Planning and working memory in obsessive-compulsive disorder and major depressive disorder: A direct comparison

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Abstract

Background: Executive deficits are prominent in both obsessive- compulsive disorder (OCD) and major depressive disorder (MDD), and although similarities have been found, differences have also been suggested. Deficits in visuospatial working memory are suggested to be specific to OCD, while planning seems to be impaired in patients with MDD and not OCD. Therefore, the aim of this study was to examine the performance of patients with OCD and MDD on a planning and a working memory task, and to identify a possible relation between symptom severity of OCD and depression and the performance on both tasks.

Methods: In this cross- sectional study, a direct comparison was made between 90 patients with OCD (M_{age} = 38.07, % male = 43.33) and 68 patients with MDD (M_{age} = 42.22, % male = 39.71). The cognitive performance was measured with a visuospatial working memory task and a planning task. Clinical symptoms were retrospectively measured with two self- report questionnaires, and symptom severity was correlated with task performance irrespective of diagnostic groups.

Results: No significant differences were found between both groups on neither the working memory task (p = .367) nor the planning task (p = .214). It was found that the severity of clinical symptoms was not associated with cognitive performance ($0.001 < r_s < 0.070$, all p values > 0.05).

Conclusion: In the current study, no disorder- or symptom- specific cognitive deficits were found. Cognitive performance might be an independent factor of a disorder, and therefore, might need to be treated separately. More research, however, is needed. In particular, longitudinal research, to further investigate the relation between clinical symptoms and cognitive performance, is recommended.

Keywords: obsessive- compulsive disorder, major depressive disorder, working memory, planning, spatial working memory, one- touch stockings of Cambridge.

Introduction

Obsessive- compulsive disorder (OCD) is a psychiatric illness characterized by recurrent thoughts and/ or compulsions (Kuelz, Hohagen & Voderholzer, 2004). Aberrant functioning of the frontal lobe has been implicated in OCD, especially in the prefrontal cortex and striatal regions (Purcell, Maruff, Kyrios Pantelis, 1998a). Several neuroimaging studies confirm these findings by showing increased activity in the orbitofrontal cortex, thalamus and caudate nucleus (Kuelz et al., 2004).

Another psychiatric disorder linked with frontal lobe dysfunction is major depressive disorder (MDD) (Rogers, Bradshaw, Pantelis & Philips, 1998). MDD is characterized by persistent emotional and affective dysregulation (Gotlib & Joormann, 2010). While similar brain regions seem to be affected in both MDD and OCD (Kuelz et al., 2004; Rogers et al., 2004), MDD is considered to be associated with decreased activity in the dorsolateral prefrontal cortex (Rogers et al., 2004).

Overall, these studies indicate that impairments in the frontal lobe and basal ganglia are associated with both OCD and MDD. The frontal lobe, especially the prefrontal cortex is considered to be an important region for executive functioning (Rogers et al., 1998; 2004). Executive functions regulate complex higher- order conduct, like goal- directed behavior and planning (Elliot, 2003). They are important for normal everyday functioning, and impairments can lead to disinhibited, uncoordinated and uncontrolled conduct (Elliot, 2003). Since both disorders show impairments in this region, executive functioning deficits are prominent in both disorders.

Previous studies on executive functioning in MDD showed deficits in set- shifting, fluency, working memory, problem solving and planning compared to healthy controls (Elliott et al., 1996; Hammar & Ardal, 2009). Some researchers found a similar pattern of executive deficits in OCD, whereas others did not (Kuelz et al., 2004; Simpson et al., 2006). This leaves a fairly inconsistent picture of executive functions in OCD. On the contrary, studies regarding visuospatial impairments in OCD do show consistent findings (Kuelz et al., 2004). It is proposed that these deficits derive from the utilization of inefficient strategies, a process which is related to executive functioning, and is often found to be impaired in studies using the Rey- Osterrieth Complex Figure task (Kuelz et al., 2004; Savage et al., 2000). Choi and colleagues (2004) found that aberrant function of the orbitofrontal cortex is associated with impaired scores on the Rey- Figure Task. This finding suggests that this particular region might be involved in directing strategic processes (Choi et al., 2004; Savage et al., 2000), and therefore, possibly explain the prominence of visuospatial deficits in patients with OCD.

Martoni and colleagues (2015) confirmed that strategies are important in visuospatial working memory as well.

There is a high comorbidity rate between OCD and MDD (Rampacher et al., 2010). The rate of a comorbid diagnosis of MDD in patients with OCD is around 15-30%, whereas the lifetime prevalence is 50-70% (Tükel, Polat, Özdemir, Aksüt & Türksoy, 2002). According to some researchers the inconsistency in findings in OCD could be explained by depressive symptoms. Moritz and colleagues (2001), for instance, found that OCD patients with elevated depressive symptoms showed impairments in executive functioning compared to healthy controls, whereas this effect was not found in patients with low rates of symptoms. It is also noted that studies which included OCD patients with comorbid depressive symptoms found impairments in executive functioning more regularly than studies in which these patients were excluded (Basso, Bornstein, Carona & Morton, 2001). Basso and colleagues (2001) found that findings of executive dysfunction in patients with OCD lost their significance after controlling for depressive symptoms. They concluded that impairments in executive functioning are correlated with the severity of depressive symptoms. These findings show that psychiatric disorders are not independent from each other (i.e., depressive symptoms are common in OCD and vice versa), and suggests that deficits might be specific to symptoms. This makes it interesting and relevant to examine the transdiagnostic factors as well.

There is little research in which OCD patients were directly compared with MDD patients. Purcell and colleagues (1998b) compared patients with OCD, unipolar depression, panic disorders and healthy controls on a neuropsychological test battery. They found deficits that were specific to patients with OCD. These patients showed deficits in spatial working memory and spatial recognition compared to the other disorders and the healthy controls (Purcell, Maruff, Kyrios & Pantelis, 1998b). They also showed decreased latency on a planning task, however, no difference was found in planning accuracy compared to the other groups (Purcell et al., 1998b). These results seem to be in line with previous research on planning in OCD, which generally shows intact planning (Kuelz et al., 2004). Although lacking some consistency, studies regarding planning in patients with MDD give a strong indication of possible planning deficits. There are various studies, including meta- analyses, in which patients with MDD show impaired planning compared to healthy controls (Hammar et al., 2009; Wagner, Müller, Helmreich, Huss & Tadic, 2015). Van Tol and colleagues (2011) found no impairments in planning in patients with anxiety disorders and subtle deficits in patients with MDD. Hence, they concluded that planning deficits are not a feature of anxiety

disorders (Van Tol et al., 2011). This suggests that there could be a possible difference between mood and anxiety disorders.

Rampacher and colleagues (2010) compared 40 healthy controls, 40 patients with OCD and 20 patients with MDD on different visual tasks and found an overall poorer performance in patients with OCD. Compared to healthy controls patients with OCD showed impairments in visual memory, set- shifting and spatial recall (Rampacher et al., 2010). In comparison with MDD patients, OCD patients were impaired in visual organization, i.e., only OCD patients showed deficits in organizing and manipulating visual information (Rampacher et al., 2010). In contrast to the results of Purcell et al. (1998b), Rampacher and colleagues did find OCD- specific deficits in planning. Patients with OCD scored lower on both accuracy and latency, on the one- touch version of the Tower of London task, compared to healthy controls and MDD patients (Rampacher et al., 2010). However, this result needs to be interpreted with caution, since patients in this study were matched according to depressive symptoms, which may have altered the results. In a different study with the same planning task, patients with OCD did not differ from healthy controls (Watkins et al., 2005).

With respect to these findings, it seems that both patients with OCD and patients with MDD are impaired in executive functioning. It also suggests a possible difference between both disorders on components of executive functioning. However, more research is needed. Both OCD and MDD are highly prevalent psychiatric disorders. By comparing the disorders more information will be collected, and disorder specific and/ or symptom- specific deficits may be found. This will lead to better understanding of the disorders and will help to create better and more specific treatment. Considering the previous findings of possible differences between OCD and MDD on planning and working memory, it is relevant to make a direct comparison between both disorders.

Therefore, the aim of this study is to examine the performance of patients with OCD and MDD on a planning and working memory task and to explore possible differences between both disorders on these subcomponents of executive functioning. Another objective of this study is to identify a possible relation between depressive symptoms, and OCD symptoms in general, and the performance on the planning and working memory tasks. Herewith, the transdiagnostic factors will be examined. In line with the results of Purcell et al. (1998b) it is expected that patients with OCD will perform worse on the spatial working memory task than patients with MDD. Complementary, patients with OCD will show reduced use of strategy. Planning is highly associated with aberrant function of the dorsolateral prefrontal cortex (Moritz et al., 2001), which is most consistently found to be impaired in

MDD and is less pronounced in OCD. Considering this, supplemented with the findings that planning deficits are more consistently found in patients with MDD than patients with OCD, it is expected that patients with OCD will perform better on the planning task compared to patients with MDD. Lastly, in elaboration to the first and second hypothesis, it is hypothesized that high rates of OCD symptoms, in both diagnostic groups, are related to worse performance on the working memory task, whereas high rates of depressive symptoms are related to worse performance on the planning task.

Method

The current study was part of a larger project which investigates the transdiagnostic cognitive deficits in different psychiatric disorders. This larger project also examines the relation between cognitive deficits and demographic data, symptom dimensions, EEG-findings and genetic variations within patients with a psychiatric disorder.

Design

The original project is a longitudinal cohort study, with a follow- up test session after a year. Unlike the original project this sub- project was a cross- sectional study. Both this sub-project and the original project have an observational, between- subject design. In the current study two groups of psychiatric patients were examined: 1) patients with obsessive-compulsive disorder and 2) patients with major depressive disorder.

The two groups were compared on planning and (spatial) working memory. The dependent variables were continuous and measured once.

Participants

All included subjects were patients of the Psychiatry Department of the Amsterdam Medical Centre (AMC). Patients who came for an intake were asked to participate in this study. Patients with OCD were recruited at the anxiety disorder unit and patients with MDD at the mood disorder unit. A total of 158 patients (90 patients with OCD and 68 patients with MDD) were included in this study. Of this number, 113 patients (54 patients with OCD and 59 patients with MDD) were using medication at time of the test session. The medication most frequently used were antidepressants.

The criteria for inclusion were: 1) age between 18 to 75 years, 2) either an OCD or MDD diagnosis according to the *Diagnostic and Statistical Manual of Mental Disorders (DSM)* edition IV-TR and V (American Psychiatric Association, 2000; 2013), 3) physically healthy, 4) fluent in Dutch and 5) clinically stable. Furthermore, the subjects needed to be competent to give an informed consent. The general criteria for exclusion were: 1) a high

suicide risk, 2) clinically unstable, 3) a premorbid IQ below 70, 4) abnormality of the neurological system and 5) a history of seizures. Finally, solely the data of patients with OCD and MDD were analyzed, hence patients with psychiatric disorders other than OCD and MDD were not selected. Also, patients with comorbid disorders including compulsive hoarding, substance abuse or attention disorders were excluded. Furthermore, OCD patients who were diagnosed with a comorbid depressive disorder, or vice versa, were excluded as well.

Measures

The Cambridge Neuropsychological Test Automated Battery (CANTAB) was used to assess the neurocognitive functions of the subjects (Cambridge Cognition, 2017). For the current study, two computerized cognitive tasks relevant for assessing spatial working memory and planning were selected and presented on a touch-sensitive monitor.

Spatial Working Memory: the Spatial Working Memory (SWM) task assesses working memory and use of strategy. SWM is a self- ordered task in which subjects were instructed to fill an empty column with blue tokens. These tokens were hidden inside colored boxes, and could be found by searching through the boxes. The boxes were displayed on the monitor, with on the right side the empty column. The number of boxes and tokens were equal to each other. When a token was found, the next would be hidden, and that certain box could never contain a blue token anymore. The difficulty level increased from three to eight boxes (Cambridge Cognition, 2017; Owen, Downes, Sahakian, Polkey & Robbins, 1990).

To measure the accuracy of working memory, the number of between- search errors was used. A between- search error was made when the subject reopened a box in which a token had already been found (Owen et al., 1990). Lower between- search errors indicate better performance. In addition, the spatial working memory task measured strategy use, the ability to search systematically. According to Owen and colleagues (1990), the best strategy to adopt is to start each search sequence with the same box. Strategy use was measured by counting up all the sequences in which the subject starts with a different box. A high strategy score indicates low use of strategy (Cambridge Cognition, 2017; Owen et al., 1990).

Planning: deficits on planning were assessed by using the One- Touch Stockings of Cambridge (OTS) task. In this task, two displays were presented on the monitor; one on the upper half (the goal set-up) and the other one on the lower half of the monitor. The displays showed three colored balls in three stockings. The subjects were instructed to match the lower half of the monitor according to the goal set- up, in the least number of moves possible. In contrast to the Stockings of Cambridge task, the subjects needed to solve this problem without actually moving the balls. The subjects then needed to indicate the minimal number of moves

(1-6) represented by the appropriate numbered box at the bottom of the screen. When incorrect, the subjects were instructed to try again (Cambridge Cognition, 2017; Schlader et al., 2015).

This task measured accuracy and response latency. Accuracy was reflected by the number of trials in which the initial answer was correct. A high score of accuracy indicates better planning. Response latency can be divided into initial thinking time (time to first choice) and subsequent thinking time (time to correct answer), and was measured in seconds (Cambridge Cognition, 2017). A higher score indicates a longer response time. Both the OTS and SWM are valid and reliable tasks (Robbins et al., 1998).

To assess the severity and presence of obsessive and compulsive symptoms the Yale-Brown Obsessive- Compulsive Scale (Y-BOCS) was used (Goodman et al., 1989). The Y-BOCS is a reliable and valid questionnaire, and consists of ten items (Goodman et al., 1989). To register the severity of depressive symptoms the Inventory of Depressive Symptomatology (IDS-SR) was used (Trivedi et al., 2004). This questionnaire consists of 30 items and is psychometrically sound with good validity and reliability (Trivedi et al., 2004).

Procedure

The protocol of this study was reviewed and approved by the Medical Ethics Committee of the Academic Medical Centre, University of Amsterdam. A week prior to the intake, subjects received a letter with information about the research. At the day of intake, subjects were informed about the research once again, and a written informed consent was signed. Blood was drawn, and an appointment for the test session was made.

At the test- session the cognitive tasks and questionnaires were administered. After the test- session a hair sample collection and EEG scan were conducted. The test- session lasted approximately three hours. When a hair sample and EEG scan were conducted as well, the test- session took about four hours to complete.

Statistical analyses

The analyses were conducted with SPSS Statistics 21.0. The independent variable in all analyses was group: OCD and MDD. Before the analyses were conducted differences in age, gender, premorbid intelligence and education were examined by performing a t- test and chi-squared- test.

The first hypothesis, whether OCD patients score worse on the working memory task compared to MDD patients, was tested by performing a MANOVA, with the total number of between- search errors and strategy score as dependent variables. A second MANOVA was conducted to examine the differences on the OTS task. The dependent variables in this

analysis were: 1) accuracy (problems solved on first choice), 2) the mean latency to first choice and 3) the mean latency to correct answer. To answer the third hypothesis, two Spearman correlation tests were conducted to examine the relation between the total score on the Y-BOCS questionnaire and the performance on the SWM task on the one hand, and the relation between the total score on the IDS- SR and the OTS task on the other hand. The correlations were based upon the clinical data of all patients, regardless of the disorder. The tests were two-tailed, with a significance level of 0.05**.**

Results

In the larger project, a total of 225 patients with either OCD or MDD were examined. Of these patients, 67 patients were not eligible for inclusion in the current study since they did not meet the inclusion criteria. In the current study, 158 patients were examined (90 patients with OCD and 68 patients with MDD). Twenty- eight patients did not complete the OTS task fully, therefore, the data of 130 patients (77 patients with OCD and 53 patients with MDD) was used to conduct the analyses of the OTS task.

Before the analyses were conducted, the data was examined and assumptions were tested. Both the variables of the SWM and OTS task did not contain any outliers. The Shapiro- Wilk test, which measures normality within groups, turned out to be significant for all dependent variables and thus suggested non- normality. The histograms and Q-Q plots, on the other hand, did appear to be normally distributed. For this reason, supplemented with the fact that transformations of the data did not improve normality, it was decided to continue with parametrical testing. By choosing the Pillai's Trace statistic, the significant Shapiro-Wilks tests were taken into account. The remaining assumptions were met.

The characteristics of the groups are shown in Table 1. The groups did not differ with respect to age, sex ratio and premorbid intelligence. There was a significant difference between the groups in clinical symptoms (Table 1).

Table 1

Characteristics

	OCD	MDD	Total	Statistics	*p*
N	90	68	158	-	-
% Male	43.33	39.71	41.77	$\chi^2 = .21$	$p = .647$
Age	38.07	42.22	39.85	$t = 1.83$	$p = .069$
	(13.79)	(14.55)	(14.22)		
Premorbid IQ	103.88	102.01	103.08	$t = -.84$	$p = .402$
	(12.96)	(14.85)	(13.79)		
IDS- SR Total	23.48	35.29	28.56	$t = 5.73$	$p < .001$
	(11.10)	(14.01)	(13.71)		
Y- BOCS Total	19.12	3.82	12.54	$t = -12.56$	$p < .001$
	(8.69)	(6.62)	(10.92)		

Note. Mean (SD), unless otherwise indicated. Premorbid IQ = estimation of premorbid verbal intelligence measured with the National Adult Reading Test (Nelson, 1982).
Abbreviations: OCD = obsessive- compulsive disorder, MDD = major depressive disorder, IDS- SR = Inventory of Depressive Symptomatology, Y- BOCS = Yale- Brown Obsessive-Compulsive Scale.

Hypotheses

A MANOVA was conducted to examine whether patients with OCD score worse on the working memory task compared to patients with MDD. The multivariate test turned out to be non- significant, Pillai's Trace = .013, $F(2, 155) = 1.009$, $p = .367$. There were no significant differences between patients with OCD and MDD. Table 2 displays the performance of the groups on the SWM task.

Table 2

Performance on the SWM task

Variable SWM	OCD (n = 90)	MDD (n = 68)
Between- search Errors	21.96 (17.19)	25.75 (19.03)
Strategy	31.61 (6.10)	32.16 (6.62)

Note. Mean (SD)

The second hypothesis, whether patients with OCD score better on a planning task compared to patients with MDD, was also tested by conducting a MANOVA. The multivariate test revealed to be non- significant, Pillai's Trace = .035, $F(3, 126) = 1.513$, $p = .214$, showing that the groups did not differ in performance on the planning task. The means of the groups are shown in Table 3.

Table 3

Performance on the OTS task

Variable OTS	OCD (n = 77)	MDD (n = 53)
Accuracy	17.29 (3.19)	17.11 (3.37)
Mean latency to first choice	21.76 (10.12)	21.48 (13.12)
Mean latency to correct	32.14 (17.29)	28.71 (15.26)

Note. Mean (SD). Mean latency in seconds, s.

The third hypothesis was tested with two Spearman correlation tests. The correlation between OCD symptoms and the performance on the SWM task turned out to be non- significant ([Between Errors] $r_s = .001$, $p = .992$; [Strategy] $r_s = .070$, $p = .382$). Additionally, it was found that MDD symptoms did not correlate with any of the measures of the OTS task ([Accuracy] $r_s = -.004$, $p = .960$; [Mean latency to first choice] $r_s = -.041$, $p = .645$; [Mean latency to correct] $r_s = -.062$, $p = .481$).

Discussion

The aim of the current study was to explore the possible differences between patients with OCD and patients with MDD on a planning and (spatial) working memory task, and to identify a possible relation between clinical symptoms and the performance of the patients on both tasks. Surprisingly, no significant differences between the groups were discovered. First, it was expected that patients with OCD would score worse on the working memory task compared to patients with MDD. However, this was not found, i.e., the number of mistakes made by the OCD patient group did not exceed the MDD group and both patient groups were quite similar in strategy use. Second, it was expected that OCD patients would score better on the planning task, but no differences were found in planning accuracy and latency. Similarly, the third hypothesis was also not supported. It was found that the severity of depressive and obsessive- compulsive symptoms was not significantly associated with the performance on

the planning and working memory task. Based on the current findings, neither deficits in planning nor working memory seem to be specific to a particular disorder, and the performance on the tasks also seems unrelated to clinical symptoms.

The findings of the current study regarding working memory and planning differ from the expectations and previous research. The results of Purcell and colleagues (1998b), who compared different disorders and found OCD- specific deficits in working memory, were not replicated in the current study. This discrepancy was surprising, especially considering the similarities, i.e., the same test battery (CANTAB) and working memory task (SWM task) were used. The total score on the Y-BOCS questionnaire, however, was higher in the study of Purcell and colleagues (1998b), indicating more severe symptomatology, which can possibly explain the difference in findings. Nedeljkovic and colleagues (2009) compared four different subtypes of OCD and healthy subjects, on the CANTAB battery, and found impaired performance of the OCD patient groups. Particularly compulsive checkers scored worse on the SWM task compared to the other groups (Nedeljkovic et al., 2009). Differences with the current OCD patient group with regard to subtypes, and particularly the percentage of compulsive checkers included in the patient group, could thus be an explanation for the difference in findings as well.

Another possible explanation for the discrepancy in findings could be the inclusion of patients with comorbid diagnoses. OCD patients with a comorbid mood disorder generally have more severe symptomatology (Tükel, Meteris, Koyuncu, Tecer & Yazici, 2006). That is, they often have poorer prognoses, a longer course of illness and more hospitalizations (Tükel et al., 2006). The exclusion of comorbid diagnoses could have influenced the results of the current study explaining differences with previous research.

Rampacher and colleagues (2010), for instance, directly compared OCD and MDD patients, and found OCD- specific impairments in planning, but did not control for comorbid diagnoses. Ten of the 40 OCD patients included by Rampacher et al. (2010) had a comorbid depressive disorder, and an additional ten patients were diagnosed with an anxiety disorder. It thus is possible that the OCD patients included by Rampacher had more severe symptomatology, which could possibly explain the planning deficits. Therewithal, Rampacher and colleagues (2010) matched their patients according to the level of depressive symptoms (i.e., both patient groups were similar in depression score), and, did not include patients with severe forms of depression to fulfill this requirement. That MDD patients were not at the peak of their illness, and often even almost remitted (Rampacher et al., 2010), could have had a beneficial effect on the results of the MDD patient group. Thus, that the patients with OCD

possibly had more severe symptomatology, and the patients with MDD less, could have exaggerated the group differences found by Rampacher and colleagues (2010). In the current study, comorbidity was excluded and patients were not matched according to depressive symptoms, which could explain the difference in findings.

The difference in findings with regard to planning could also be explained by variation in measures. The one- touch version used in the current study, differs from the original version in which the individual steps were visualized, and which is more frequently conducted than the one- touch version. The one- touch version measures planning ability more purely and might be more sensitive than the original version (Watkins et al., 2005). However, it puts more pressure on working memory as well, which could have influenced the results.

Furthermore, the inclusion of medication varies between studies as well. The medication most often used in the current study were antidepressants. Given that it is suggested that antidepressants have no adverse effects on cognitive functioning (Mataix-Cols, Alonso, Pifarre, Menchon, Vallejo, 2002), and that users of medication in the current study did not differ in performance from non- users, it was decided not to control for medication use in the current study. However, a possible moderating effect of medication use cannot be ruled out fully. Since depressive symptoms are associated with cognitive complaints, it could be that treatment and diminishment of these symptoms improve cognitive performance. In that case, medication itself has no direct effect, but the decrease of symptoms does. Previous studies which examined the effect of treatment with antidepressants are inconsistent. Nielen and den Boer (2003) investigated the effect of antidepressants on cognitive performance in OCD patients, and found persistent cognitive deficits, even after successful treatment of clinical symptoms. This finding suggests that treating depressive symptoms is not effective to improve cognitive performance. Shilyansky et al. (2016) found the same result in MDD patients. However, there is also research which do show promising results of antidepressants (Bartolato et al., 2016). More clarity on this topic is needed, especially since this information might be useful to improve existing treatment of cognitive functioning in psychiatric disorders.

The current study did not find any relations between the severity of clinical symptoms and the performance on the cognitive tasks. This finding is in agreement with the study of Nielen and Den Boer (2003), who found that performance is not secondary to clinical symptoms. However, there are also studies which state the contrary (Purcell et al, 1998). That no relation was found may be due to some aspects of the study design. First, the questionnaires were taken at the end of the test session, which could have affected the

reliability of the patient's answers. The cognitive tasks lasted approximately two hours, so attention and concentration could have been depleted. Therefore, the questionnaires may have been completed with less accuracy and precision. Furthermore, "mood congruent memory" could have affected the answers (Brewin, Andrews & Gotlib, 1993). That is, the recall of symptoms harmonized with the patient's mood, which could result in higher reportage of symptoms with lower mood and vice versa (Brewin, Andrews & Gotlib, 1993). Mood could be evoked by the patient's performance on the cognitive tasks.

However, it could also be that cognitive performance is not necessarily influenced by clinical symptoms but more so by other clinical factors, like length of illness, history of treatment or, in case of OCD, subtype. In the current study, no claims can be made about these factors, since they were not taken into consideration, but because of their possible moderating effects it is recommended to include them in future research. It is also recommended to conduct longitudinal research to further investigate the relation between clinical symptoms and cognitive performance, and to examine the effect of treatment.

A limitation of the current study is that there was no exact baseline in which the participants were tested, and thus variation, for example in treatment, between patients was present. Some participants were tested shortly after intake, without receiving treatment or therapy, while other were tested during treatment, or even after finishing treatment. Treatment could have had a beneficial effect on the patient's physical and mental well-being, compromising the results of patients who did not follow treatment (and probably scored worse), and improve the overall performance on the planning and working memory tasks. In addition to what is stated above, it is also likely that patients were tested at different stages of illness, which could also have affected the findings. Thus, it is recommended for future research to set certain guidelines about the times of testing in order to avoid confounding effects, and to include more homogeneous patient groups to make results more comparable.

Another limitation of the current study is that a healthy control group was not included. Claims can be made about the performance of one disorder in comparison with another, but nothing can be said about whether the scores of the disorder(s) are different from a normal population. It could be that despite the fact that the two disorders do not differ from each other, they do differ from healthy participants. This is key information to tell whether there is an actual problem. Hence, it is important to include a group of healthy participants in future research.

In conclusion, it seems that there is no difference between the psychiatric disorders OCD and MDD in planning and (spatial) working memory. Additionally, severity of clinical

symptoms does not seem to influence the performance on the cognitive tasks. The large sample sizes, the exclusion of comorbid disorders and the direct comparison between OCD and MDD, which is sparse in previous research, makes this study an important contribution to the literature. Although no differences between the groups were found, the current findings did give an insight in the cognitive performance of two highly prevalent psychiatric disorders. That in the current study clinical symptoms were not associated with performance, suggests that cognitive performance might be independent of symptom severity. Hypothetically, this could mean that treating and reducing clinical symptoms, will not improve cognitive performance. If that is the case, deficits in this domain might need to be treated separately. The current study was not designed to investigate this question, but it does highlight the importance of conducting more research on this topic. Future research should take the limitations of the current study into consideration. Longitudinal research, to further investigate the relation between clinical symptoms and cognitive performance, with more homogenous patient groups, particularly with regard to treatment and stage of illness, is recommended for future research.

References

American Psychiatric Association (2000). *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., Text Revision). Arlington, VA: Author.

American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.). Arlington, VA: Author.

Bartolato, B., Miskowiak, K. W., Köhler, C. A., Maes, M., Fernades, B. S., Berk, M., & Carvalho, A. F. (2016). Cognitive remission: a novel objective for the treatment of major depression? *BMC Medicine, 14*(9), 1-18. https://doi.org/10.1186/s12916-016-0560-3

Basso, M. R., Bornstein, R. A., Carona, F., Morton, R. (2001). Depression accounts for executive function deficits in obsessive- compulsive disorder. *Neuropsychiatry, Neuropsychology, and Behavioral Neurology, 14*(4), 241-245.

Brewin, C. R., Andrews, B., & Gotlib, I. H. (1993). Psychopathology and Early Experience: Reappraisal of Retrospective Reports. *Psychological bulletin,113*, 82-98. http://dx.doi.org/10.1037/0033-2909.113.1.82

CANTAB® [Cognitive assessment software]. Cambridge Cognition (2017). All rights reserved. www.cantab.com

Chamberlain, S. R., Blackwell, A. D., Fineberg, T. W., & Sahakian, B. J. (2005). The neuropsychology of obsessive compulsive disorder: the importance of failures in cognitive and behavioural inhibition as candidate endophenotypic markers. *Neuroscience and Biobehavioral Reviews 29*(3), 399–419. http://dx.doi.org/10.1016/j.neubiorev.2004.11.006

Choi, J.S, Kang, D. H., Kim, J.J., Ha, T. H., Lee, J. M., Youn, T, Kim, I. Y., Kim, S. I., & Kwon, J. S. (2004). Left anterior subregion of orbitofrontal cortex volume reduction and impaired organizational strategies in obsessive-compulsive disorder. *Journal of Psychiatric Research, 38*(2), 193-199. https://doi.org/10.1016/j.jpsychires.2003.08.001

Elliot, R. (2003). Executive functions and their disorders. *British Medicine Bulletin, 65,* 49-59. https://doi-org.ezproxy.leidenuniv.nl:2443/10.1093/bmb/65.1.49

Elliott. R., Sahakian, B. J., McKay, A. P., Herrod, J. J., Robbins, T. W., & Paykel, E. S. (1996). Neuropsychological impairments in unipolar depression: the influence of perceived failure on subsequent performance. *Psychological Medicine, 26*(5), 975-989. https://doi-org.ezproxy.leidenuniv.nl:2443/10.1017/S0033291700035303

Goodman, W. K., Price, L. H., Rasmussen, S. A., Mazure, C., Fleischmann, R. L., Hill, C. L., Heninger, G. R., & Charney, D. S. (1989). The Yale- Brown Obsessive- Compulsive Scale: I. Development use, and reliability. *Archives of General Psychiatry, 46*(11), 1006-1011. http://dx.doi.org/10.1001/archpsyc.1989.01810110048007

Gotlib, I., Joormann, J. (2010). Cognition and Depression: Current status and future Directions. *The Annual Review of Clinical Psychology,* 6, 285-312. https://doi-org.ezproxy.leidenuniv.nl:2443/10.1146/annurev.clinpsy.121208.131305

Hammar, A., & Ardal, G. (2009). Cognitive functioning in major depression – a summary. *Frontiers in Human Neuroscience, 3,* 1-7. https://doi.org/10.3389/neuro.09.026.2009

Kuelz, A., Hohagen, A., & Voderholzer, U. (2004). Neuropsychological performance in obsessive- compulsive disorder: a critical review. *Biological Psychology, 65*(3),185-236. https://doi.org/10.1016/j.biopsycho.2003.07.007

Martoni, R. M., Salgari, G., Galimberti, E., Cavallini, M. C., & O'Neill, J. (2015). Effects of gender and executive function on visuospatial working memory in adult obsessive-compulsive disorder. *European Archives of Psychiatry and Clinical Neuroscience, 265*(8), 707-718. http://dx.doi.org/10.1007/s00406-015-0604-2

Mataix- Cols, D., Alonso, P., Pifarre, J., Menchon, J. P., & Vallejo, J. (2002). Neuropsychological performance in medicated vs. unmedicated patients with obsessive compulsive disorder. *Psychiatry Research, 109*(3), 255-264. https://doi.org/10.1016/S0165-1781(02)00024-0

Moritz, S., Birkner, C., Kloss, M., Jacobsen, D., Fricke, S., Böthern, A., & Hand, I. (2001). Impact of Comorbid Depressive Symptoms on Neuropsychological Performance in Obsessive- Compulsive Disorder. *Journal of Abnormal Psychology, 110*(4), 653-657. http://dx.doi.org/10.1037//0021-843X.110.4.653

Moritz, S., Birkner, C., Kloss, M., Jahn, H., Hand, I., Haasen, C., & Krausz, M. (2002). Executive functioning in obsessive- compulsive disorder, unipolardepression, and schizophrenia. *Archives of Clinical Neuropsychology, 17*(5), 477-483. https://doi.org/10.1016/S0887-6177(01)00130-5

Nedeljkovic, M., Kyrios, M., Moulding, R., Doron, G., Wainwright, K., Pantelis, C.,Purcell, R., & Maruff, P. (2009). Differences in neuropsychological performance between subtypes of obsessive-compulsive disorder. *The Australian & New Zealand journal of psychiatry, 43*(3), 216-226. http://dx.doi.org/10.1080/00048670802653273

Nelson, H. E. (1982). *National Adult Reading Test (NART): Test Manual.* Windsor: NFER -NELSON.

Nielen, M. M., & Den Boer, J. A. (2003). Neuropsychological performance of OCD patients before and after treatment with fluoxetine: evidence for persistent cognitive deficits. *Psychological Medicine, 33*(5), 917-925. https://doi-org.ezproxy.leidenuniv.nl:2443/10.1017/S0033291703007682

Owen, A. M., Downes, J. J., Sahakian, B. J., Polkey, C. E., & Robbins, T. W. (1990). Planning and Spatial Working Memory Following Frontal Lobe Lesions in Man. *Neuropsychologia, 28*(10), 1021-1034. https://doi.org/10.1016/0028-3932(90)90137-D

Purcell, R., Maruff, P., Kyrios, M., & Pantelis C. (1998a). Cognitive deficits in obsessive compulsive disorder on test of frontal- striatal function. *Biological Psychiatry¸43*(5), 348-357. https://doi.org/10.1016/S0006-3223(97)00201-1

Purcell, R., Maruff, P., Kyrios, M., & Pantelis, C. (1998b). Neuropsychological deficits in obsessive- compulsive disorder. A comparison with unipolar depression, panic disorder, and normal contrals. *Archives of General Psychiatry,55*(5), 415-423. http://dx.doi.org/10.1001/archpsyc.55.5.415

Rampacher, F., Lennertz, L., Vogeley, A., Schulze- Rauschenbach, S., Kathmann, N., Falkai, P., & Wagner, M. (2010). Evidence for specific cognitive deficits in visual information processing in patients with compared to patients with unipolar depression. *Progress in Neuro- Psychopharmacology & Biological Psychiatry, 34*(6), 984-991. https://doi.org/10.1016/j.pnpbp.2010.05.008

Robbins, T. W., James, M., Owen, A. M., Sahakian, B. J., Lawrence, A. D., McInnes, L., & Rabbitt, P. M. A. (1998). A study of performance on tests from the CANTAB battery sensitive to frontal lobe dysfunction in a large sample of normal volunteers: implications for theories of executive functioning and cognitive aging. *Journal of the International Neuropsychological Society, 4*(5), 474-490.

Rogers, M. A., Bradshaw, J. L., Pantelis, C., & Philips, J. G. (1998). Frontostriatal deficits in unipolar major depression. *Brain Research Bulletin, 47*(4), 297-310. https://doi.org/10.1016/S0361-9230(98)00126-9

Rogers, M. A., Kasai, K., Koji, M., Fukuda, R., Iwanami, A., Nakagome, K., Fukuda, M., & Kato, N. (2004). Executive and prefrontal dysfunction in unipolar depression: a review of neuropsychological and imaging evidence. *Neuroscience Research¸50,* 1-11. https://doi.org/10.1016/j.neures.2004.05.003

Savage, C. R., Deckersbach, T., Wilhelm, S., Rauch, S. L., Baer, L., Reid, T., Jenike, M. A. (2000). Strategic processing and episodic memory impairment in obsessive compulsive disorder. *Neuropsychology, 14,* 141-151. http://dx.doi.org/10.1037//0894-4105.14.1.141

Schlader, Z. J., Gragnon, D., Adams, A., Rivas, E., Cullum, M., & Grandall, G. G. (2015). Cognitive and perceptual response during passive heat stress in younger and older

adults. *American Journal of Physiology, 308*(10), 847-854. https://doi.org/10.1152/ajpregu.00010.2015

Shilyansky, C., Williams, L. M., Gyurak, A., Harris, A., Usherwood, T., & Etkin, A. (2016). Effect of antidepressant treatment on cognitive impairments associated with depression: a randomized longitudinal study. *Lancet Psychiatry, 3*(5), 425-435. https://doi.org/10.1016/S2215-0366(16)00012-2

Simpson, H. B., Rosen, W., Huppert, J. D., Lin, S. H., Foa, E. B., & Liebowitz, M. R. (2006). Are there reliable neuropsychological deficits in obsessive- compulsive disorder? *Journal of Psychiatric Research, 40*(3), 247-257. https://doi.org/10.1016/j.jpsychires.2005.04.004

Tol, M. J. van, Wee, N. J. A. van der, Demenescu, L. R., Nielen, M. M. A., Aleman, A., Renken, R., Buchem, M. A. van, Zitman, F. G., & Veltman, D. J. (2011) Functional MRI correlates of visuospatial planning in out-patient depression and anxiety. *Acta Psychiatrica Scandinavica, 124*(4), 273-284. https://doi-org.ezproxy.leidenuniv.nl:2443/10.1111/j.1600-0447.2011.01702.x

Trivedi, M. H., Rush, A. J., Ibrahim, H. M., Carmody, T. J., Biggs, M. M., Suppes, T., Crismon, M. L., Shores- Wilson, K., Toprac, M. G., Dennehy, E. B., Witte, B., & Kashner, T. M. (2004). The Inventory of Depressive Symptomatology, Clinician Rating (IDS-C) and Self-Report (IDS-SR), and the Quick Inventory of Depressive Symptomatology, Clinician Rating (QIDS-C) and Self-Report (QIDS-SR) in public sector patients with mood disorders: a psychometric evaluation. *Psychological Medicine, 34*, 73-82. o https://doi-org.ezproxy.leidenuniv.nl:2443/10.1017/S0033291703001107

Tükel, R., Meteris, H., Koyuncu, A., Tecer, A., & Yazici, O. (2006). The clinical impact of mood disorder comorbidity on obsessive- compulsive disorder. *European Archives of Psychiatry and Clinical Neurosciences, 265*(4), 240-245. http://dx.doi.org/10.1007/s00406-006-0632-z

Tükel, R., Polat, A., Özdemir, Ö, Aksüt, D., & Türksoy, N. (2002). Comorbid conditions in obsessive- compulsive disorder. *Comprehensive Psychiatry, 43*(3), 204-209. https://doi.org/10.1053/comp.2002.32355

Wagner, S., Müller, C., Helmreich, I., Huss, M., & Tadic, A. (2015). A meta- analysis of cognitive functions in children and adolescents with major depressive disorder. *European Child and Adolescent Psychiatry, 24,* 5-19. http://dx.doi.org/10.1007/s00787-014-0559-2

Watkins, L. H., Sahakian, B. J., Robertson, M. M., Veale, D. M., Rogers, R. D., Pickard, K. M., Aitken, M. R. F., & Robbins, T. W. (2005). Executive function in Tourette's syndrome and obsessive- compulsive disorder. *Psychological Medicine, 35*(4), 571-582. https://doi-org.ezproxy.leidenuniv.nl:2443/10.1017/S0033291704003691