European Journal of Molecular & Clinical Medicine
ISSN 2515-8260 Volume 08, Issue 1, 2021

The Effectiveness of Neuro feedback Training on the Working-Memory of People with Obsessive-Compulsive Disorder Symptoms

1. Shirin Esmaeeli
MA Graduate in Cognitive Psychology, Faculty of Psychology and Educational Sciences, Ferdowsi University of Mashhad, Mashhad, Iran.

Abstract

Background and Objectives:

Obsessive-Compulsive Disorder (OCD) is one of the most common psychiatric disorders that sometimes begins in childhood and adolescence. Epidemiological studies have reported the prevalence of obsessive-compulsive symptoms in a high clinical population; hence, the use of new methods can be very useful. This study aimed to evaluate the effectiveness of neurofeedback on working-memory in people with obsessive-compulsive disorder.

Method:

A total of 20 obsessive-compulsive patients were selected by convenient sampling and were randomly placed in two groups of 10 (experimental and control). In this study, the N-back test was used to collect information from the Yale-Brown Obsessive-Compulsive Scale (Y-BOCS). In the beginning, the pretest was done and then the experimental intervention (neurofeedback) was performed on the experimental group during 15 one-hour sessions. At the end of the treatment program, a post-test was given to both groups. Multivariate analysis of variance (MANCOVA) was used for data analysis.

Results:

The results showed that neurofeedback is significantly associated with increased working memory and decreased symptoms of obsessive-compulsive disorder in people with obsessive-compulsive syndrome ($p < 0.05$).

Conclusion:

Neurofeedback training increases working memory in people with obsessive-compulsive disorder; therefore, it can be used as an effective method with regard to these patients.

Keywords: Neurofeedback, Obsessive-Compulsive Disorder, Working Memory, N-back Test.

Introduction

Obsessive-compulsive disorder (OCD) is one of the 10 leading causes of disability worldwide (World Health Organization (WHO), 2005). It affects not only the lives of parents but also their family members. The burden of responsibility increases and quality of life decreases in acquaintances of patients with obsessive-compulsive disorder (Sahrakorpi, N., 2017). Obsessive-compulsive disorder (OCD) is one of the anxiety disorders. The results of previous research and studies on obsessive-compulsive disorder show that the 12-month prevalence of this disorder internationally is 1.1 to 1.8 (American Psychiatric Association, 2013). Obsessive-compulsive disorder (OCD) and related disorders are presented in a separate and independent category in the Diagnostic and Statistical Manual of Mental Disorders, Edition 5. This disorder affects thoughts, cognition, and emotions. In psychiatric terminology, obsessive-compulsive disorder is defined as ideas, thoughts, impulses, or perceptions that are repetitive and long-lasting, so it can be said that at least at first it is a disturbing and stupid experience. In obsessive-compulsive disorder, disturbing and anxious thoughts are accompanied by practical obsessions. These practical obsessions are coercive actions that a person does to reduce his or her obsessions. These actions are repetitive, stereotypical, and somewhat involuntary. Obsessive-compulsive disorder depletes a person's ability, and the presence of these forced thoughts and actions creates a feeling of tiredness. Recent approaches to the obsessive-compulsive disorder have suggested

some neurobiological abnormalities involved in the disorder. These studies have identified cognitive deficits as a mediator between neurological abnormalities and obsessive-compulsive disorder (Sharma et al., 2012). These include defects in working memory and executive functions. Working memory can be considered as a comprehensive cognitive system that includes mechanisms of storing, processing, and attention and it can be used as a framework for identifying the cognitive characteristics of people with the obsessive-compulsive disorder because this system is constantly storing, processing, and integrating information. It is to guide one's current actions. However, people with obsessive-compulsive disorder seem to have serious problems with these functions because they are not successful in using memorization strategies such as categorization by category (Harkin and Kessler, 2011). As a result, it encrypts less information and the functions mentioned in its memory [storing, processing, and integrating information] will not work optimally. Also, a fundamental weakness in actual monitoring is one of the factors that suggest a weakness in the working memory capacity as one of the root causes of obsessive-compulsive tendencies. On the other hand, some memory deficits in people with obsessive-compulsive disorder and weakness in working memory may be the result of executive dysfunction. Obsessive-compulsive disorder has a direct effect on memory and working memory and causes it to be impaired. Working memory is a part of the memory system that uses cognition to keep information temporarily active to perform other operations on it. Compulsive thoughts and actions in people with obsessive-compulsive disorder become so difficult that they have difficulty suppressing or inhibiting thoughts of memory or actions. Patients are not always sure whether or not, and the result of this uncertainty is repeated conflict with mental doubts or repetitive mirrors. It is also a set of cognitive processes that interact to hold and manipulate the information needed to perform daily activities. This memory is located in the lateral dorsal frontal cortex and interacts with the visual cortex in the occipital lobe and the lingual cortex in the temporal lobe. Various neuropsychological studies have shown that obsessive-compulsive disorder causes defects in some cognitive functions, such as attention, memory, executive functions, visual-spatial skills, and information processing speed. Patients with the obsessive-compulsive disorder show a significant slowness in completing and performing daily activities of life, such as eating, dressing, and bathing. Neuropsychological studies have also shown that these patients may perform worse on scheduled tests than on non-scheduled tests. The slowness of movement in these patients has been attributed to the presence of disturbing, distracting thoughts or obsessive-compulsive disorder during the test or work performance (Alakron et al., Quoted by Kazempour et al., 2015).

Working memory is a system with limited capacity where information is stored for a short time. This memory interacts with long-term memory and uses long-term memory information to transfer information to long-term memory for longer storage. Working memory is a three-part system that holds information temporarily when a person is performing a cognitive task. Working memory is like a mental desk where manipulating information and gathering information on it allows us to understand written and oral language, make decisions, and solve problems. Working memory is not like a shelved information warehouse waiting for its information to go into long-term memory (Nyberg et al., 2002). As a result, it can be said that the role in working memory causes a person to forget the things such as washing his hands or closing the door, etc., so he/she wants to do them again, three times and sometimes many times. do it.

So far, various theories such as biological, psychodynamic, psychosocial, cognitive, behavioral, and cognitive-behavioral theories explain and provide a therapeutic model for obsessive-compulsive disorder. Most studies show that 70 to 90 percent of patients treated with medication alone experience a recurrence of symptoms within a few weeks of discontinuation. Clomipramine for obsessive-compulsive disorder also has side effects such as dry mouth, blurred vision, constipation, transpiration, lethargy, dizziness, and premature ejaculation. On the other hand, about 25% of people refuse exposure and response prevention, and 3 to 12% will not complete treatment. There is a reversal of symptoms in 20 to 25% of patients (Demos, 2005), and one of the new methods is neurofeedback.

Numerous studies have shown that the neurofeedback method is effective in increasing attention and concentration, increasing IQ scores, and improving indicators related to continuous attention, which are mainly measured through continuous performance evaluation tests such as attention change tests (Barzegari and Yaghoubi, 2009). The researchers showed that neurofeedback was effective in

regulating cortical activity, improving attention and intelligence, and advancing in cognitive and behavioral domains. Also, the effect of neurofeedback on anxiety and attention (Salman Mahini, 2010), change in gamma power and reduction of reaction time (Keizer, Verchoor & Verment, 2009), reaction time (Dreschler et al., 2007), the difference in hemispheric function in the left parietal region and changes in attention and response time (Beauregard and Levesque, 2006), attention and reaction time (Baek, 2004) have been shown. In this study, we seek to answer the question of what is the effect of neurofeedback training on working memory in people with obsessive-compulsive disorder?

Research Methodology

This quasi-experimental study was performed using a pretest-posttest design with a control group. The statistical population included all clients who were referred to Kavosh, Rahyab, and Arn counseling centers of Mashhad due to obsessive behavior in the spring of 2017. The research sample included 35 people with obsessive-compulsive disorder who were referred to as Kavosh, Rahyab, and Arn counseling centers. Out of these 35 people, 20 obsessive-compulsive individuals were replaced individually in two experimental (n = 10) and control (n = 10) groups. Sampling in this study was "available sampling" and voluntary.

Research measurement tools

Yale-Brown Obsessive-Compulsive Scale (Y-BOCS)

The Yale-Brown Scale is a research tool developed by Goodman et al (1989). It is one of the measuring tools of OCO and measures their severity regardless of the types of obsessions or compulsions. The scale has 10 articles, five of which focus on obsessions and five on compulsions. The highest score on this scale is 40. The correlation coefficient was reported from 0.80 to 0.99 and this value was 0.81 to 0.97 with a gap of 2 weeks for reliability between scorers. Cronbach's alpha coefficient has been reported from 0.69 to 0.91 for its internal stability.

N-BACK test

This test is a cognitive function assessment task related to executive actions and was first introduced in 1953 by Kirchner. It is well-known for measuring working memory performance because this important task involves storing and manipulating cognitive information. Validity coefficients in a range from 0.54 to 0.84 showed high validity of this test. The validity of this test is also very acceptable as an indicator of working memory performance. In this test, the subject is asked to compare each stimulus with the items that appeared n times before the sequence and press the answer key if the match is the same. In the 0-back task, the stimulus is the first stimulus observed in the peer sequence. In the 1-back task, the target stimulus is equal to the stimulus immediately before it. In the 2-back task, the target stimulus is considered when the stimulus that appears is equal to the two previous stimuli, and in the 3-back task, the target stimulus is equal to the three previous stimuli.

Software test

The software test in this study was created by the researcher using SuperLab 4.0 software. In this test, 100 visual stimuli were used and each of which appeared for 1.5 seconds and a distance of 3 seconds. The total score of N-Back is the sum of correct answers from which incorrect and unanswered answers are differentiated. In this test, only accuracy (number of correct answers), unanswered (items that the subject did not answer), incorrect (number of incorrect answers), speed (average reaction time to correct answers), and the total score (the sum of correct answers minus incorrect answers and unanswered questions) are recorded and calculated. In this test, only the visual dimension is examined.

Procedure

To carry out this research, the researcher announced the call for his research project in Aren, Kavosh, Rahyab counseling centers in the middle of April 2017, and finally, 35 men and women aged 18 to 40 with obsessive-compulsive disorder participated in the research project and completed the Yale-Brown Obsessive Questionnaire. Participants were asked to fill out a research consent form at the beginning of the questionnaire and enter their telephone number to participate in the treatment sessions. After collecting and analyzing the data, people with obsessive-compulsive disorder (score above 16 in the Yale-Brown questionnaire) were contacted. According to other criteria for entering the research and also asking for their purpose to participate in this workshop, 20 people were selected for the study who were randomly assigned to experimental and intervention groups.

Experimental group: The members of the experimental group received neurofeedback training in 15 sessions of 60 minutes three days a week. In the first session, 10 people completed the Yale-Brown questionnaire and N-Beck test (pre-test). At the end of the 15th session, 10 participants completed the Yale-Brown questionnaire and N-Beck test (post-test).

Intervention group: The members of the intervention group received 15 sessions of 60 minutes three days a week, watching the video recorded from the neurofeedback treatment window. However, the electrodes were attached to their heads and the feedback they received did not match their brain waves. In the first session, 10 people completed the Yale-Brown questionnaire and N-Beck test (pre-test). At the end of the 15th session, 10 participants completed the Yale-Brown questionnaire and N-Beck test (post-test).

Implement the protocol

In the present study, Procomp Infiniti-2 software from Thought Technology Canada was used to teach neurofeedback, and neurofeedback training was performed on the subjects in 1 month with 3 sessions per week and 40 minutes per session. The references were placed in front of the computer screen and the electrodes were installed according to the international system of 10-20 standard locations of the electrodes in the desired location with a special gel. All subjects were trained for 40 minutes to increase beta (15 to 18 Hz), decrease theta (4 to 8 Hz), and decrease beta 3 (18 to 26 Hz) in the F3 and Fcz regions. When a person could keep his BETA level above the threshold for 0.05 seconds and keep theta and beta 3 below the thresholds at the same time, his task would go one step further, otherwise, he would see a negative result. Treatment window feedback was visual-auditory. An example of audio-visual feedback is boat games. In this game, 3 boats are shown to the authorities and the person is asked to move the middle boat ahead of the other two boats and win. The middle boat moves when the person maintains the above conditions. For example, the mid-boat keeps the beta above the threshold 80% of the time and the theta and beta-3 wave below the threshold 20% of the time in beta training, and the middle boat starts moving.

In this study, descriptive statistics including average and standard deviation, and inferential statistics such as correlation analysis were used to analyze the data. All data were analyzed in SPSS 22 software.

Results

Description of research variables

Table 1 shows the descriptive statistics for each of the variables.

Table 1. Description of obsessive and memory variables

Group	Obsession	No.	Min.	Max.	Average	SD
Intervention	Obsessive pre-test	10	22	33	24.80	3.52
	Obsessive post-test	10	22	32	26.10	3.75
experimental	Obsessive pre-test	10	23	33	27.40	3.16
	Obsessive post-test	10	10	17	14.10	1.79

Working memory		Pre-test		Post-test	
		M	SD	M	SD
Intervention	Correct answers	6.5	1.64	6.60	1.34
	Reaction time to correct answers	7.80	1.39	7.60	1.77
	Number of errors	12.50	1.84	12.20	2.04
	No answer	1	1.33	1.20	1.22
	Total score	-7	3.29	-6.80	2.69
experimental	Correct answers	6.70	1.63	13.70	1.70
	Reaction time to correct answers	14.30	1.49	6.77	0.89
	Number of errors	12.20	1.93	5.60	1.26
	No answer	1.20	1.03	0.50	0.70
	Total score	-6.70	3.33	7.60	3.23

Kolmogorov-Smirnov test

Table 2: Evaluation of normality of score distribution in groups using Kolmogorov-Smirnov test

	Intervention				**experimental**			
	Post-test		Pre-test		Post-test		Pre-test	
Variable	Z	Significance level	Z	Significance level	Z	Significance level	Z	Significance level
Obsession	0.61	0.5	0.24	0.29	0.52	0.23	0.32	0.30
Total working memory score	0.217	0.200	0.219	0.191	0.252	0.200	0.189	0.072

According to the results of Table 2, a significance level of more than 0.05 has been obtained and it can be concluded that the distribution of data in post-test and pre-test in all variables is normal in experimental and intervention groups. Therefore, the analysis of covariance can be used.

Investigating the assumptions of homogeneity of variances

Table 3. Leven test results

	Sig.	df2	df1	Leven statistics
Obsession	0.929	18	1	0.008
Total working memory score	0.792	18	1	0.072

According to the results of Table 3, the significance level of the Leven test in all subscales of the experimental and intervention groups in pre-test and post-test is above 0.05 and it can be said that the variance of the groups is homogeneous. As a result, a covariance analysis can be used.

Investigation of research hypotheses

Neurofeedback training reduces the bias of the experimental group towards the intervention group.

Table 4. ANKOA analysis of attention bias in experimental and intervention groups

Source	Eta coefficient	Sig.	F	Average squares	df	Total squares
Pre-test	0.512	0.001	17.84	317.61	1	317.61
Error				17.80	17	302.62
Total					20	1084.31

To investigate the effect of stimuli interference, the covariance method was used. The dependent variable of the interference score was calculated for obsessive stimuli and the independent variable was entered into the model. The results of Table 4 showed that the group has a significant effect on the score of obsessive stimulus interference (f = 17.84, P = 0.001) and then the hypothesis is confirmed. Also, the effect size for the interference score is 0.512, which indicates that 51% of the changes in the post-test score are due to neurofeedback training.

Neurofeedback training reduces the signs of obsessive-compulsive disorder in the experimental group compared to the intervention group.

Table 5. ANKOA analysis of obsessive-compulsive disorder in two experimental and intervention groups

Source	Eta coefficient	Sig.	F	Average squares	df	Total squares
Pre-test	0.69	0.001	77.04	670.58	1	670.58
Error				8.70	17	147.95
Total					20	8956

The dependent variable of the obsessive score and the independent variable was entered into the model. The results of Table 5 showed that the group has a significant effect on the score of obsessive stimulus interference (f = 17.04, P = 0.001) and then the hypothesis is confirmed. Also, the effect size for the obsessive score is 0.690, which indicates that 69% of the changes in the post-test score are due to neurofeedback training.

Conclusion

In this study, the effect of neurofeedback training on working memory in people with the obsessive-compulsive disorder was discussed. The results indicate that neurofeedback training increases the working memory of the experimental group compared to the control group. An analysis of covariance was used to test this hypothesis. The results showed that neurofeedback training increased the working memory of the experimental group compared to the control group. The results of this hypothesis are consistent with previous research such as Vernon et al. (2003). Part of the protocol used in this study was SMR in the area (CZ).

Neural biological models of obsessive-compulsive disorder emphasize the functional role of the frontal-striatal circuits (Menzies et al., 2008). Due to the abnormalities in the forehead-striatum circuit, executive functions have always been discussed in this disorder, and deficiencies in controlling the inhibition of their behavior and neural communication have been reported (Chamberlain et al., 2008). Executive functions can be considered as a domain that includes three important functions of working memory, inhibition, and cognitive flexibility (Diamond, 2013). Combining these three functions helps to perform complex activities such as reasoning, problem-solving, and planning.

As a result, one of the disorders that can be observed in people with obsessive-compulsive disorder is memory and working memory disorders. One of the other sources involved in the information acceptance process is working memory. Working memory is the process by which current experience relates to stored schemas. This system is responsible for the temporary storage of information and keeps the input data to the cognitive system on standby. Thus, working memory is an active and dynamic system used to temporarily store and manipulate information and perform complex cognitive tasks such as learning, reasoning, perception, and thinking. When you mentally review, retrieve, and recall

information, that information is transferred from long-term memory to working memory. It is also actively associated with information that wants to be transferred to long-term memory. Simon Hansmeer et al. (2005) sought to answer the question of whether neurofeedback training under the protocol of increasing high alpha strength and decreasing theta strength could increase cognitive function. Only those who were able to increase their high alpha power performed better on the cognitive task after neurofeedback. The study of Benedict Zoffel complements the study of Hansmeer et al. There was both a control group and that the alpha wave was separated from the other waves and the number of samples was higher in this case. Finally, the hypothesis of "high alpha wave training increases cognitive function" was proved and the scores of mental rotation in the neurofeedback group were higher than the control group.

Finally, some researchers have reported the effect of this method on cognitive function in addition to many studies that show the effect of neurofeedback training on inactive and inattentive problems. The results of cognitive training indicate different positive and negative results. It has been hypothesized that neurofeedback training may help improve cognitive function in obsessive-compulsive patients based on the theoretical findings and in line with the researchers' findings. Although many studies have been performed on neurofeedback in the treatment of diseases, there is limited research on its effectiveness in the treatment of stroke patients. Research shows that increasing high alpha power leads to improved cognitive performance, especially in the field of working memory. Since working memory is one of the most important functions in individuals cognition, it is inferred that performing therapeutic measures to return the waves to the amplitude can lead to improved cognitive functions in patients.

Finally, neurofeedback training is a controlled method for systematically altering arousal levels. So that the nervous system is dynamically challenged with frequency, the time of occurrence of specific brain waves for better performance. The low alpha amplification in the occipital lobe and visual cortex seems to act as a barrier to the entry of irrelevant information during the processing of executive tasks in the form of working memory, which results in more accurate and faster working memory. According to him, the improvement of executive action due to the application of the alpha/theta protocol in the Pz region is due to the effective role of these waves to perform these tasks correctly. In general, recent research has reported the role of alpha and theta waves in the processing of executive tasks.

The findings of this study showed that neurofeedback training increased working memory and reduced obsessive-compulsive symptoms and attention bias in the experimental group. This finding is consistent with previous findings. It can also be said that neurofeedback is a continuous exercise program that strengthens the neural pathways while increasing mental resilience and flexibility.

In Gholizadeh's research, he performed neurofeedback training in Cz and it simultaneously affected three sensory-motor cortices, motor and cingulitis. As Damasio (1994) states, systems in cingulate that deal with emotion/feeling, attention, and working memory interact closely with each other in such a way that they are the source of energy for external actions (movement) and internal actions (reasoning, thinking). Neurofeedback training may facilitate long-term modulation of thalamocortical and cortical network excitation levels. Recent research focusing on individuals has shown that individuals can control their EEG during neurofeedback sessions, and such control has led to improved attention processing, in the form of electrocortical behaviors and scales.

Neurofeedback training also reduces the symptoms of obsessive-compulsive disorder in the experimental group compared to the control group. To test this hypothesis, an analysis of covariance was used. The results showed that neurofeedback training reduced the symptoms of obsessive-compulsive disorder in the experimental group compared to the control group. Research on the treatment of obsessive-compulsive disorder has been performed using neurofeedback, which indicates the high efficiency of this method in the treatment of the obsessive-compulsive disorder. Hammond (2005) has studied the effect of neurofeedback on reducing the symptoms of obsessive-compulsive disorder. In these studies, neurofeedback therapy was able to significantly improve the symptoms of obsessive-compulsive disorder measured by the Yale-Brown and Padua Questionnaire as well as the

Minnesota Multidimensional Questionnaire. Barzegari's research (2009) in the field of obsessive-compulsive disorder shows the same result.

Obsessive-compulsive disorder is one of the most common anxiety disorders. The name OCD is one of the prominent symptoms of this disorder, which affects both cognition and motor behavior. It is a complex neuropsychiatric syndrome characterized by unwanted, repetitive, and disturbing thoughts, as well as repetitive and annoying behaviors and obsessive-compulsive behaviors that are performed to avoid anxiety or to neutralize obsessive thoughts (American Psychiatric Association, 2000). The study of attention bias in OCD has important applications in theoretical etiology and treatment. The problem of inhibiting irrelevant information (ie, obsessive thoughts and impulses) is an important concept in OCD. In general, the focus of OCD patients' attention span is on threatening stimuli related to their concerns. Therefore, their ability to pay attention to appropriate information and simultaneously ignore irrelevant information is limited.

Obsessive-compulsive disorder is considered as one of the debilitating mental states. This disorder is known by three distinct components. The first are constant thoughts or ideas and beliefs that are characterized by their unwantedness and annoyance, which in the images section includes: insulting sacred things, sexual beliefs, or violent images and disturbing thoughts about contamination or doubts about the completeness or incompleteness of certain tasks. The second component of obsessions is coercion, which is defined as specific behavioral activities, unconscious mental rituals, attempts to neutralize obsessions or behaviors that indicate uncertainty. Besides, both components of the disorder exhibit avoidant behaviors to prevent obsessive-compulsive disorder. Most studies in the general population have defined non-clinical obsession as very similar to practical obsessive-compulsive disorder. The prevalence of OCD in the Iranian population is estimated to be 1.8% (0.7% in men and 2.8% in women). Obsessive-compulsive disorder affects men and women almost equally (White et al., 2009).

Explaining this finding, we can point to the importance of reducing or increasing the amplitude of brain waves, especially 4 to 8 Hz and 15 to 18 Hz waves in excellent mental functions. Studies have shown that the increase in slow brain waves in different areas of the brain is associated with a lack of impulse control and decreased attention and arousal in individuals. Therefore, we can see a behavior change, especially arousal, and attention in people by reducing or suppressing the amplitude of theta and delta waves. As a result, neurofeedback can help obsessive-compulsive disorder sufferers regulate brainwave activity, thereby improving their attention and planning problems. In other words, the underlying mechanism of the neurofeedback method is the same as the theory of factor conditioning, so that if the stimulus change (amplitude of the brainwaves) is amplified and amplified according to a predetermined contract with the desired outcome (motion of video images or sound production), it will lead to learning. This learning will be more effective when using simpler stimuli (such as neurofeedback training) that lead to receiving reinforcement. Neurofeedback is how information is provided to a person after the expression of the desired behavior until this information leads to the recurrence of that behavior in the future. As a result, people learn to change the behavior in the desired direction, which improves the symptoms of obsessive-compulsive disorder.

Reference

1. Barzegari, L., and Yaghoubi, H. (2009). Determining the effectiveness of neuro-feedback therapy based on quantitative electroencephalography compared to drug therapy in reducing the symptoms of obsessive-compulsive disorder. Journal of Psychology, University of Tabriz. 4 (15).

2. World Health Organization. (2005). The ICD-10 classification of mental and behavioral disorders. Diagnostic criteria for research. Geneva: World Health Organization.

3. Hrakorpi, N., Koivusalo, S. B., Eriksson, J. G., Kautiainen, H., Stach-Lempinen, B., & Roine, R. P. (2017). Perceived Financial Satisfaction, Health-Related Quality of Life, and Depressive Symptoms in Early Pregnancy. Maternal and Child Health Journal, 21(7), 1493-1499.

4. American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders (4th ed.). Washington.

5. Harkin, B., Miellet, S., Kessler, K. (2012). What Checkers Check An EyeTracking Study of Inhibitory Control and Working Memory. Chichester: Wiley.

6. Nyberg, L., Forkstam, C., Peterssqn, K.M., Cabeza, R., & Ingvr, M. (2002). Brain Imaging of Human Memory System Differences, Brain Research: Cognitive Brain Research, 13, 281-292.

7. Demos, N.J. (2005). Getting Started with Neurofeedback. W.W. Norton & Company. New York.

8. Keizer, A., Verchoor, M., Verment, M. (2009). "Neurofeedback on the control of feature binding and intelligence measures". International Journal of Psychology. INTPSY -10078; No of pages 8- October 2009.

9. Drechsler, R., Straub, M., Doehnert, M., Heinrich, H., Steinhausen, H. C., & Brandeis, D. (2007). Controlled evaluation of a neurofeedback training of slow cortical potentials in children with attention-deficit/hyperactivity disorder (ADHD). Behavioral and brain functions, 3(1), 35.

10. Beauregard, M., & Levesque, J. (2006). Functional magnetic resonance imaging investigation of the effects of neurofeedback training on the neural bases of selective attention and response inhibition in children with attention-deficit/ hyperactivity disorder. Applied Psychophysiology and Biofeedback, 31(1), 3-20

11. Baek, H. (2004). CyberPsychology & Behavior. In Young, K. & Sun I, K. (2004). "Neurofeedback Training with Virtual Reality for Inattention and Impulsiveness". 7(5), 519-526

12. Menzies, L., Achard, S., Chamberlain, S. R. (2008).patients with obsessive-compulsive disorder and their unaffected relatives. Science, 421-422.

13. Chamberlain, S. R., Fineberg, N. A., Menzies, L. A., Blackwell, A. D., Bullmore, E. T., Chir, B., & Sahakian, B. J. (2008). Impaired cognitive flexibility and motor inhibition in unaffected first-degree relatives of patients with obsessive-compulsive disorder. American Journal of Psychiatry, 164, 335–338.

14. Diamond, A. (2013). Development of cognitive control and executive functions from 4 to 13 years: Evidence from manipulations of memory, inhibition, and task switching. Neuropsychologia, 44(11), 2037- 2078

15. American Psychiatric Association. (2000) Diagnostic and Statistical Manual of Mental Disorders (4th ed., text rev.). Washington.

16. White, K., Steketee, G. S., & Julian, J. (2009). Course and comorbidity in OCD. Unpublished manuscript.