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A COMPARISON OF NEUROCOGNITIVE FUNCTIONS IN ADULTS DIAGNOSED WITH OBSESSIVE COMPULSIVE DISORDER AND HEALTHY VOLUNTEERS

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Abstract: The aim of the study was to evaluation of neuropsychological areas to determine whether or not there were cognitive differences and whether the impairment was in a specific form in obsessive-compulsive disorder (OCD) patients compared to healthy control subjects. The sample comprised 30 patients aged 16-65 years diagnosed with OCD, and a control group of 30 age and gender-matched healthy volunteers. According to the DSM diagnostic criteria, various neurocognitive tests were applied to the patients diagnosed with OCD. A statistically significant difference was determined between the two groups in respect of the WCST scores. No statistically significant difference was determined between the groups in respect of the Forward, Reverse, or total Digit Span Test values. WAIS-R; The results of this test were determined as a mean of 43.1 ± 15.4 in the OCD group and 56.2 ± 6.8 in the control group, and the difference between the groups was statistically significant. When the groups were examined in terms of interference errors, the value of 2.2 ± 2.8 in the OCD group was determined to be statistically significantly greater than the 0.8 ± 0.8 value of the control group. A statistically significant difference was determined between the groups in respect of the mean words counted with perseverance by the OCD group (1.7 ± 2.1) and the control group (0.6 ± 0.8). It can be said that combining cognitive function impairments specific to OCD with neuroimaging studies would be useful in understanding OCD symptoms in more detail. Thus, new treatment strategies could be developed.

Keywords: Neurocognitive functions, Obsessive-compulsive disorder, Cognition

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1. Introduction

One of the current subjects of debate is that frontal subcortical dysfunction plays an important role not only in the symptomatic explanation of obsessive-compulsive disorder (OCD) but also in explaining cognitive deficits (Kwon et al., 2003). As the neurobiological basis of OCD is the prefrontal-striatal system, defects are expected related to distraction, working memory, attention focusing, and verbal fluency (Chudasama and Robbins, 2006). Unlike brain imaging studies, in studies related to neuropsychological functions, consistent results have not been obtained in OCD patients and defects have been shown in different cognitive areas. While some studies have found significant differences in respect of cognitive characteristics in OCD patients (Basso et al., 2001), others have found no difference (Kıvırcık et al., 2003). The results of a meta-analysis that investigated the causes of cognitive function disorders in patients diagnosed with OCD showed that the cognitive functions most affected were non-verbal memory and visual-spatial memory. In a study that examined the relationship between the managing and sensory functional mechanisms within the orbitofrontal cortex functions, and the pathological processes observed in OCD, impairments were determined especially in working memory and visual recall functions in OCD patients. The researchers suggested that this could be the reason for the doubt and compulsions to check that are observed in OCD (Evans et al., 2004).

In a study that compared the verbal memory performance, information organization strategies, and the duration of analyzing stimulus characteristics of OCD patients with a control group, the verbal memory performances of the OCD patients were seen to be much lower than those of the control group. Important results were also obtained that the OCD patients used fewer organization strategies in the memory tests and took longer to differentiate stimuli into categories (Sawamura et al., 2005). Foa et al. (1997) compared OCD patients with controlling compulsions with a control group in respect of memory functions. In the results of the memory tests, it was reported that OCD patients with

controlling compulsions remembered threatening stimuli more than non-threatening stimuli. In a study by Purcell et al. (1998) OCD patients were compared with healthy control subjects in respect of cognitive functions. Although no difference was seen between the groups in respect of short-term memory, distraction, and planning skills, the OCD patients demonstrated worse performance than the control group in respect of the functions of working memory and starting and maintaining an action. It was suggested that the OCD patients did not show general cognitive impairment but demonstrated impairments in working memory, short and long-term memory, executive functions, and visual memory functions (Siviero et al., 2002). While these impairments show biased attention to stimuli causing concern at the stage of encoding information in OCD, it can be explained by the fact that no deeper information processing is made of this coded information.

The aim of the current study was to make a detailed evaluation of neuropsychological areas to determine whether or not there were cognitive differences and whether the impairment was in a specific form in OCD patients compared to healthy control subjects. To be able to more fully understand the etiopathogenesis of OCD, it would be useful to clearly determine the form of impairments in cognitive areas.

2. Materials and Methods

This study was conducted in the Psychiatry Polyclinic of Maltepe University Medical Faculty. The sample comprised 30 patients aged 16-65 years diagnosed with OCD, and a control group of 30 age and gender-matched healthy volunteers. Patients were excluded if they had any degenerative neurological disease, mental retardation, epilepsy, cerebral tumor or cerebrovascular disease, head trauma that had caused loss of consciousness, any neurological or systemic disease which could affect the research, benzodiazepine use in the previous 24 hours, or had received electroconvulsive therapy (ECT) within the previous 6 months.

Each of the study participants was evaluated in a single session. Sociodemographic information was collected from the patients for evaluation. Then a psychiatric interview was conducted and the SCID-I was applied (Structured Clinical Interview for DSM-IV Axis I Disorders). According to the DSM-IV diagnostic criteria, the following neurocognitive tests were applied to the patients diagnosed with OCD: Wisconsin Card Sorting Test, Rey Verbal Learning Test, Trail Making Test, the Wechsler Adult Intelligence Scale-Revised (WAIS-R) subtests of Digit Span Test and Digit Symbol Test, the Visual Reproduction Test with the Stroop test, Controlled Oral Word Association Test, and Word List Generation. The tests used in the measurement of cognitive functions and the areas measured are shown in Table 1.

2.1. Statistical Analysis

Data obtained in the study were analyzed statistically using SPSS in 19.0 software. Qualitative data such as demographic information were calculated as mean ± standard deviation values and compared using the Chi-square test. The results of measurable tests and other quantitative data were first assessed for conformity to a normal distribution using the Kolmogorov-Smirnov test, then in the comparisons of the groups, the Independent Samples t-test was applied. A value of $P<0.05$ was accepted as statistically significant.

Table1. The tests used in the study and the cognitive areas measured

Tests	Cognitive areas measured
Wisconsin Card Sorting Test	Executive functions
Rey Auditory Verbal Learning Test	Short and long-term memory
WAIS-R (Visual Reproduction Test)	Visual memory, attention
Trail Making Test	Executive functions, attention
WAIS-R (Digit Symbol Test)	Attention, short-term memory
Stroop Test	Attention, interference
WAIS-R (Digit Span Test)	Working memory, attention
Controlled Oral Word Association Test	Concentration, language skills
Word List Generation	Language skills

3. Results

In the comparison of sociodemographic data between the patient and control groups, no statistically significant difference was determined in respect of age, gender, educational level, or marital status (Table 2).

Wisconsin Card Sorting Test (WCST): The OCD group completed mean 4.8 ± 1.8 categories and the control group completed mean 8.4 ± 1.4 categories. The total of correct responses was determined to be 70.3 ± 15.4 in the OCD group and 75.6 ± 20.1 in the control group ($P<0.001$). The total of incorrect responses was 31.5 ± 20.1 in the OCD group and 21.7 ± 6.0 in the control group ($P<0.001$). Perseverance errors were determined at the rates of 16.4% ± 13.6% in the OCD group and 9.9% ± 5.4% in the control group ($P= 0.015$). A statistically significant difference was determined between the two groups in respect of the WCST scores ($P= 0.020$) (Table 3).

WAIS-R (Digit Span Test): The Digit Span Test is measured in 2 forms as Forward and Reverse. In the Forward Digit Span Test, the values were determined as 7.6 ± 2.4 in the OCD group and 8.2 ± 1.7 in the control group. In the Reverse Digit Span Test, the values were determined as 6.6 ± 2.2 in the OCD group and 7.6 ± 1.7 in the control group. The total values of the Forward and Reverse Digit Span Tests were determined as 14.2 ± 3.9 in the OCD group and 15.9 ± 3.8 in the control group. No

statistically significant difference was determined between the groups in respect of the Forward, Reverse, or total Digit Span Test values (P>0.05) (Table 4).

WAIS-R (Digit Symbol Test): The results of this test were determined as mean 43.1 ± 15.4 in the OCD group and 56.2 ± 6.8 in the control group, and the difference between the groups was statistically significant (P<0.001) (Table 5).

Stroop Test: No statistically significant difference was determined between the two groups when evaluated in respect of reading times of words and mean errors made during this time, the time of reading colors and errors made with the durations of interference (P>0.05). When the groups were examined in terms of interference errors, the value of 2.2 ± 2.8 in the OCD group was determined to be statistically significantly greater than the 0.8 ± 0.8 value of the control group (P= 0.012) (Table 6).

Table 2. Demographic characteristics of the OCD patients and the healthy control group

	Groups	n	Mean ± SD	Min	Max	t	df	P
Age (years)	Case	30	40.6 ± 10	18	61	0.10	28	0.919
	Control	30	41.1 ± 10	18	64			
Education (years)	Case	30	11.6 ± 4.2	5	22	0.53	28	0.600
	Control	30	12.5 ± 4.7	5	19			
		Female	Male	Total		X^2	df	P
Gender (Female/Male)	Case	15 %50	15(%50)	30		0.00	1	0.602
	Control	15 %50	15(%50)	30				
		Single	Married	Divorced		X^2	df	P
Marital Status	Case	10	17	3		1.61	2	0.447
	Control	6	19	5				
	Control	27	3	30				

SD= standard deviation, X^2 = Chi-square test, t= T test, Min: minimum, Max: maximum, n: number.

Table 3. Wisconsin Card Sorting Test (WCST) results

	Groups	n	Mean	SD	P
WCST- Category	Case	30	4.8	1.8	<0.001
	Control	30	8.4	1.4	
WCST- Total Correct	Case	30	70.3	15.4	<0.001
	Control	30	75.6	20.1	
WCST- Total Error	Case	30	31.5	20.1	<0.001
	Control	30	21.7	6.0	
WCST- Perseverance errors (%)	Case	30	16.4	13.6	0.015
	Control	30	9.9	5.4	

WCST= Wisconsin card sorting test, SD= standard deviation, n= number, WCST Category= the number of categories completed in the test by the participants, WCST Total Correct= the total correct answers of the participants, WCST Total Correct= the total errors of the participants, WCST Perseverance errors= perseverance error amount of participants in percent (%).

Table 4. WAIS-R (Digit Span Test) results

	Groups	n	Mean	SD	P
Forward Range	Case	30	7.6	2.4	0.271
	Control	30	8.2	1.7	
Back Range	Case	30	6.6	2.2	0.059
	Control	30	7.6	1.7	
Total Number Range	Case	30	14.2	3.9	0.104
	Control	30	15.9	3.8	

SD= standard deviation, n= number

Table 5. WAIS-R (Digit Symbol Test) results

	Groups	n	Mean	SD	P
Digit Symbol Test Score	Case	30	43.1	15.4	<0.001
	Control	30	56.2	6.8	

SD= standard deviation, n= number

Table 6. Stroop test results

	Groups	n	Mean	SD	P
Stroop word reading time (sec)	Case	30	31.7	6.7	0.196
	Control	30	33.7	4.9	
Stroop word reading error	Case	30	0.23	0.6	0.185
	Control	30	0.06	0.25	
Stroop color reading time (sec)	Case	30	40.0	9.0	0.952
	Control	30	39.9	5.0	
Stroop color reading error	Case	30	0.4	0.7	0.130
	Control	30	0.16	0.4	
Stroop interference time (sec)	Case	30	82.4	33.5	0.232
	Control	30	77.4	16.2	
Stroop interference error	Case	30	2.26	2.85	0.012
	Control	30	0.8	0.8	

SD= standard deviation, n= number

Controlled Oral Word Association Test: A statistically significant difference was determined between the groups in respect of the mean words counted by the OCD group (36.2 ± 12.2) and the control group (48.6 ± 11.3) (P<0.001). A statistically significant difference was determined between the groups in respect of the mean words counted with perseverance by the OCD group (1.7 ± 2.1) and the control group (0.6 ± 0.8) (P= 0.019).

Word List Generation: The words counted in the fluency category test were found to be 20.8 ± 3.5 for the OCD group and 24.2 ± 2.7 for the control group and the words counted with perseverance were 0.70 ± 0.9 in the OCD group and 0.13 ± 0.3 in the control group. The difference between the groups in respect of these values was found to be statistically significant (P= 0.004) (Table 7).

Trail Making Test: This test is formed of two tests; A and B. In the A test, the completion time was 41.4 ± 15.9 seconds in the OCD group and 33.7 ± 6.3 seconds in the control group. The difference between the two groups in respect of the completion time of Test A was statistically significant (P= 0.019). No statistically significant difference was determined between the groups in respect of the completion time of Test B (P>0.05). In respect of the number of errors made in both A and B Trail Making Tests, no statistically significant difference was determined between the groups (P>0.05) (Table 8).

Rey Verbal Learning Test: In the first attempt, the number of words remembered was 6.7 ± 2.0 in the OCD group and 9.4 ± 1.4 in the control group, and the total number of words remembered in the 1st -5th attempts was 52.0 ± 8.4 in the OCD group and 58.8 ± 6.0 in the control group. These results were found to be statistically significant (P>0.05). In the 7th attempt, no statistically significant difference was determined in respect of the number of words recalled (OCD: 12.7 ± 1.8, control: 13.3 ± 1.6) (p>0.05). No statistically significant difference was determined in respect of correct identification in the efforts to recall (OCD: 13.8 ± 1.5, control: 13.7 ± 1.1) and incorrect identification (OCD: 0.86 ± 1.1, control: 1.2 ± 1.1) (P>0.05) (Table 9).

WAIS-R (Visual Reproduction Test); The points in the immediate recall section of the test were 33.3 ± 5.0 in the OCD group and 33.5 ± 4.3 in the control group with no statistically significant difference determined between the groups (P>0.05). In the second section of the test, delayed recall, the points were 29.4± 6.9 in the OCD group and 29.9 ± 6.5 in the control group, with no statistically significant difference determined between the groups (P>0.05) (Table 10).

Table 7. The results of the controlled oral word association test and the word list generation test

	Groups	n	Mean	SD	P
Controlled Word Association Test Score	Case	30	36.2	12.2	<0.001
	Control	30	48.6	11.3	
Controlled Word Association Test Perseveration	Case	30	1.7	2.1	0.019
	Control	30	0.6	0.8	
Category Fluency Test Score	Case	30	20.8	3.5	0.000
	Control	30	24.2	2.7	
Category Fluency Test Perseveration	Case	30	0.70	0.9	0.004
	Control	30	0.13	0.3	

SD= standard deviation, n= number

Table 8. Trail making test results

	Groups	n	Mean	SD	P
Tracking Time A (sec)	Case	30	41.4	15.9	0.019
	Control	30	33.7	6.3	
Tracking A Error Count	Case	30	0.13	0.3	0.694
	Control	30	0.10	0.3	
Tracking Time B (sec)	Case	30	102.9	45	0.059
	Control	30	82.9	22	
Tracking B Error Count	Case	30	0.90	1.08	0.274
	Control	30	0.66	0.75	

SD= standard deviation, n= number

Table 9. Rey Verbal learning test results

	Groups	n	Mean	SD	P
REY -I	Case	30	6.7	2.0	<0.001
	Control	30	9.4	1.4	
REY-VII	Case	30	12.7	1.8	0.185
	Control	30	13.3	1.6	
REY I-V	Case	30	52.0	8.4	0.010
	Control	30	58.8	6.0	
REY- Correct Identification	Case	30	13.8	1.5	0.698
	Control	30	13.7	1.1	
REY Incorrect Identification	Case	30	0.86	1.1	0.168
	Control	30	1.2	1.1	

REY Misrecognition= incorrectly marked words from the written list. SD= standard deviation, n= number, REY –I= number of words recalled at the first attempt, REY-V= number of words recalled at the fifth attempt, REY I-V= total number of words recalled from the first to the fifth attempt, REY-VII= number of words recalled at the seventh attempt after the interference list, REY-Correct Identification= words recalled correctly from the written list, REY- Incorrect Identification= words in correctly identified from the written list.

Table 10. WAIS-R (Visual Reproduction Test) results

	Groups	n	Mean	SD	P
Visual Reproduction, immediately	Case	30	33.3	5.0	0.869
	Control	30	33.5	4.3	
Visual Reproduction, Delayed	Case	30	29.4	6.9	0.774
	Control	30	29.9	6.5	

SD= standard deviation, n= number

4. Discussion

In the comparisons made in this study between patients with OCD and the healthy control group, although a statistically significant difference was seen in some of the tests measuring cognitive functions, in others, the differences between the groups did not reach a level of statistical significance. Extremely consistent data have been presented in the literature that there is no basic attention function impairment in OCD patients. However, it is thought that there could be an increase in selective

attention. According to this view, OCD patients may pay attention to selective features depending on the nature of their obsessions and compulsions and may neglect other stimuli. It has been suggested that OCD patients experience difficulty in neglecting a selected stimulus and therefore their ability to maintain their attention in another area may be impaired (Martinot et al., 1990). However, more recent studies do not support this view (Mataix-Cols et al., 2002; Moritz et al., 2002). Similarly, in the current study, no statistically significant difference was determined between the groups in respect of the number of errors in reading words, which is the subtest measuring basic attention. However, the difference between the groups in respect of interference errors was seen to be statistically significant. The interference section of the test shows the ability of the subject to oppose an inappropriate stimulus and to prevent an inappropriate response. That a greater number of OCD patients gave an inappropriate response in the test, not able to resist their obsessions and compulsions is highly consistent with the pathophysiology of the disease. As no difference was found between the groups in the count test measuring attention and working memory, this showed that attention functions were not affected in OCD patients, which has been similarly suggested in literature (Okasha et al., 2000; Moritz et al., 2002).

In the Rey Verbal Learning Test, a statistically significant difference was determined between the groups, showing that the instantaneous memory, language skills and learning points of the OCD group were insufficient. Previous studies have shown that verbal memory functions are not affected in OCD patients (Boone et al., 1991; Zielinski et al., 1991; Martin et al., 1995; Cohen et al., 1996; Mataix-Cols et al., 1999). The verbal memory was actually protected but as the information encoding method was not developed, the result of impaired verbal memory was produced in the test. Focusing on details can reduce memory by delaying the directing of attention to general information. As in the current study, there are other studies which have found impairments in verbal memory functions, especially in tests where the stimuli are given in clusters (Deckersbach et al., 2000; Savage et al., 2000). In some studies, it has been argued that some basic symptoms, such as doubt in OCD, do not arise from general memory impairment, but that impairment related to trust of memory performance leads to these symptoms (Foa et al., 1997; Tolin et al., 2001). The ability to strategically encode information entering the memory is closely related to executive functions. Current research has revealed that defects have been determined secondary to the underlying executive function impairment in visual and verbal memory in OCD. Executive functions lead to memory defect by making differentiation of the stimulus structure more difficult. Therefore, OCD patients experience problems during encoding of both verbal and visual information. It is thought that the memory impairments seen in OCD are secondary to executive function impairment (Penadés et al., 2007). The impairments seen in the Digit Symbol Test measuring attention and short-term memory and in the Trail-Making Test measuring attention and executive functions are consistent with data in literature suggesting impairments in executive functions and that irrelevant stimuli cannot be inhibited in OCD. The brain areas related to executive functions are the orbitofrontal cortex in particular and basal ganglia structures. Changes in blood flow in these areas have been found to be related to errors in WCST, and neuroimaging studies have revealed a significant relationship between impairment and altered performance in this test and the left inferior frontal cortex (Del Casale et al., 2011). In the current study, there was a statistically significant difference between the groups in respect of the total incorrect number, the number of completed categories, the total number of perseverance errors, and the number of reactions used in the completion of the first category in the WCST. Poor performance shown by OCD patients in the WCST could be a reflection of over-working the "error determination system" causing thoughts that there is something wrong and efforts to reach perfection (Yalçın et al., 2012).

In studies researching cognitive functions related to OCD, perhaps the view achieving the most agreement is about the evaluation of impairments seen in visual-mechanical skills and visual memory functions. The view that the non-application of effective and detailed strategies in OCD is related to non-verbal memory dysfunction rather than memory dysfunction has become more predominant (Martinot et al., 1990; Schmidtke et al., 1998; Savage et al., 1999; Savage et al., 2000; Deckersbach et al., 2000; Kim et al., 2002; Kuelz et al., 2004). It has been observed that by concentrating on details they have drawn, OCD patients often distort the whole shape, whereas the control group has displayed a more holistic strategy, thereby demonstrating better performance. However, in contrast to previous findings, no difference was determined between the two groups of the current study in the visual copying test. However, as the patient group was under treatment, it could be concluded that there could be an improvement in the test associated with that. A previous neuroimaging study observed improvements in visual memory tests with treatment, and as an important clinical finding, showed a significant correlation between the orbitofrontal cortex, right putamen and the cerebellum, and cerebral glucose metabolic changes in the right hippocampus (Kang et al., 2003).

The Controlled Word Association Test is a test measuring verbal fluency. The number of words counted by the OCD group was lower than that of the control group, and when the comparison was made of the number of words counted with perseverance, the OCD group was seen to have repeated more words than the control group. The verbal fluency tests in this study were based on the total number of words that could be said and the difference between the groups was determined to be statistically

significant. In verbal fluency tests related to OCD in literature, it has been reported that fluency is usually affected (Ayçiçeği et al., 2003; Choi et al., 2004). In the current study, verbal fluency was found to have been affected.

With the aim of appropriate filtering and presenting information by recall from the memory, perseverance tendencies are prevented, and this is a function of the prefrontal striatal thalamic circuit. The findings show that the functions of verbal fluency and mental recall, which are a prefrontal striatal thalamic circuit function, are impaired in OCD. The perseverance word count in the test indicates inhibition weakness. This result is compatible with the continuing pattern of the same behavior of OCD patients because of insufficient organization of thoughts and inhibition weakness. In the Word List Generation tests, there is thought to be a relationship between prefrontal dysfunction and medial and orbitofrontal region dysfunctions in particular. PET studies have indicated activation especially in the anterior singulate cortex (Crowe, 1992). If all these findings are evaluated together, the impairments seen in OCD patients in the Word List Generation tests are consistent with the data obtained from neuroimaging studies related to OCD.

In conclusion, it can be said that after minimizing methodological problems, combining cognitive function impairments specific to OCD with neuroimaging studies would be useful in understanding OCD symptoms in more detail. Thus, new treatment strategies could be developed. In addition, how cognitive function impairments are affected by treatment is a separate subject for research. There is a need for further prospective studies with larger sample groups to make comparisons before and after treatment to be able to learn whether or not treatment improves these cognitive skills.

Author Contributions

Percentages of the author(s) contributions is present below. All authors reviewed and approved final version of the manuscript.

%	P.K	S.Z	A.G.H
C	40	20	40
D	40	20	40
S	40	20	40
DCP	50	40	10
DAI	40	20	40
L	40	40	10
W	40	40	10
CR	40	40	10
SR	40	40	10

C= concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision.

Conflict of Interest

The authors declared that there is no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

Ethical Approval/Informed Consent

The participants were informed that their information would be kept confidential and used only for scientific purposes. For the study, the Ethics committee approval was obtained from Maltepe University Medical Faculty Ethics Committee with the decision numbered 2022/1157. The study was conducted in accordance with the principles of the Declaration of Helsinki. Informed consent forms were obtained from all individuals included in the study.

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