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Research Paper

Effect of Cognitive Training on Cognitive Flexibility and Non-Verbal Memory of Individuals with Obsessive Compulsive Disorder: A pre-post study

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ABSTRACT

Neuropsychological deficits often act as hindering factors in the treatment of Obsessive-compulsive disorder (OCD). The present study assessed the effect of cognitive training on cognitive flexibility, non-verbal memory and symptoms of obsessions and compulsions. The study was conducted on 9 individuals, aged between 20-40 years, diagnosed with OCD. They were randomly assigned to two groups, the delayed trial group and experimental group. Baseline measures were taken using scales on OCD and neuropsychological assessments. This was followed by cognitive training of experimental group for 6 sessions. Post-intervention measures were taken from both the groups. Statistical analysis of findings suggested the presence of significant improvement in the post intervention scores of some of the variables, of individuals belonging to experimental group.

Keywords: *Cognitive Training, Cognitive Flexibility, Non-verbal Memory, Obsessive Compulsive Disorder*

Obsessive Compulsive Disorder (OCD), because of its intrusive nature, causes severe disturbance in the life of an individual. In addition to this, research studies also indicate that OCD leads to reduced quality of life in different spheres (Fontenelle, 2010).

Brain Imaging studies have indicated individuals with OCD have abnormal activation of the orbitofrontal cortex, anterior cingulate cortex, lateral frontal and temporal cortices, caudate nucleus, thalamus, amygdala, and insula (Harrison et al, 2009; Rotge et al, 2009; Saxena et al, 2000). Connectivity studies further reveal abnormal cortico-striato-thalamo-cortical (CSTC) connectivity in OCD (Fitzgerald et al, 2010; Sakai et al, 2011). Deficit in CSTC circuit often causes disturbance in executive functioning.

Studies on neuropsychological correlates of OCD have yielded somewhat inconsistent results. While some studies have indicated deficits in non-verbal memory and in

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organizational capacity (Penades, et al 2005; Shin,et al 2010; Savage et al, 2000). Other studies suggest deficit in cognitive flexibility and response inhibition (Brannon et al, 2002; Chamberlain et al,2006; Penades et al, 2007). Some studies, on the other hand, revealed that there are no neuropsychological deficits in OCD. Research conducted by Abramovitch et al (2013) on OCD patients showed generalized neuropsychological deficits in all domains, with maximum deficit occurring in the domains of memory and response inhibition and moderate level of deficit occurring in the domains of attention, executive functioning and processing speed. The research also indicated the presence of minimal deficits in the areas of working memory and visuo-spatial deficits.

Studies have shown that Cognitive inflexibility and impairment of nonverbal memory are considered to be central features of Obsessive Compulsive disorder (Savage, 1998). For example, patients with OCD fail to form memories that have global organization. Instead, their memory structures are localized and fragmented, which may result in breakdown of their organizational capacities, and consequently, an abnormally high degree of doubt and uncertainty about events (Griesberg et al, 2003). Despite their normal ability to cluster group verbal information semantically (Park, et al, 2003), the impairment of executive function causes problems in the everyday life of patients with OCD. When faced with a problem, patients with OCD tend focus on trivial details, rather than consider the overall context to find a fundamental solution to the problem. In addition, after they successfully solve the problem, they cannot remember having done so (Enright et al, 1996; Rubin et al, 1999). It is also because of these deficits that individuals with OCD find it difficult to comprehend, remember and implement the issues raised during therapeutic interventions (Fontenelle, 2001).

Non-pharmological treatment of OCD have mostly focused on Cognitive Behavioural Therapy (CBT). However, what remains somewhat unfocussed is the resolution of neuropsychological deficits found present in OCD clients. Furthermore, in case of OCD there always remains the possibility for symptoms to relapse, specially because the threat association circuits does not disappear with the extinction of the compulsive symptoms. Therefore, Cognitive training was thought of as possible mode of therapeutic intervention for OCD, which will be based on the premise that if executive functioning of individuals with OCD could be improved, it would lead to improvement of cognitive flexibility and non-verbal memory functioning, which will help in alleviating the symptoms (Park, et al, 2006).

Cognitive training, also known by several other names like ‘brain training’, ‘drill for skill’, involves various exercises that are designed to enhance attention, concentration, memory functioning, executive functioning, visuo-spatial functioning and so on (Bahar-Fuchs et al, 2019). This mode of training was initially used for individuals with dementia and traumatic brain injury but was later applied to psychiatric disorders as well.

The basic principle behind cognitive training is that direct training can result in a reorganization of neural functions (Park, 2013; Klineberg, 2016). Among other effects, neuroplasticity allows the central nervous system to learn new skills, remember information and reorganize neural networks in response to external stimulation.

The efficacy of cognitive training has been already proved not only in neurological disorders but also in psychiatric disorders like Schizophrenia, Obsessive compulsive Disorder,

Depression and Aneroxia Nervosa. Cohen (2016) was able to reduce the activation of amydala with just 6 days of training and helped his adolescent clients to engage in more rational decision making. Similarly, Tchanturia (2017) could bring about improvement in the cognitive flexibility of Individuals with Obsessive Compulsive Disorder after 10 sessions of cognitive training. Park (2006) could improve the memory functioning of Individuals with obsessive Compulsive disorder and also brought about a reduction in the frequency and intensity of their symptoms. Buhlman (2006) also worked with individuals having Obsessive Compulsive Disorder and could bring about similar results.

The aim of the present research is to provide cognitive training to individuals with Obsessive Compulsive Disorder in the domains of cognitive flexibility and non-verbal memory and then to conduct a pre-post assessment to see if it has any effect on the obsessive compulsive symptomatology, cognitive flexibility and non-verbal memory of these individuals.

METHODOLOGY

Sample

In the present study, the sample consists of individuals having obsessive compulsive disorder (diagnosed as per ICD 10) between the age ranges 20 years to 40 years. The individuals selected for the study were randomly assigned using fish bowl method to two groups. The groups were the experimental group consisting of 5 individuals and the control group (Randomised control with delayed trial) consisting of 4 individuals.

In present study, an attempt will be made to administer cognitive training on 5 individuals with OCD having either washing compulsion and/or checking compulsion and it will be examined whether cognitive training has an effect on obsessive compulsive symptoms, cognitive flexibility and non-verbal memory. On the other hand, individuals in the control group will not be provided with cognitive training or any other mode of psychotherapy for that time phase (randomised control group with delayed trail; Higginson et al, 2006).

The individuals included in the study were experiencing at least moderate level of obsessive compulsive symptoms (score of 16 or more on Yale Brown Obsessive Compulsive Scale) and mild to moderate level of subjective distress (score of below 20 on Beck Depression Inventory II). All the individuals had formal education till class 10 and a minimal knowledge of English. They were all suffering from the illness for at least 2 years and were receiving pharmacological treatment. The participants had either washing or checking compulsion. Individuals exposed to any form of psychotherapy were excluded from the study. Similarly, individuals having physical disability, co morbid psychiatric illness, substance use or psychosis were excluded from the study.

Tools Used

- Information schedule was used to collect relevant informant about the individuals.
- Patient Informed Consent Form was used to inform the participants about the details of the research and to get their approval for the research.
- Yale-Brown Obsessive Compulsive Scale (Y-BOCS) (Goodman, et al, 1989) was used to assess severity of obsessive compulsive symptoms.
- Beck Depression Inventory II (BDI II) (Beck, 1996) was used as a screening test to assess severity of subjective distress.

- Colour Trail Test (D'Elia, et al, 1996) was used as pre intervention and post intervention measure of cognitive flexibility.
- Rey's Complex Figure Test (Rey and Osterrieth 1944) was used as pre intervention and post intervention measure of non verbal memory.
- Stroop Colour word Test (Stroop, 1935) was used as a medium to train cognitive flexibility.
- Visual N-back Test (Smith and Jonides, 1999) was used as a medium to train non verbal memory.

Procedure

- Individuals who have received a diagnosis of Obsessive Compulsive disorder on the basis of ICD 10 were first shortlisted for the study.
- Phase 1: 10 individuals were selected on the basis of criteria and then they were randomly divided into two categories: A randomized control group with delayed trial that will not receive cognitive training during the phase of the study and an experimental group that will receive cognitive training. After attending the first session, one participant from the control group did not come for further sessions. So, there were 4 participants in the control group and 5 participants in the experimental group.
- Phase 2: The Information schedule and Consent form (where the details and purpose of research was stated) was duly filled up by the participants of both groups. Yale Brown Obsessive Compulsive Scale (YBOCS) and Beck Depression Inventory II (BDI II) were administered in order to know the severity of the participants' symptoms. BDI II was also administered as a screening test. The clients experiencing mild to moderate level of subjective distress were included in the study. Then Colour Trail Test (Trail A and B) and Rey- Osterrieth Complex figure Test were administered on the participants in order to get the baseline measure. Here again, another statistical analysis (Mann whitney U test) was done with respect to obsessive compulsive symptoms, cognitive flexibility and non verbal memory to assess if there exists any significant difference between the two groups with respect to pre intervention measures. No significant difference was found (Table 3).
- Phase 3: Stroop Colour Word Test and Visual N-back test were administered on the experimental group participants for the next 6 sessions as means of 'training' the neuropsychological correlates of cognitive flexibility and non-verbal memory. The delayed trial control group did not receive any training. They were only undergoing medication.
- Phase 3: Post-intervention measure was taken from both the groups by administering Colour Trail Test 1 and 2 and Rey Osterrieth Complex figure Test again. Y-BOCS test will also be administered again.
- Phase 4: Statistical Analysis: Statistical analyses were done using IBM SPSS Statistics 21. The mean and standard deviations of both the groups will be assessed. Wilcoxin Sign rank Test was used to assess if there exists a significant difference between pre and post treatment mean scores of both delayed trial control and experimental groups. Mann Whitney U test will be used to examine significant differences between the mean scores of control and experimental group if any. 0.05 level of significance were considered as critical level.

This study received Ethical Committee Clearance on 30.11.2017. Following this further changes and literature view was done based on the recommendations of the ethical committee. Data collection was started in December 2017 and it continued till April 2018. Data was collected from individuals who were referred for therapy to Clinical Psychology Centre of University of Calcutta. While cognitive training was immediately started on individuals belonging to experimental group, individuals belonging to delayed trial control group were exposed to therapy only after pre-post assessment measures were taken. Data was collected from them only after they agreed to participate in the research and they were made to sign the Consent form.

RESULTS

As per the objectives, the aim was to assess whether there exists any facilitatory effect on the post intervention scores of the two groups, that is the delayed trial control group (N=4; who did not receive cognitive training) and experimental group (N=5; who received cognitive training)

Result table indicated that in case of delayed trial control group, no significant facilitatory effect could be observed between the pre and post treatment scores of any the domain. However, in case of experimental group a significant facilitatory effect could be observed with respect to the domains of obsessive-compulsive symptoms and nonverbal memory (both immediate and delayed recall). The post intervention scores were significantly higher than the pre intervention scores.

Table 1: U test will be used to find out significant differences among the post treatment mean scores of the two groups, namely control group who did not receive cognitive training (N=4) and experimental group who received cognitive training (N=5) with respect to the domains of obsessive-compulsive symptoms, cognitive flexibility and non-verbal memory (Both immediate and delayed recall).

DOMAINS	GROUPS	SUM OF RANKS	U VALUE
Obsessive Compulsive symptoms	Control Group (N=4) Experimental Group (N=5)	25.50 19.50	1.376
Cognitive flexibility	Control Group (N=4) Experimental Group (N=5)	17.50 27.50	0.615
Non-verbal memory (Immediate recall)	Control Group (N=4) Experimental Group (N=5)	10.00 35.00	2.460*
Non-verbal memory (Delayed recall)	Control Group (N=4) Experimental Group (N=5)	11.00 34.00	2.214*

**: significant at 0.05 level*

It becomes pertinent to mention here that there existed no significant difference between the pre-treatment scores (related to non-verbal memory) between both the groups (indicated in Table 2).

Table 2 U test will be used to find out if there exists any significant difference among the mean scores of the two groups, namely control group who did not receive cognitive training (N=4) and experimental group who received cognitive training (N=5), prior to the introduction of any treatment with respect to the domains of obsessive compulsive symptoms, cognitive flexibility and non-verbal memory (Both immediate and delayed recall).

DOMAINS	GROUPS	SUM OF RANKS	U VALUE
Obsessive Compulsive symptoms	Control Group (N=4) Experimental Group (N=5)	12.50 32.50	1.853
Cognitive flexibility	Control Group (N=4) Experimental Group (N=5)	19.00 26.00	0.245
Non-verbal memory (Immediate Recall)	Control Group (N=4) Experimental Group (N=5)	18.50 26.50	0.369
Non-verbal memory (Delayed Recall)	Control Group (N=4) Experimental Group (N=5)	17.00 28.00	0.735

DISCUSSION

Cognitive training, as it has been previously discussed, involves guided practice on a set of tasks pertaining to memory, attention and so on. Repeated practice is provided on these tasks and just like physical training helps to improve functioning of muscles and body organs, similarly cognitive training helps to improve cognitive functioning by forming either new neural networks or by strengthening the existing ones (Kueider et al, 2014). Human Brain registers experiences, thoughts and observations by forming neural connections and these neural connections further determine thoughts and how events are perceived. Using cognitive training, new neural connections can formed or the unused ones can be strengthened and this way.

A look at the table (Table 3) indicates that there has been improvement in some of the domains of Obsessive-Compulsive Disorder, including the obsessive compulsive symptomatology. Following cognitive training, there has been a reduction in the severity of the obsessive compulsive symptoms. This may be attributed to 'cognitive training'.

Table 3: Wilcoxin Sign Rank test was used as a statistical measure to assess if there is any significant difference between the means of the pre-treatment and post-treatment measures of Individuals with Obsessive Compulsive Disorder who received cognitive training (N=5) with respect to the domains of obsessive compulsive symptoms, cognitive flexibility and non-verbal memory(Both immediate and delayed recall).

	Z value	
Domain	**Post-pre**	**Probability Value**
Obsessive compulsive symptoms	2.023*	0.043
Cognitive flexibility	0.674	0.500
Non-verbal memory (Immediate recall)	2.023*	0.043

Similarly, the result table of the delayed trail group (Table 4) did not suggest any improvement in any of the domains assessed.

Table 4: Wilcoxin Sign Rank test was used as a statistical measure to assess if there is any significant difference between the means of the pre-treatment and post-treatment measures of Individuals with Obsessive Compulisve Disorder who did not receive cognitive training (N=4) with respect to the domains of obsessive compulsive symptoms, cognitive flexibility and non-verbal memory(Both immediate and delayed recall).

	Z value	
Domain	**Post-pre**	**Probability value**
Obsessive compulsive symptoms	1.461	0.414
Cognitive flexibility	1.461	1.000
Non-verbal memory (Immediate recall)	1.342	0.180
Non-verbal memory (delayed recall)	0.27	0.785

Research in general has ample evidence has cognitive training has successfully improved the functioning of neuropsychological domains (Sari et al, 2015; Passel et al, 2016). More specifically, research evidence also indicates that cognitive training helps to improve non-verbal memory functioning (Park et al, 2006; Buhlman et al,2006) and also it is effective in reducing symptom severity (Tachanturia et al, 2007; Dr Sari et al 2015).

Vast research studies have suggested that Obsessive Compulsive Disorder is caused by the neural circuit involving Orbito-frontal cortex, Anterior Cingulate Cortex, Basal Ganglia and Thalamus (Saxena et al, 2000; Rotge et al, 2009; Harrison et al, 2009). Hyperactivity of the Orbitofrontal frontal cortex and Anterior cingulate cortex (Hazari et al, 2019) primarily plays an important role in the genesis of OCD.

The Orbitofrontal cortex has been implicated in several important functions like inhibiting impulses, comparing value of decisions among several others and is found to have intricate connections with the amygdala. Anterior cingulate cortex on the other hand, detects and monitors errors, appraises social processes and maintains connections with the 'limbic brain' (Stevens et al, 2011).

Therefore, when holistically viewed, it appears that negative experiences activate the amygdala and surrounding areas which constitute the limbic system. This leads to hyperactivity of the thalamus, which again activates the Orbito-frontal cortex (OFC) and the anterior-cingulate cortex (ACC), leading to heightened emotional appraisal (Thorsen, 2018) (that is, making a situation appear more negative than it actually is) and less reasoning. Activation of the OFC further leads to activation of the basal ganglia. Heightened emotional appraisal which undermines the activities of the working memory, reasoning power and attentional abilities. Thus, by introducing cognitive training, new neural networks (Park, 2013; Klineberg, 2016) can be formed which will strengthen the working memory, reasoning power and attentional abilities of these individuals. Thus, in other words cognitive training is expected to enhance the functioning of the dorsolateral prefrontal cortex so that the heightened emotional appraisal can be curtailed.

Result table has further indicated that Cognitive training had a significant facilitatory effect on the non-verbal memory (Refer to Table 3 given above). A comparison between the

control group (group that did not receive cognitive training) and the experimental group (group which received cognitive training) showed that there exists a significant difference between the two groups with respect to non-verbal memory, as indicated by Table 1.

It is possible that through cognitive training, there has been an improvement in the encoding strategies of these individuals. People with Obsessive Compulsive Disorder tend to focus more on trivial details rather than taking the overall situation into consideration. This results in failure to globally organize their memories that leads to fragmented memories and which eventually results in doubt and uncertainity about their behavior and therefore these individuals tend to repeat their behavior (Griesberg et al, 2003). In the present situation, it may be inferred from the results that cognitive training has helped to strenghthen their encoding strategies which improved their ability to form organised memories and thus reducing their doubt and uncertainity. Research has found that non-verbal memory has a direct relation with severity of obsessions and an inverse relationship with compulsions (Penades et al, 2005). This reduction in doubt and uncertainity and improvement in the organisation of memories led to a decrease in their symptom severity, thus improving their scores in the Yale-Brown Obsessive Compulsive Scale.

No significant difference was found in the pre-post treatment scores with respect to cognitive flexibility (Refer to Table 1 given above). Individuals with obsessive compulsive disorder tend to make dominant but irrelevant responses to a situation (for example, when facing fear of contamination, they tend to wash their hands repeatedly which is a dominant response to them but is usually irrelevant in that situation). Bringing about cognitive flexibility meant that these individuals will be trained using cognitive training to make the weaker response, the more dominant one, as per the need of the situation. During the therapy sessions, it became evident that in case of some of the participants, even though there have been inter-trail improvements with cognitive training, but their emotional appraisal of the perceived threat is so high that when faced with threatening situations, they find it difficult to monitor the situation and ended up making the habitual response.

Though the findings from the present study have been limited by a number of caveats like the small sample size and the limited period of cognitive training, but it highlights the necessity of cognitive training to address neuropsychological difficulties which may over time also help to reduce the emotional difficulties.

CONCLUSION

The applicability of cognitive training as mode of intervention in psychiatric disorders is quite restricted, especially in the Indian context. However, as evident from several studies, neuropsychological deficits play a very significant role as maintaining factors of the disorder. Therefore, cognitive training can be used as an adjunct to cognitive behavioural therapy in order to deal with neuropsychological problems.

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Conflict of Interest
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