. The main aim of the current study was to find out the effect of eight weeks of

neurofeedback training on the stress tolerance level of swimmers. From the findings, the current researcher found that eight weeks of neurofeedback training using alpha (frequency range, 8–12 Hz) and beta (frequency range, 12–38 Hz) training (each for three weeks; 20 minutes per session) improved the stress tolerance level of the swimmers. The neurofeedback training of swimmers would increase their stress tolerance level, improve their self-control, and improve their self-regulation ability during stressful and more challenging situations. This would enhance their ability to control themselves in stressful situations and enhance their sports performance.

Alpha is associated with attentiveness and meditation, while beta training assists in the preservation of consciousness or attention [32, 33]. In our situation, alpha and beta



training were expected to raise the subject's degree of attentiveness and focus. It was expected that the alpha frequency would grow by 8–12 Hz because it was so close to the individual alpha band. The increases in these frequencies were also anticipated since the individual lower and individual higher alpha bands are both parts of the individual alpha band. Beta training has been used with healthy [26] and clinical populations [27, 28], and it is typically thought to be a component of a strategy for producing relaxation that was first connected with meditation [29]. It was expected to increase the beta frequency from 12-38 Hz. Participants in this type of training are always required to unwind while keeping their eyes closed and listening exclusively to feedback. The use of such techniques has demonstrated that after just five NFT sessions, healthy individuals are capable of changing their beta/alpha ratios [30, 31].

Conclusion

The current author discovered that the 21 tutorial sessions of neurofeedback training held every other day for eight weeks and lasting 20 minutes were effective for improving swimmers' stress tolerance levels. This could be due to Alpha and Beta training significantly increasing Alpha and Beta wave frequencies, or it could be due to an improvement in self-regulation ability. An increase in alpha and beta wave frequencies enhances concentration and decision-making abilities, along with mental calmness.

Conflict of interest

The present author has no conflict of interest to disclose.

Funding

Authorities provided no further funds; the researcher funded the whole study process, including the research design, data collecting, and submission. The present publication's content is totally the author's responsibility.

Acknowledgement

It has been an honor to work under the

esteemed supervision of Prof. B. C. Kapri, Dr. Binayak Dubey, and Mr. Chanderkant Dhiman. I was able to give this research the appropriate shape thanks to their meticulous direction, great attention, inspiration, critical supervision, and intellectual attitude.

Reference

1. Mann, H. B., & Whitney, D. R. (1947). On a test of whether one of two random variables is stochastically larger than the other. *The annals of mathematical statistics*, 50-60.
2. Lubar, J. F., & Bahler, W. W. (1976). Behavioral management of epileptic seizures following EEG biofeedback training of the sensorimotor rhythm. *Biofeedback and Self-regulation*, 1(1), 77-104.
3. Schempp, P. G., Cheffers, J. T., & Zaichkowsky, L. D. (1983). Influence of decision-making on attitudes, creativity, motor skills and self-concept in elementary children. *Research Quarterly for Exercise and Sport*, 54(2), 183-189.
4. Krylyshkina, O., Anderson, K. I., Kaverina, I., Upmann, I., Manstein, D. J., Small, J. V., & Toomre, D. K. (2003). Nanometer targeting of microtubules to focal adhesions. *The Journal of cell biology*, 161(5), 853-859.
5. Smith, W. D. (2008). The effect of neurofeedback training on PTSD symptoms of depression and attention problems among military veterans (Doctoral dissertation, Capella University).
6. Tan, G., Thornby, J., Hammond, D. C., Strehl, U., Canady, B., Arnemann, K., & Kaiser, D. A. (2009). Meta-analysis of EEG biofeedback in treating epilepsy. *Clinical EEG and neuroscience*, 40(3), 173-179.
7. Gevensleben, H., Holl, B., Albrecht, B., Schlamp, D., Kratz, O., Studer, P., ...& Heinrich, H. (2010). Neurofeedback training in children with ADHD: 6-month follow-up of a randomised controlled trial. *European child & adolescent psychiatry*, 19(9), 715-724.

1507



8. Lansbergen, M. M., van Dongen-Boomsma, M., Buitelaar, J. K., & Slaats-Willemse, D. (2011). ADHD and EEG-neurofeedback: a double-blind randomized placebo-controlled feasibility study. *Journal of neural transmission*, 118(2), 275-284.
9. Hammond, D. C. (2011). What is neurofeedback: An update. *Journal of Neurotherapy*, 15(4), 305-336.
10. Rostami, R., Sadeghi, H., Karami, K. A., Abadi, M. N., & Salamati, P. (2012). The effects of Neurofeedback on the improvement of rifle shooters' performance. *Journal of Neurotherapy*, 16(4), 264-269.
11. Arns, M., Kleinnijenhuis, M., Fallahpour, K., & Breteler, R. (2013). Golf performance enhancement and real-life Neurofeedback training using personalized event-locked EEG profiles. *Journal of Neurotherapy*, 11(4), 11-18.
12. Sharma, S. (2014). Perceived stress and coping strategies of senior players and relationship with doping. *Indian Journal of Health and Wellbeing*, 5(7), 83.
13. Sahraee, S. (2016). Effect of neurofeedback training on consumption temptation, depression and anxiety of smokers. *Iranian journal of educational sociology*, 1(1), 121-131.
14. van der Kolk, B. A., Hodgdon, H., Gapen, M., Musicaro, R., Suvak, M. K., Hamlin, E., & Spinazzola, J. (2016). A randomized controlled study of neurofeedback for chronic PTSD. *PloS one*, 11(12), e0166752.
15. Nan, W., Wan, F., Chang, L., Pun, S. H., Vai, M. I., & Rosa, A. (2017). An exploratory study of intensive neurofeedback training for schizophrenia. *Behavioural neurology*, 2017.
16. Michael Phelps Says He Contemplated Suicide, Struggled with Depression. (2018). Bleacherreport.Com. <https://bleacherreport.com/articles/2754933-michael-phelps-says-he-contemplated-suicide-struggled-with-depression>
17. Xiang, M. Q., Hou, X. H., Liao, B. G., Liao, J. W., & Hu, M. (2018). The effect of Neurofeedback training for sport performance in athletes: a meta-analysis. *Psychology of Sport and Exercise*, 36, 114-122.
18. Dobrakowski, P., & Łebecka, G. (2020). Individualized neurofeedback training may help achieve long-term improvement of working memory in children with ADHD. *Clinical eeg and Neuroscience*, 51(2), 94-101.
19. Ryanroessler. (2017, November 1). What is Neurofeedback and How Does it Work? Chicago Mind Solutions. <https://chicagomindsolutions.com/what-is-neurofeedback-and-how-does-it-work/>
20. CENTER, T. M. (2016, April 26). Stress and Athletic Performance. The Micheli Center. <https://www.themichelicer.com/post/stress-and-athletic-performance-1#:~:text=Conversely%2C%20too%20much%20stress%2C%20or>
21. TipSheetStressTolerance. (n.d.). https://uwaterloo.ca/student-success/sites/ca.student-success/files/uploads/files/TipSheet_StressTolerance.pdf
22. Contributors, S. (2022, May 17). *Mental Health For Swimmers*. SwimSwam. <https://swimswam.com/mental-health-for-swimmers/#:~:text=Research%20demonstrates%20that%20swimmers%20actually>
23. Köroğlu, M., & Yiğiter, K. (2016). Effects of Swimming Training on Stress Levels of the Students Aged 11-13. *Universal Journal of Educational Research*, 4(8), 1881-1884. <https://doi.org/10.13189/ujer.2016.040818>
24. Jackson, M., Kang, M., Furness, J., & Kemp-Smith, K. (2022). Aquatic Exercise and Mental Health: A Scoping Review. *Complementary Therapies in Medicine*, 66, 102820. <https://doi.org/10.1016/j.ctim.2022.102820>
25. Breathing to reduce stress - Better Health Channel. (n.d.).

1508



www.betterhealth.vic.gov.au.
<https://www.betterhealth.vic.gov.au/health/healthyliving/breathing-to-reduce-stress#breathing-and-stress>

26. Egner, T., Strawson, E., &Gruzelier, J. H. (2002). EEG signature and phenomenology of alpha/theta neurofeedback training versus mock feedback. *Applied psychophysiology and biofeedback*, 27, 261-270.
27. Peniston, E. G., &Kulkosky, P. J. (1999). Neurofeedback in the treatment of addictive disorders. In *Introduction to quantitative EEG and neurofeedback* (pp. 157-179). Academic Press.
28. Peniston, E. G., & Saxby, E. (1995). Alpha-theta brainwave neurofeedback training: an effective treatment for male and female alcoholics with depression symptoms. *The Biofeedback Center*, 51(5), 685-693.
29. Kassamatau, A., & Hirai, T. (1969). An electroencephalic study of Zen meditation. *Psychologia*, 12, 205-225.
30. Egner, T., Strawson, E., &Gruzelier, J. H. (2002). EEG signature and phenomenology of alpha/theta neurofeedback training versus mock feedback. *Applied psychophysiology and biofeedback*, 27, 261-270.
31. Vernon, D., Egner, T., Cooper, N., Compton, T., Neilands, C., Sheri, A., &Gruzelier, J. (2003). The effect of training distinct neurofeedback protocols on aspects of cognitive performance. *International journal of psychophysiology*, 47(1), 75-85.
32. Friel, P. N. (2007). EEG biofeedback in the treatment of attention deficit/hyperactivity disorder. *Alternative medicine review*, 12(2), 146.
33. Nan, W., Rodrigues, J. P., Ma, J., Qu, X., Wan, F., Mak, P. I., ...& Rosa, A. (2012). Individual alpha neurofeedback training effect on short term memory. *International journal of psychophysiology*, 86(1), 83-87.

1509

