

Research Paper

Working Memory, Rumination, and Autobiographical Memory Specificity Impairment



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ABSTRACT

Objectives: Specificity impairment is a memory alteration that occurs in people with major depressive disorder (MDD). In this investigation, we intended to shine a light on obscure aspects of executive resource and capture and rumination frameworks to determine whether these theories are reliable in predicting underlying mechanisms for specificity impairment.

Methods: In this correlational research, we used the convenience sampling method over two months, between January and February 2021. We administered the digit span working memory test, ruminative response scale (RRS), and autobiographical memory interview to indicate whether working memory capacity and subtypes of rumination can predict memory specificity in people with MDD. Using RRS enabled us to determine the correlation between subtypes of rumination and memory specificity.

Results: Our samples consisted of 105 adults (53 males (50.5%) and 52 females (49.5%)) with MDD. The participants' mean age was 33.38 years with a range of 22-43 years. The results no significant difference between gender, marriage, and age groups in terms of memory specificity ($P > 0.05$). The results of the Spearman correlation coefficient and multiple regression analysis showed that only working memory capacity can predict memory specificity ($r = 0.216$, $P < 0.05$). There was no significant correlation between brooding and reflection, as two subtypes of rumination and memory specificity.

Discussion: In line with our results, it should be stated that depression is accompanied by executive deficits, which result in memory impairments. These impairments are due to the structural and functional alterations in the brain in the depressed group. As the Carfax model emphasized, working memory capacity is not only required to maintain, define, and hold the optimal retrieval model but it is also crucial to inhibit interfering autobiographical information. Nonetheless, neither brooding nor reflection rumination can predict memory specificity. Therefore, memory capacity is probably occupied due to ineffective search strategies, not rumination.

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Highlights

- This investigation was conducted on depressed individuals to examine the underlying mechanisms for memory specificity impairment in this population.
- Working memory capacity was determined as a predictor of specificity impairment.
- Our results supported the credibility of the executive resource hypothesis, which in turn encourages clinical psychologists to target executive dysfunctions to address reduced specificity.

Plain Language Summary

People who suffer from depression find it difficult to remember memories in full detail. Because memories are so important for problem-solving as well as for therapeutic purposes, a growing number of researchers have investigated the causes of this problem. There are some popular ideas about the possible role of intrusive thoughts and short-term memory capacity limitation in the occurrence of this memory problem. Some psychologists argue that failure in accessing detailed memories occurs since depressed people are prone to the invasion of irrelevant information while trying to remember a memory. Other researchers maintain that this memory problem is a result of short-term memory capacity limitation. Accordingly, depressed people fail to maintain information while trying to remember memories. Our results are aligned with the viewpoint of the second group of researchers.

Introduction

The issue of specificity impairment in depressed individuals remains fiercely debated. Major depressive disorder (MDD) is a common psychiatric disorder with uncertain etiology, which is accompanied by several symptoms, such as depressed mood and loss of interest. Frequent reports exist regarding cognitive impairments in people with MDD, including executive impairments as well as attention and memory deficits [1, 2]. These cognitive impairments prevent the improvement of depression as they increase relapse episodes [3]. From an etiological perspective, shrinking hippocampus and prefrontal cortical grey matter volume result in some of these cognitive impairments [4, 5]. In depressed populations, memory and attention impairments are more prominent [6]. Mood-congruent recall, impaired memory specificity (over general autobiographical memory), and intrusive memories are three alterations in the memory functioning of depressed people, which have been frequently reported [7]. In this paper, we investigated the underlying mechanisms for memory specificity impairment. Autobiographical memory is defined as a memory system that stores our life experiences and maintains information in three levels: Lifetime periods, general memories, and specific memories. Specificity impairment occurs when individuals fail to complete the hierarchical retrieval process from lifetime periods to specific memories and retrieval is subsequently truncated prior to the activation of specific memories [8].

Specificity impairment leads to problem-solving disabilities in people with MDD [9], which in turn indicates the importance of examining underlying mechanisms for memory specificity impairment.

Executive resource framework

One proposed explanation for individual differences in autobiographical memory recall lies in the executive resource hypothesis. Conway and Pleydell-Pearce's model (2000) assumes that the limitation of working memory capacity results in reduced specificity so that executive capacity is required for model definition retrieval and maintenance, as well as to avoid the interference of autobiographical information. This assumption relies on some arguments proposed in the cognitive resource models of depression. A proposed explanation for the resource allocation model states that depressed individuals should be offered an optimal task completion strategy because they lack initiative during task execution [10]. In Conway and Pleydell-Pearce's model (2000), an efficient search description is required to map the memory space to be searched. The lack of initiative is, therefore, likely to hinder this process. Another supporting theory states that depressed individuals have inhibition problems during cognitive task performance [11]. In the capture and rumination theory, which will be discussed in the following section, it is easier to conceptualize how inhibition deficits contribute to specificity impairment.

Capture and rumination framework

In this framework, it is believed that many intermediate descriptions, which are applied to assist autobiographical memory recall are based on self-representations [12]. When people experience rumination, like people with MDD, the dominance of self-representation results in specificity impairment and truncation of retrieval. Failure in completing the retrieval process also occurs once individuals have negative self-schemas [13]. As cue words presented in the autobiographical memory test are emotional words, they activate negative self-beliefs and deter depressed people from completing the hierarchical retrieval process. The search process is compromised when people lack decent inhibition ability. In this case, emotional cue words lead to the activation and accumulation of irrelevant information raised by negative self-beliefs and consequently, result in the excessive occupation of working memory [13].

Current study

In this study, we administered the ruminative response scale (RRS) as well as the forward and backward digit span test to examine whether subtypes of rumination and working memory capacity predict specificity impairment. There is contradictory evidence for the supporting role of working memory in memory specificity [14, 15], which encouraged us to conduct the current study.

Materials and Methods

Participants

Our sample size consisted of 105 adults with MDD, 53(50.5%) males and 52(49.5%) females, referred to a psychiatric clinic in Sari City between January and February 2021 using the convenience sampling method. Each participant was informed about the study aims and procedures before the study and consent forms were signed by participants. Patients aged 20 to 45 years who met the inclusion criteria of the diagnostic and statistical manual of mental disorders, fifth edition, were included. The inclusion criterion was MDD adults aged between 20 and 45. We also established exclusion criteria, including people younger than 20 and older than 45 years old, people with comorbidity and substance use disorder, amnesic patients, and people who did not sign the consent form. For diagnosis purposes, two clinicians examined the patients and used structured clinical interviews as well as the second edition of the Beck depression inventory (BDI) to make diagnoses.

Materials and procedure

The current study is correlational research, in which we administered the following questionnaires as well as autobiographical memory interviews to collect the data. We distributed the ruminative response scale, BDI, and autobiographical memory test (AMT). Participants also performed the digit span working memory test and autobiographical memory interviews.

Beck depression inventory (BDI-II)

The second version of the self-report BDI consists of 21 items and allows one to recognize the severity of depression in adults and its items are scored on four various degrees—from low degree to intensive.

Autobiographical memory test (AMT)

The interview was used to measure the capability of retrieving specific memories in response to cue words. To clarify the feature concept, we explained to the participants that the recalled memories should be memories that happened in one day and they should try to remember the people, objects, environmental features, etc. involved in the memory.

Ruminative response scale (RRS)

RRS is a self-report questionnaire that consists of 22 items and measures the depressive mood and rumination in individuals. Each item is evaluated on a 4-point Likert scale, which allows for measuring the severity of rumination more precisely. The total score ranges from 22 to 88, with higher scores indicating higher degrees of ruminative symptoms.

Forward and backward digit span test

Short-term memory capacity was measured by the digit span forward and backward tasks from the Wechsler memory scale-revised. The two tasks were operated separately. In the digit span forward task, number sequences were presented to the patients and they were asked to repeat the numbers immediately. After every successful attempt, numbers were increased until individuals failed to repeat numbers in the same order. After two consecutive unsuccessful attempts, the test was stopped and the last sequence of numbers was considered the score for this part of the experiment. The backward section of the test required participants to recall the number sequence inversely. Measuring the backward digit span was the same as the forward digit span.

Data analysis

Initially, we recorded the demographic information and used descriptive statistics, including Mean±SD, and minimum and maximum scores to describe them. Then, to test our hypotheses, we used the Spearman correlation coefficient and multiple regression analysis.

Results

Our samples consisted of 105 adults with MDD (53(50.5%) males and 52(49.5%) females). It is also worth mentioning that our data lacked any missing values to exclude from the sample. This enabled us to enter the entire sample for analysis. To have a comprehensive demographic profile of the participants, we also took the marital status and age of the participants into account: 31 cases (29.5%) were single, 64 cases (61.0%) were married and, ten cases (9.5%) were divorced. Also, 30 cases (28.6%) belonged to the 20-29 age group, 61 cases (58.1%) to 30-39, and 14 cases (13.3%) to the 40-49 age group. The participants' mean age was 33.38 years with a range of 22-43 years.

The Mann-Whitney U test showed no significant difference between males and females based on memory specificity ($P=0.438$). The Kruskal-Wallis test indicated no significant difference between single, married, and divorced participants ($P=0.860$) as well as between various age groups in terms of memory specificity ($P=0.235$). The demographic characteristics of participants as well as the results of the Mann-Whitney U and Kruskal-Wallis tests are demonstrated in Table 1.

The descriptive statistics, including the Mean±SD and minimum and maximum values for rumination (including brooding and reflection), working memory capacity (both forward and backward digit span), and memory specificity were calculated. The results provided in Table 2 show a difference in the mean values of the subscales of rumination. The difference in the mean values also existed in the forward and backward digit span tasks. Descriptive statistics of research variables indicated that the means working memory capacity, brooding, reflection, and memory specificity scores were 7.38 ± 1.38 , 15.31 ± 2.56 , 12.51 ± 2.13 , and 2.17 ± 0.48 , respectively. Descriptive statistics of the research variables are illustrated in Table 2.

After data analyses, we tested our research hypotheses. After checking the assumptions for parametric and non-parametric statistics, including normality of distribution, the existence of outliers, linearity of the relationship, etc. We used the Spearman correlation coefficient to examine the correlation between research variables. The non-parametric statistic was performed given that the normality assumption was not met for all the research variables. This means that not all research variables follow a normal distribution and the skewness is statistically significant. The Kolmogorov-Smirnov test was used to check the normality of the data.

Our data analysis determined a significant direct relationship between working memory capacity and memory specificity ($r=0.216$, $P<0.05$). However, our analysis did not show a significant correlation between memory specificity and rumination ($r=-0.157$, $P>0.05$). To determine the correlation between subtypes of rumination and memory specificity, we also examined the correlation

Table 1. Demographic characteristics of the participants

Demographic Characteristics		No. (%)	P
Gender	Male	53(50.5)	0.438*
	Female	52(49.5)	
Marriage	Single	31(29.5)	0.860**
	Married	64(61.0)	
	Divorced	10(9.5)	
Age group (y)	20-29	30(28.6)	0.235**
	30-39	61(58.1)	
	40-49	14(13.3)	

*Mann-Whitney U test, **Kruskal-Wallis test.

Table 2. Descriptive statistics of the research variables

Measure	Minimum	Maximum	Mean±SD
Working memory capacity	5	10	7.38±1.38
Forward digit span	3	7	4.48±0.88
Backward digit span	2	4	2.87±0.68
Rumination	48	81	67.39±6.70
Memory specificity	0.9	4.5	2.17±0.48
Brooding	10	20	15.31±2.56
Reflection	8	19	12.51±2.13

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coefficient between brooding, reflection, and memory specificity. As shown in Table 3, no meaningful relationship was found between neither brooding and memory specificity ($r=0.086$, $P<0.05$) nor reflection and memory specificity ($r=-0.074$, $P<0.05$).

Multiple regression was conducted to examine how working memory capacity and rumination can predict memory specificity levels. By examining the scatter plot and linearity of the relationship, we ensured that our data met the assumptions of the model. We also checked the outliers and made sure that there were no outliers in the data. Examining the power of working memory capacity and rumination in the prediction of autobiographical memory specificity determined that only working

memory capacity could predict memory specificity and rumination could not predict our dependent variable. A detail of the regression model is demonstrated in Table 4.

Discussion

The results of our study showed that working memory capacity could predict specificity impairment in people with MDD. This is consistent with studies that demonstrated the relationship between executive deficits and specificity problems [15-18]. All these findings support the executive resource hypothesis. In line with this hypothesis, it should be stated that depression is accompanied by executive deficits, which result in memory impairments. These memory impairments are due to the

Table 3. Spearman correlation between the research variables

Memory Specificity	r	P
Working memory capacity	0.216*	0.027
Rumination	-0.157	0.110
Brooding	0.086	0.382
Reflection	-0.074	0.456

*Correlation is significant at the 0.05 level (2-tailed).

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Table 4. Multiple regression analysis summary for working memory and rumination predicting memory specificity

Model	B	Std. Error	Beta	t	P
Constant	1.805	0.530		3.408	0.001
Working memory capacity	0.097	0.033	0.279	2.945	0.004
Rumination	-0.005	0.007	-0.072	-0.756	0.451

Dependent variable: Memory specificity.

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structural and functional alterations of the brain in the depressed group. Widespread alterations occur in several brain regions, including the hippocampus, amygdala, and prefrontal cortex as regions associated with executive, cognitive, and emotional processing [19-21]. In addition, decreasing grey matter volume in the prefrontal cortex is another factor involved in executive deficits. As the Carfax model emphasized, working memory capacity is not only required to maintain, define, and hold the optimal retrieval model but it is also crucial for inhibiting interfering autobiographical information.

The credibility of the executive resource framework is pronounced by taking other executive processes into account. In other words, the cumulative effects of these executive impairments can lead to specific retrieval deficits. For instance, inhibition disability has been determined in people with MDD [22]. Any deficits in inhibiting irrelevant information during retrieval lead to the occupation of memory capacity. The lack of capacity caused by a cascade of irrelevant thoughts leads to an inefficient process of mnemonic items associated with episodes [13], which in turn leads to specificity impairment. This attentional deficit can occur at any point during the retrieval process. To have a better understanding of this process, two types of autobiographical memory retrieval should be differentiated. The retrieval of autobiographical events occurs in two ways: Direct and generative retrieval [23]. Direct retrieval happens as a result of the immediate activation of specific memories. This retrieval strategy is an effortless process that only occurs when mnemonic items that are related to the memory are accessible and when memories are not emotionally demanding. However, when one of these two conditions is not met, episodes are retrieved as a result of generative retrieval, which is a top-down process, in which memories are activated through a hierarchical retrieval pattern from the lifetime events to specific memories [14]. Given the emotional nature of the words, which are presented during the autobiographical memory test, memories are most likely recalled through generative retrieval. Therefore, inhibition problems at any stage of the generative retrieval can occur and result in a limited capacity. In our previous study, we demonstrated the relationship between inhibitory control and specificity impairment [24].

In our current investigation, we also intended to determine if subtypes of rumination can be regarded as irrelevant information, which is activated during generative retrieval. There was no relationship between either subtype of rumination and specificity impairments. Inconsistent results exist regarding the relationship between brooding and reflection rumination with specificity im-

pairment in depressed groups. While the Carfax model did not differentiate between subtypes of rumination as a predictor of specificity impairment, several investigations have demonstrated a correlation between brooding and specificity problems [25-28]. However, our results are consistent with some studies indicating no meaningful relationship between subtypes of rumination and memory specificity [29, 30]. Concerning these contradictory results, it can be concluded that the capture and rumination framework is not as credible as the executive resource hypothesis to predict specificity impairments. To conceptualize how memory capacity is occupied, we can return to the executive resource framework instead of relying on the capture and rumination theory. Working memory capacity can be occupied as a result of ineffective search strategies instead of ruminative thoughts. As described by affect-as-information theory, information is processed by either interpretive or detailed processing depending on the mood. Once a low mood is experienced, detailed processing is adopted, in which attention is divided into details instead of concepts. Conversely, when individuals experience high mood, they apply interpretive processing, in which attentional resources are devoted more efficiently and memory capacity is less likely to be occupied by irrelevant or peripheral details [31].

These results convinced us to observe reduced specificity as a result of either avoidance strategies or executive deficits. Along with the executive resource hypothesis, active avoidance can also play a part as an underlying mechanism for reduced specificity. Although depressed people are always susceptible to intrusive memories, they are typically inclined to avoid thinking about past events because they have negative interpretations of these events, which in turn enhances negative emotions (functional avoidance theory) [13]. This avoidance can result in the overgenerality of memories.

Future research can investigate the interaction of other executive functions and specificity impairment to support our results. As there is a strong interplay between attention and working memory, we encourage future researchers to examine the interplay of various types of attentional control, working memory and reduced specificity to conceptualize the underlying mechanisms for this retrieval type more efficiently and methodically.

Considering the importance of specific memories for problem-solving and treatment purposes, we highly encourage using neuropsychological treatments to improve executive functions for specificity purposes in MDD people. Our results determined the crucial role of execu-

tive capacity for memory specificity and convinced us to observe proper executive functions as a prerequisite for recalling specific memories. It is worth mentioning that we never overlooked the importance of other therapy approaches, such as cognitive behavioral therapy (CBT) or mindfulness-based cognitive therapy (MBCT) to prevent avoidance coping strategies. Our recommendation is to use the combination of neuropsychological treatments with other types of treatments, especially cognitive treatments to address specificity impairment in this population. Psychological treatments have been developed and used in Iran for patients with mental health issues [32-34]. Such treatments need to be evaluated and used for depressed patients with memory problems in the Persian context.

Conclusion

Considering our results, limited executive capacity deters depressed people from retrieving specific memories. Although rumination is a characteristic of depression, neither brooding nor reflection rumination can result in reduced specificity.

Ethical Considerations

Compliance with ethical guidelines

The study was approved by the Ethics Committee of Mazandaran University of Medical Science (Code: IR.MAZUMS.REC.1401.9319).

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Authors' contributions

All authors equally contributed in preparation of the paper.

Conflict of interest

The authors declared no conflict of interest.

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