

Comparison of retrospective and prospective memory in subtypes of obsessive-compulsive disorder

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Abstract

Retrospective and prospective memory deficits play a role in maintaining and perpetuating the symptoms of obsessive-compulsive disorder (OCD), but less is known about these deficits in different subtypes of OCD. The aim of the present study was to evaluate the retrospective and prospective memory in patients suffering from cleaning, checking, symmetry, and religious obsessions. In a comparative causal method, 60 participants aged 28 to 55, in 2023, were selected by convenience sampling and placed in five groups of individuals with cleaning, checking, symmetry, religious obsessions, and a healthy group. Participants completed self-report questionnaires and neurocognitive tools. Results showed that defects in retrospective memory were significant in all types of obsessions ($p < 0.05$) except religious obsessions. Also, this defect was more severe in checking obsession disorder compared to other types of OCD. Also, the finding indicated that the defect in prospective memory was significant only in checking obsession disorder ($p < 0.05$). Retrospective and prospective memory impairments and their relationship with deficits in executive functions can be different depending on the type of OCD. Based on the findings, impairment of executive function indirectly by impacting the impairment of other cognitive mechanisms diminishes confidence in retrospective and prospective memory which leads to compulsive behaviors in individuals with contamination and checking obsessions. Also, the impairment of retrospective memory in symmetry obsessions might have a relationship with information encoding, which in turn leads to difficulty recalling information from memory.

Key Words: obsessive-compulsive disorder; retrospective memory; prospective memory; executive functions.

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Obsessive-compulsive disorder is one of the most debilitating mental health disorders.¹ It is a chronic disorder affecting 4.6 percent of the population in Iran.² Also, according to the DSM-5, the OCD was moved out of the anxiety disorder category and classified in a new diagnostic category.³ OCD is characterized by two distinctive features obsessions and compulsions. Obsessions are intrusive, repetitive, and annoying thoughts, images, and impulses that cause anxiety, restlessness, and distress. Compulsions are repetitive behaviors or mental acts which alleviate the distress and anxiety caused by obsessions.⁴ In order to understand the etiology of OCD, the role of various factors such as

biological, behavioral, and cognitive factors were studied among which the cognitive factors were more focused upon in recent decades.⁵ Research literature indicates that individuals with OCD have impairment of some cognitive functions such as executive functions, information processing speed, attention, and memory.⁶ Evidence suggests that patients with OCD function differently in some memory-related tasks, especially, those of retrospective and prospective memory.^{7,8} Vafa et al. studied retrospective, prospective, and short-term memory in patients with OCD and non-patients. The results revealed a significant difference in the retrospective and prospective memory between patients with OCD and non-patients, while no significant

difference was observed between the two groups in short-term memory.⁹ Bhat et al. drew a comparison between retrospective and prospective memory in individuals with OCD, schizophrenia, and non-patients showed that those with OCD have the most impairment of these memory functions compared to others.¹⁰ Also, predicting checking behaviors based on prospective memory and executive functions, such as response inhibition, indicated that this impairment of prospective memory and executive functions can predict checking behaviors.¹⁰ Retrospective memory is the ability to remember events and information related to the past, e.g. remembering that "I had a conversation with my brother at 2 p.m.". Prospective memory is a cognitive function by which individuals can remember intentions and objectives related to the future.¹¹ Completing prospective memory tasks requires individuals to remember purposeful actions while currently engaged in other activities. Research has identified two types of prospective memory: time-based prospective memory and event-based prospective memory. Time-based prospective memory is remembering to do a specific action at a specific time, e.g., remembering to take a test at tomorrow 9 a.m. Event-based prospective memory is the ability to remember a specific action when a specific event takes place, e.g., remembering to call a friend after university.¹² Four phases are involved in the formation of prospective memory: in the first phase, intentions, objectives, and activities related to them are formed with coding and mental planning as the two main factors of this phase. In the second phase, coded intentions are stored and retained in retrospective memory. The third phase is called retrieving, in which the previously coded intentions and objectives in retrospective memory get activated. In this phase, some executive functions such as self-monitoring, cognitive flexibility, and response inhibition play a key role. The fourth phase includes the execution of previous intentions.⁸ Most importantly, while functionally distinguished these two memories are closely related. For instance, in the second phase of prospective memory, retrospective memory plays a role in remembering intentions and objectives; i.e. the retrospective component reminds the individual of what should be done and the prospective component reminds the individual of something that should be done.¹² Impairment of retrospective and prospective memory in individuals with OCD explains their unwanted doubts forcing them to check.¹³ It seems they are trying to compensate for the impairment of the retrospective and prospective memory by such compulsive methods. As if each compulsive behavior according to the individual equals to a functional failure of retrospective and prospective memory.¹⁴ Consecutive failures may reduce trust in retrospective and prospective memory. Little trust in the memory results in higher levels of annoying hesitations in completing tasks correctly. So, this vicious cycle persists, troubling the individual's function in everyday life.¹⁵

Given the above, various researchers addressed the role of retrospective and prospective memory impairment in the maintenance and persistence of OCD symptoms. Also, we should consider that OCD is a heterogeneous disorder including distinct subtypes with significantly different symptoms. So, understanding the level of memory impairment of these subtypes of OCD and the possible significant difference between them might help researchers study the role of memory impairment in the formation and persistence of OCD's symptoms more specifically and accurately. As we examined, only a few studies have addressed the evaluation of retrospective and prospective memory in distinct subtypes of OCD which leaves many of its aspects still unknown. So, in this study, we intended to assess retrospective and prospective memory in individuals with cleaning, checking, symmetry, and religious obsessions.

Materials and Methods

The present study was conducted with a comparative method. This study was approved by the Research Ethics Committees of Tabriz University, in the ethic no. IR.TABRIZU.REC.1402.089. The clinical population included those who were referred to the health centers of Maragheh city in 2023 and received an OCD diagnosis (of different types). To be sure about the diagnosis of OCD, along with completing valid questionnaires, a structured clinical interview based on DSM-5 was conducted with all participants in the research. Among these individuals, 45 people who met the inclusion criteria were selected by the convenience sampling method. The non-clinical sample includes 15 individuals selected by the convenience sampling method. The sample of patients and the normal group were matched based on gender. The inclusion criteria were: 1) 28 to 55 years of age; 2) A minimum of 2 years duration passed from the onset of disease for the clinical group and disease-free for the non-clinical group; 3) Filling in the consent form; 4) Having a minimum education level of diploma. The exclusion criteria include: 1) absence of another comorbid disorder or the diagnosis of substance abuse in the past or present (based on the structured diagnostic interview); 2) Not taking any specific medication (medicinal or psychological) within the last year.

Measures

Prospective and Retrospective Memory Questionnaire (PRMQ)

The scale includes 16 items that measure Prospective Memory and Retrospective Memory. Items 1 to 8 measure Prospective Memory and items 9 to 16 Retrospective Memory. It is a five-point Likert-type scale with responses ranging between 1 (never) to 5 (always). The total scale consisted of 16 items ($\alpha=.89$), the Prospective Scale consisted of 8 items ($\alpha=.85$), and the Retrospective Scale consisted of 8 items ($\alpha=.80$). Zare et al. reported a Cronbach's alpha of 0.83 in Iranian population.¹⁷

Yale-Brown Obsessive-Compulsive Scale (Y-BOCS).¹⁸ Includes severity of Obsessions (5 items), and the severity of Compulsions (5 items). Castro-Rodrigues et al. reported internal consistency of the scale 0.84.¹⁹ *Obsessive-Compulsive Inventory-Revised (OCI-R)*.²⁰ The previous version of this test included 42 items which were reduced by Foa et al. to 18 items. The internal consistency of the Persian version of OCI-R. reported 0.85 by Mohammadi et al.²¹

Penn inventory of scrupulosity (PIOS) is a 19-item measure that assesses scrupulosity, including fears of sin (e.g., I feel guilty about immoral thoughts I have had) and fears of God (e.g., I worry that God is upset with me), on a 5-point scale.²² We made no predictions regarding the specific PIOS scales and thus used the PIOS total scale.^{23,24} The PIOS has shown acceptable convergent validity in prior studies, showing moderate relations with OCD symptoms (rs ranging from 0.20 to 0.36) and a moderate relation with religiosity ($r^2=0.36$). Moreover, self-identified religious individuals have especially high PIOS scores.²²

The Stroop Color and Word Test (SCWT) was designed to measure selective attention and cognitive flexibility. We used a computerized version of the Stroop test to measure response inhibition. The task in the first trial requires reading a word list as quickly as possible without making mistakes and reading the colour of the ink in which a word is shown in the second trial, interference trial.²⁵

Wisconsin Card Sorting Test (WCST) measures planning and mental flexibility in the subjects. In this study, a computerized version of this test was used. In computerized version of the WCST four main cards (i.e. one red triangle, two green stars, three yellow crosses, and four blue circles) appear in the upper half of the screen in the same places throughout the test. Meanwhile, 128 cards will appear one by one in a completely random order in the lower half towards the right corner of the screen. To score and explain the results, three main factors should be considered: the number of correct responses, the number of errors, and perseverative. Kopp et al. reported the reliability confident of this test in measuring cognitive deficiencies as more than 0.90.²⁶

Tower of Hanoi

The Tower of Hanoi is one of the most famous tests for the measurement of planning and problem-solving, designed for evaluating executive functions, especially deficiency in planning and ability of problem-solving. In this study, the computerized version of this test was used and it was presented to the subjects on a touch screen. To score the test, the number of moves for problem-solving, redundant moves, and the duration of time problem-solving were calculated. The reliability coefficient demonstrated with test re-test was reported higher than 0.90.²⁷ Hoseini et al. reported a test re-test reliability of 0.81.²⁸

Digit Span Subtest of the Wechsler Adult Intelligence Scale (WAIS-IV) is one of the subtests of the Working

Memory Index derived from the fourth edition of Wechsler Adult Intelligence Scale. This task consists in repeating in direct and reverse order the series of digits, of increasing size, and distributed by items. Each item corresponds to a different sequence length. The task ends when the subject fails two trials on the same sequence. The total score consists of the maximum number of correctly repeated sequences. The score ranges from 0 to 14, in which higher scores are associated with better the working memory ability.²⁹ Another study reported a Cronbach's alpha of 0.84 for the Digit Span Subtest.³⁰

Implementation of methods

45 people diagnosed with OCD were selected from clinics of Maragheh in Iran. A DSM-5-based structured Interview was used to examine comorbid disorders and confirm OCD in the clinical group. After the interview, the participants completed Y-BOCS and PIOS. In the end, considering the assessment, participants were categorized into different groups based on their dominant obsession: symmetry (12), contamination (14), checking (11), and religious (8). Also, the non-clinical sample consists of 15 individuals selected by the convenience sampling method. Data were analyzed using IBM SPSS Statistics (Version 28). Statistical significance was based on a nominal p-value <0.05.

Ethical Considerations

The questionnaires were collected without any personal records included to respect the confidentiality of the participants. Only the researcher has access to the data collected through questionnaires and access by other individuals has been denied so that confidentiality can be maintained. The participants were free to leave the study and withdraw from answering the questions whenever they wished.

Results and Discussion

The findings obtained from the studied groups were analyzed using descriptive statistics and multivariate analysis of variance methods. Table 1 shows the descriptive statistics for the research variables in the clinical and healthy samples. Table 1 shows that 1) checking obsessions group obtained the highest average in prospective and retrospective memory; 2) compared other groups, religious obsessions group had a poor performance in planning; 3) compared other groups, cleaning obsessions group had a poor performance in response inhibition; 4) compared other groups, checking obsessions group had a poor performance in working memory and flexibility. Multivariate analysis of variance (MANOVA) was run to compare the groups suffering from symmetry obsessions, cleaning obsessions, checking obsessions, religious obsessions, and healthy individuals (Table 2). Before running MANOVA, the assumption of normality of data distribution and homogeneity of variances were examined. As can be seen, there were significant differences between the two groups in terms of prospective memory, retrospective memory, the duration planning tasks, incongruent

Table 1. The descriptive statistics.

Indicator Variable	symmetry obsessions		cleaning obsessions		checking obsessions		religious obsessions		healthy samples		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Prospective memory	17.08	3.57	18.07	6.87	21.90	2.70	15.87	3.38	16.20	3.36	
Retrospective memory	18	2.98	17.85	6.01	19.09	2.54	17.50	4.27	13.73	3.05	
Planning	Time	00:55	00:23	01:10	00:39	01:14	00:29	00:46	00:15	00:48	00:15
	Number of movements	18.91	10.39	21.42	9.94	21.90	10.17	25.12	13.72	15	5.60
	Additional movements	11.83	10.34	14.42	9.94	14.90	10.17	17.75	13.72	8	5.60
Response inhibition	Congruent reaction time	00:57	00:10	01:10	00:22	01:06	00:23	01:00	00:19	01:08	00:16
	Incongruent reaction time	01:14	00:18	01:36	00:28	01:39	00:28	01:31	00:33	01:14	00:16
	Interference	00:17	00:10	00:25	00:13	00:29	00:11	00:20	00:07	00:10	00:07
	Number of incongruent errors	2.16	1.26	2.57	1.22	2.27	1.19	2.25	1.28	1.13	0.990
Working memory	Digit span forward	5.83	1.26	4.85	2.03	4.27	1.95	7.25	2.12	6.33	1.79
	Digit span backward	4.58	0.996	3.64	0.744	3.54	1.29	5.50	1.77	5.13	1.55
Flexibility	Time	08:15	00:43	08:05	01:09	07:27	01:16	08:26	00:41	07:40	01:09
	Perseverative errors	31.58	22.33	36.29	19.68	38.91	17.21	32.38	9.78	20.13	8.95
	The number of correct responses	70.41	21.86	66.14	9.57	62.18	12.35	64.62	9.88	78.06	10.72
	The number of errors	48.66	17.73	56.21	11.19	65.81	12.35	63.62	10.26	49.26	11.84

reaction time, interference, the number of incongruent errors, digit span forward and backward, perseverative errors, the number of correct responses, and the number of errors in the Wisconsin test ($p < 0.05$). To compare the difference between the groups' mean pairs, Fisher's LSD post hoc test was run. The results showed a significant difference only between the healthy group and the group with checking obsessions in the prospective memory. There was a significant difference in retrospective memory between the healthy group and all groups except those suffering from religious obsessions. The group with checking obsessions had higher scores in retrospective memory (leading to more errors). There was a significant difference between the healthy group with cleaning obsessions and the group with checking obsessions in the Hanoi tower duration. The differences in mean pairs in the Hanoi tower duration scores between the healthy group, the group with cleaning obsessions, and the group with checking obsessions were significantly higher than in the members of the group with checking obsessions. There was also a significant difference between the healthy group and the groups with cleaning and checking

obsessions in terms of incongruent reaction time. The group with checking obsessions responded more slowly than the other groups to incongruent stimuli (longer reaction time). There was also a significant difference between the healthy group with the groups with cleaning obsessions and checking obsessions in terms of interference. The differences in mean pairs in interference scores between the healthy group, the group with cleaning obsessions, and the group with checking obsessions were significantly higher in the members of the groups with checking obsessions. There was a significant difference between the healthy group and all groups in the number of incongruent errors. The mean difference in the number of errors in the group with cleaning obsessions was higher compared to other groups. There was a significant difference between the healthy group and the groups with checking obsessions and cleaning obsessions in the forward digit span. The difference of mean pairs in forward digit span scores was higher in the checking group compared to other groups (with lower digit span scores). There was a significant difference between the healthy group and the groups with

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Table 2. *Multivariate Analysis of Variance.*

Variable	Df	F	Sig	n2
Prospective memory	4	2.74	0.038	0.174
Retrospective memory	4	3.38	0.016	0.207
Time	4	2.56	0.049	0.165
Number of movements	4	1.93	0.118	0.130
Additional movements	4	1.94	0.117	0.130
Congruent reaction time	4	0.998	0.417	0.071
Incongruent reaction time	4	2.87	0.032	0.181
Interference	4	6.064	0.000	0.318
Number of incongruent errors	4	3.24	0.019	0.200
Digit span forward	4	3.19	0.020	0.197
Digit span backward	4	4.05	0.006	0.238
Time	4	1.31	0.276	0.092
Perseverative errors	4	2.87	0.031	0.181
The number of correct responses	4	2.75	0.037	0.175
The number of errors	4	4.17	0.005	0.243

cleaning obsessions and checking obsessions in the backward digit span. The difference between the mean pairs in the backward digit span scores was higher in the group with checking obsessions compared to other groups (with lower backward digit span scores). There was a significant difference between the healthy group, the group with cleaning obsessions, and the group with checking obsessions in terms of perseverative errors. The mean difference in perseverative errors in the group with checking obsessions was higher compared to other groups (with more perseverative errors). There was a significant difference between the healthy group and the groups with cleaning obsessions, checking obsessions, and religious obsessions in terms of the number of correct responses. The mean difference in the total number of correct responses by the group with checking obsessions was higher compared to other groups (with a lower number of correct responses). There was a significant difference between the healthy group and the groups with checking obsessions and religious obsessions in the total number of errors. The difference of the mean pairs in the total number of errors in the group with checking obsessions was higher compared to other groups (with a higher number of errors).

The purpose of this study was to compare retrospective and prospective memory in people with OCD subtypes of

washing, checking, symmetry, and religious obsession. The results showed significant impairment in the retrospective memory of all subtypes of OCD except for the religious subtype. Also, the impairment is greater in the subtype of checking compared to the rest. These results are consistent with the findings of Vafa et al [9]. Results indicated that individuals with checking obsessions witnessed the most impairment in retrospective memory. According to Rachman et al. checking obsessions create a self-perpetuating mechanism.³¹ Individuals with checking obsessions display compulsive behaviors, such as checking if the stove is turned off, to prevent harm by reducing the possibility of harming themselves and others. With each checking and rechecking, confidence in their retrospective memory diminishes, resulting in increased checking behaviors. It is the repetition of this vicious circle that intensifies checking obsessions.³² Individuals with checking obsessions also use less mental visualization for storing information, and they are less likely to differentiate actual behaviors from mental visualizations. While in individuals with religious obsessions who use more visualization and illustration in storing information compared to other subtypes of OCD, and understand the difference between these visualiz (appropriate and on-time retrieval of information related

to goals from episodic memory). As the difficulty of the tasks increase (i.e. doing several actions and actual events, increased confidence in retrospective memory is observed.³³ Since confidence in retrospective memory and recalling it depends on the clarity of information, less mental visualization and confusing visualizations with actual events in individuals with checking obsessions leads to impairment of their retrospective memory. The results of this study indicated that individuals with checking obsessions had the most impairment in response inhibition. It can be explained that the ability of individuals in providing responses and remembering previous information depends on their ability in ignoring or inhibiting unrelated information, therefore, focusing on the main task. This may be the reason for low scores in retrospective memory of individuals with checking and contamination obsessions: an inability to inhibit unrelated information and decreased ability in shifting their focus from the threatening factors to the task-related stimuli. It can be stated that impairment in attentional control is one of the common characteristics of both checking and contamination obsessions, as these individuals have problems in attentional control and maintaining their focus in response inhibition. Results revealed that individuals with checking obsessions and contamination obsessions had lower scores in cognitive flexibility. The relationship between cognitive flexibility and impairment of retrospective memory can be explained by how mental rumination, worries, and countless obsessive thoughts of checking and contamination subtypes of OCD can lead to cognitive overload, occupied working memory, and therefore result in an impaired function of working memory.³⁴ The correct function of cognitive flexibility (i.e. the ability to keep information and shift focus between various subjects based on environmental needs) mostly depends on a functional working memory. Johann et al. also showed working memory and cognitive flexibility are positively correlated, so individuals with higher scores in working memory had higher scores in cognitive flexibility as well.³⁵ It can be concluded that in individuals with checking and contamination subtypes of OCD the impairment of working memory affects their cognitive flexibility. With lower cognitive flexibility, their ability in shifting attention and focus which is essential to encode information also decreases, resulting in difficulty focusing on tasks related to the present time. But why are the obsessions and concerns in these two OCD related to the filling of working memory and defects in cognitive flexibility, while this relationship is weaker in other subtypes? It can be explained that the triggering of worries and obsessions related to checking obsessions and contamination obsessions occurs in more situations in daily life, and as a result, it can cause more disturbances in working memory and cognitive flexibility. It can be concluded that individuals with checking and contamination OCD are stuck in a vicious circle of an occupied working memory with ruminations,

worries, and related obsessions to these two disorders leading to the impaired efficacy of their working memory. The impairment of working memory also impacts cognitive flexibility, causing it to lower. Subsequently, this lowered level of cognitive flexibility disturbs the ability of attention shift and correct information encoding which is essential for recalling past events. In conclusion, impairment in cognitive flexibility can explain the impairment of retrospective memory in these two disorders. Although individuals with symmetry obsessions have weaker retrospective memory compared to the group of normal individuals, no significant difference was observed between the executive function of these two groups: which can be explained by the nature of symmetry obsession as these individuals pay attention to the environmental physical characteristics, such as color, number, order, etc., using superficial processing method to code and store information. According to the information processing level theory, remembering information stored through more superficial and physical characteristic-based data processing methods is harder compared to those processed by semantic data processing. Meanwhile, as individuals with symmetry obsession always pay attention to the similar characteristic of their environment (such as color, number, order, etc.) large amounts of similar information is stored in their memory, causing interference between information and restoring them. Also, results revealed that impairment of prospective memory was only significant in individuals with checking obsession. These findings are consistent with those of the papers.^{8-10,13}

As mentioned before, there are four stages that contribute to the formation of prospective memory: formation of intentions and objectives, storing and remembering the encoded intentions, retrieving previous intentions and objectives, and actively implementing the previous objectives.⁸ Based on the statistical findings, we can interpret that most of the impairments of the prospective memory in checking subtype of OCD are due to problems in stage three of this process. In the third stage, previously encoded intentions and objectives are retrieved. Some executive functions, such as self-monitoring, cognitive flexibility, and response inhibition, have key roles in this stage.⁸ The results of this study showed that individuals with checking obsession have higher levels of impairment in their cognitive flexibility and response inhibition. The role of response inhibition in the impairment of prospective memory can be explained by how individuals with checking obsessions have difficulty in suppressing unrelated information. The reason behind this difficulty in suppressing information is impairment in selective attention and extreme involvement with obsessive thoughts of hurting oneself and others. Since the ability to suppress unrelated information is essential for successfully recovering information, disruption of it leads to an increase in doubt and worries concerning previous behaviors and also disturbs future normal performances. Doubt causes

compulsive checking behaviors and by each checking confidence in memory progressively diminishes.^{10,36} Cognitive flexibility assists prospective memory through the selection of an appropriate strategy based on the changes in the environment. Healthy individuals apply either of two different cognitive strategies depending on the difficulty of tasks: 1) proactive control (storing goals in the memory and active monitoring of the environment), and 2) reactive control (appropriate and on-time retrieval of information related to goals from episodic memory). As the difficulty of the tasks increase (i.e. doing several activities in a day) individuals tend to use proactive control more.³⁷ Moreover, as the time gap between encoded goals and actualizing them stretches, individuals would become more likely to use the reactive control.¹² It seems that individuals with checking subtype of OCD who have lower levels of cognitive flexibility are not able to flexibly apply either of these two strategies; causing impairment in the correct retrieving of information related to future-related intentions and eventually leading to impairment of prospective memory. Results indicated that no significant difference exists between the non-clinical group and the group of obsessive individuals regarding the accuracy of planning (number of moves and excessive moves). Still, individuals with the checking and contamination obsession performed the Tower of Hanoi task significantly slower (longer time) compared to the non-clinical group. It seems that the impairment of working memory existing in these two subtypes of OCD results in an increase of mental control in the Tower of Hanoi task. Individuals necessarily need to keep the planned sequences to start and perform planned activities. Individuals with checking and contamination obsession are incapable of keeping the sequences of plans in their mind which forces them to re-plan the next moves or insert more mental control in future moves in the Tower of Hanoi task (was this move right?), causing them to need more time to make their next moves.³⁸ On the other hand, Veale et al. observed that slowness of planning in individuals with obsession is because of their fear of making mistakes which is rooted in the perfectionism characteristic. They are inclined to doubt the accuracy of each movement and evaluate it several times, which results in a loss of time.³⁹ Overall, it can be said that in obsessive individuals, planning is performed normally as a cognitive component that plays a role in the first stage of prospective memory. The only problem is that individuals with checking and contamination obsessions need more time to plan which might be rooted in the impairment of working memory or fear of making mistakes. The role of working memory in the impairment of retrospective and prospective memory can be explained by Abramovitch's excessive executive load model.³⁴ The overflow of thoughts related to being threatened and hurt and importance to these thoughts overloads the executive system in individuals with the

checking and contamination obsessions. This occupied memory leads to impairment in monitoring information in individuals with the checking and contamination obsessions. This is consistent with preparatory attentional and memory process. According to this theory, the successful event-based PM requires monitoring of intention in mind as well as in the environment. It seems that cognitive overload disrupts the efficacy monitoring of the future intentions and as a result difficult to retrieve prior objectives.⁴⁰ Overall, the impairment of retrospective memory and executive function can be different depending on subtype of the OCD. Based on the findings, an impairment exists in the retrospective memory of individuals with contamination, checking, and symmetry obsessions. Impairment of executive function indirectly by impacting the impairment of other cognitive mechanisms diminishes confidence in retrospective memory which leads to compulsive behaviors in individuals with contamination and checking obsessions. Thus, impairment in retrospective memory and executive function could be an important reason for the persistence of symptoms in contamination and checking obsessions. As findings indicated that indicated that impairment of retrospective memory in individuals with symmetry obsessions has no relationship with weakness in executive function, such as response inhibition, flexibility, and working memory, with executive functions in these individuals being reported as normal; it seems that, as mentioned before, the impairment of retrospective memory in this kind of obsession might have a relationship with information encoding. People with symmetry obsessions use superficial information processing for storage and encoding of information, which in turn leads to difficulty recalling information from memory.

In sum, the findings of this study showed significant impairments of prospective memory only in checking subtype of OCD. This can be explained by the relatedness of impairment in an interconnected set of executive functions (such as working memory, response inhibition, and cognitive flexibility) with impairment in prospective memory performance. Efficacy reduction of prospective memory results in an increase in doubt and uncertainty, leading to intensified checking behaviors. Consequently, an increase in checking behaviors diminishes confidence in prospective memory and checking obsessions become more severe by the continuation of this vicious circle. Considering the role of prospective memory impairments in the persistency of compulsive checking behaviors and weakness of retrospective memory in the contamination and checking subtypes of OCD, it seems that other than the usual treatment methods, such as cognitive-behavioral therapy and Acceptance and Commitment Therapy (ACT), therapeutically techniques designed to improve memory could be advantageous to these individuals as well. One of the main limitations of this study is the limited number of samples for the different

subtypes of OCD, which could affect the generalization of the findings in a negative way.

It is suggested to use larger samples in the future studies. Another limitation of this study is excluding the severity of OCD symptoms in different subtypes of OCD which could impact on the function of memory.

We suggest that future studies also take into account the impact of severity of symptoms on the function of memory. Furthermore, more accurate tools, such as fMRI, are suggested to analyze memory problems in OCD.

Finally, considering the impairment of memory in individuals with OCD and its role in the persistence of their symptoms, we suggest the implementation of treatments focusing on recovering retrospective and prospective memory other than the usual psychological and pharmacological treatments which reduce compulsive behaviors. Besides, mobile applications designed to improve executive functions and memory can be used.

List of acronyms

MANOVA - Multivariate analysis of variance

OCD - obsessive-compulsive disorder

OCI-R - Obsessive-Compulsive Inventory-Revised

PIOS - Penn inventory of scrupulosity

PRMQ - Prospective and Retrospective Memory Questionnaire

SCWT - Stroop Color and Word Test

WAIS-IV - Digit Span Subtest of the Wechsler Adult Intelligence Scale

WCST - Wisconsin Card Sorting Test –

Y-BOCS - Yale-Brown Obsessive-Compulsive Scale

Contributions of Authors

MTY: conceptualization, writing and editing of the manuscript, statistical analysis, review and editing; MRS: review and editing, conceptualization; SJ: methodology, data collection, editing of the manuscript; TGH: writing and editing of the manuscript; TH: review and editing. All authors read and approved the final edited manuscript.

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Conflict of Interest

The authors declare they have no financial, personal, or other conflicts of interest.

Ethical Publication Statement

We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

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