Relationship between prospective memory and executive functions in predicting symptoms of anxiety and depression in students

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Abstract

The aim of the present research was to investigate the relationship between prospective memory and executive functions in predicting symptoms of anxiety and depression in students. Our research was applied and methodologically a descriptive correlational design. The present statistical population included all students studying in the academic year of 2013-2014 in Shiraz University; using a simple random method, we selected 250 of them as a sample. Tools used included retrospective and prospective memory questionnaires, the Wisconsin card (Problem Solving) Card sorting Test, the Continuous Performance Test (CPT), the test of Tower of London and the Depression, Anxiety, and Stress Scale (DASS-21). We used Pearson correlation coefficient and regression for the investigation. The results showed that prospective memory has a significant negative correlation with depression and anxiety at the level of 0.01. Prospective memory also explained 0.30 percent of anxiety variance and 0.43 percent of depression variance. In addition, there is a significant negative relationship between depression and executive functions of planning and the number of classes at the level of 0.01 and a significant positive relationship between depression and executive function of perseveration error at the level of 0.01. The executive function of perseveration can predict and explain 0.27% of anxiety variance and 0.43% of depression variance.

Keywords: prospective Memory, Executive Functions, Anxiety, Depression

I. Introduction

Depression is one of the most common psychiatric diagnoses that, by blocking a person's innate capacity for growth and flourishing, lead to a disorder in his or her mental health (Vojdani, Golzari, and Borjali, 2014). Its prevalence rate is higher than all other disorders and is about 17% and in the Iranian population it varies between 5.69 and 73%; this rate is 1.7 times higher among women than men (Sadeghi, Saffarinia, Sohrabi and Alipour, 2017). According to the latest estimates, more than 300 million people worldwide suffer from depression, and women are

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more likely than men involved in the disease (World Health Organization, 2018). Meanwhile, higher level of depression among students than in the general population and their poor mental health has caused global concern (January et al., 2018). According to studies, the prevalence of depression or its symptoms among students has been 51% (Kebede, Anbessie & Ayano, 2019). This disorder leads to many social, educational and functional damages in this group (Krieger, Berger & Grosse Holtforth, 2016). In Iran, studies have shown that 49% of depression is prevalent among women and 48% in men (Sarukhani et al., 2017).

On the other hand, the World Health Organization (WHO) has reported an increase in mental disorders, especially anxiety. Studies show that the prevalence of anxiety disorders in the general population is 15-35% (Vafaei, Safavi and Salehi, 2013). Anxiety is somewhat effective in dealing with adverse conditions, but high anxiety can impair a person's overall functioning. Anxiety is an unpleasant feeling and emotion caused by a person's perception of stress and physical changes in the body. Although it is part of a normal adaptive response, it is a clinical disorder when it worsens and does not fit the situation (Pine et al., 2009).

In recent years, due to the prevalence of depression and anxiety disorders, the researchers have reinterpreted and revised these disorders; they are now among the neuropsychological disorders. The data collected from clinical areas, brain electrophysiology, pharmacology and neuroimaging researches indicate the failure of some cognitive functions in the depressed and anxious patients (Molaei, 2012).

Executive functions are a set of neurological processes related to autonomy, decision-making, and purposeful behavior. Autonomy and decision-making skills are part of the neurological processes of executive functions as responsible for purposeful behavior. The development and improvement of executive functions is associated with the development of the prefrontal cortex and its integration with the centers of motivation and emotion in the inferior cortex of the brain (Maayan, Hoogendoorn, Sweat & Convit, 2011; Mueller et al., 2012). Processes such as concentration, attention, planning, controlling thoughts and behavior, organizing reasoning and memory, as the origin of the brain, are among the cognitive functions through which human beings can have intelligent activities (Shahabi, 2013). The executive functions perform their functions with the help of a series of important functions and forces such as working memory, flexibility, inappropriate response inhibition, reasoning, organizing-planning and attention. We can describe inappropriate response inhibition of executive functions as an indicator of "how" and "when" to perform normal behavioral functions (Firoozi, Ebrahimi Ghavam and Darjaj, 2011).

Researches show that depressed and schizophrenic patients have disruptions in prospective memory and retrospective memory; they also have more difficulty in imagining future events than in remembering past ones (D'Argembea et al., 2008). Engvar described prospective memory for the first. This type of memory allows the person to imagine future events. Prospective memory is also an application to describe the ability to recall future activities; in other words, it is a process in which a person "remembers the remembering" (Saed, 2010). Studies have shown that people with depression are more absent-mindedness (Wanga et al., 2008). The inability to remember names and get information about them has been a behavioral complication of depression. The anterior temporal cortex is for recovering names. Damage to the anterior temporal cortex leads to an inability to recover names (Werheid &Clare, 2007). Memory is also impaired in patients with depression (Elderkin et al., 2007).

Patients with generalized anxiety disorder also regularly experience memory problems. Such people are exposed constantly to distractions that make it impossible for them to pay proper attention to the new things they need to remember (Christopher and Katherine, translated by Gahan, 2018). In a research conducted by Issank (1992; quoted by Sheikhi, 2013), the limitation in working memory capacity (which is responsible for poor cognitive function) is a characteristic of people with high levels of anxiety. We see decentralization, absent-mindedness, and memory impairment in people with generalized anxiety disorder (Davodian, 2008). Anxiety and oversupply of information can all affect patients' ability to remember names (Christopher and Catherine; Gahan's translation, 2018).

Researchers have studied many times Depression and anxiety disorders in terms of etiology and phenomenology. In this regard, various schools of psychology have presented various theories. Identifying the various aspects of these disorders from a cognitive perspective may also lead to a revision of existing theories and perspectives and an understanding of the causes of these disorders. Therefore, the present research seeks to investigate whether there is a relationship between prospective memory and executive functions (problem solving, planning and attention) in the development of symptoms of depression and anxiety disorders. Are prospective memory and executive functions able to predict anxiety and depression?

II. Methodology

The present research was applied and, in terms of the method, a descriptive correlational design. The present statistical population included all students studying in the academic year of 2013-2014 in Shiraz University. From among these, we selected 250 using a simple random method. Tools used included retrospective and prospective memory questionnaires, the Wisconsin card (Problem Solving) Card sorting Test, the Continuous Performance Test (CPT), the test of Tower of London and the Depression, Anxiety, and Stress Scale (DASS-21). We used Pearson correlation coefficient and regression for the investigation.

Retrospective and prospective memory Questionnaire: A Short Scale of self-report made by Crawford et al. (2003) and has 16 items. We ask respondents to answer questions about the frequency of memory problems on a 5-grade Likert scale (from *always* indicating full agreement = 5 to *never* indicating complete opposition = 1). The sum of the scores obtained for each person is in the range of 16 to 80. The questionnaire includes two subscales of prospective and retrospective memory; the first 8 items measure prospective memory and the second 8 items measure retrospective memory. In examining the psychometric properties, Crawford et al. (2003) reported a good internal consistency for all three indicators of the overall score, Total score of 8 prospective items and a total of 8 retrospective scores that were 0.89, 0.85, and 0.80, respectively. The results of the confirmatory factor analysis also confirm the proposed triple pattern. In Zare et al.'s (2014) research, Cronbach's alpha for the whole questionnaire was 0.83. This indicates that the questionnaire is highly reliable.

Continuous Performance Test: Stable Attention Test is a valid test to find performance impairment for persistent attention and inhibition defects. In a series, numbers appear with a certain interval and two stimuli are determined as the target stimulus. The participant must see the numbers and press the corresponding key on the computer screen as soon as possible. The target stimulus is relatively rare and its latency is relatively short. The

variables under measurement in this test are: 1) Elimination error (not pressing the target key against the stimulus); 2) False notification error (pressing the key against the non-target stimulus) and 3) Reaction time (average response time of correct answers vs. stimulus in a thousandth of a second). In this test, the elimination error and the reaction time are associated with the lack of attention and the false notification error with the impulsivity. The speed of information processing is also associated with the average reaction time and the similarity with the change in reaction time. Researchers have used this test to measure attention deficits in a wide range of mental disorders (Nejati et al., 2012). In a study conducted by Mahmoud Aliloo, Hamidi and Shirvani (2011), the reliability coefficient of retesting in the student population with a two-week time interval was 0.81.

Wisconsin Card Classification Test: Wisconsin Card Classification Test is one of the main indicators for determining the function of the frontal lobe of the brain and the most common test for evaluating executive functions. They used this test traditionally to examine the executive functions of the brain, including set change, flexibility, problem solving, and concept formation, and the ability to overcome the tendency to repeat and stagnate. In addition, the test is an evaluator of the response rate. In this test, the participant must maintain a legal concept that he or she has learned at a stage of the experiment, and when the classification rules change, he or she must change the previous concepts. In the present research, we used the Wisconsin test computer type. The test has 64 dissimilar cards and has three components of shape (four types), number (four modes) and color (four colors). The combination of these three principles forms 64 states. The validity of this test for measuring cognitive impairment after brain injury has been more than 0.86 in Lezak's (2004) research (quoted by Nejati et al., 2012). The validity of this test for cognitive impairment following brain injuries has been above 0.86 and its reliability in the Iranian sample by retesting method was 0.85 (Naderi et al., 1994, quoted by Mahmoud Alilou, Hamidi and Shirvani, 2011).

London Tower Test: In the London Tower Test as a cognitive test used for programming ability, we ask participants to displace a set of colored beads mounted on three vertical bars for fitting with a specific goal. Participants must pass all of the beads from the first bar to the third bar by following these three rules: A) Displacing only one bead at a given time; that is, two beads should not be moved at the same time. B) A bead shall not be held on a table or in the hands of a participant while another bead is being moved. C) The third and most important rule is that a larger bead should never be placed on a smaller bead. In the computer version of this test, the beads are displayed as rings with a three-dimensional structure. This test has good structure validity in measuring the planning and organization of people. The validity of this test is acceptable and by 0.79 (Lezack et al., 2004, quoted by Nejati et al., 2013).

Depression, Anxiety, and Stress Scale (DASS-21): DASS-21 is a set of three self-measurement subscales designed to measure the negative emotional states of depression, anxiety, and stress. Each of the three subscales of DASS-21 contains 7 items. The scale of depression measures Dysphoria, Hopelessness, Devaluation of life, self-depreciation, lack of interest / involvement, Anhedonia and Inertia. The subscale of Autonomic arousal anxiety measures skeletal-muscular effects, situational anxiety, and Subjective experience of anxious affect. The stress subscale is sensitive to the level of chronic and nonspecific arousal and measures Difficulty relaxing, Nervous arousal, Being easily upset/ agitated, irritability / over-reactivity, and Impatience. Anthony et al. (1998) studied the scale for the factor analysis; their research indicates three factors of depression, anxiety and stress. The research showed that these three factors measured 68 percent of the total scale variance. The specific value of the factors of stress, depression

and anxiety in the research were 9.07, 2.89 and 1.23, respectively; the alpha coefficient for these three factors was 0.97, 0.92 and 0.95, respectively (Quoted by Gloster et al., 2008).

III. Findings

Table 1: Mean and standard deviation of the main research variables

Variables	Mean	Standard deviation	Skewness	Z K-S	Significance level
Depression	8.93	3.75	0.47	1.12	0.08
Anxiety	7.40	3.40	0.67	0.31	0.39
Prospective memory	45.62	5.56	-0.42	0.42	0.57
Planning	31.18	2.81	0.35	0.61	0.12
Stable attention	123.15	17.82	-0.31	0.54	0.38
Number of classes	3.62	2.09	-0.18	0.49	0.09
Error in perseveration	7.39	5.42	0.59	0.67	0.16

As you can see in the table, the mean and standard deviation of the research variables are visible. To examine the relationship between these variables, we embark upon examination and test. Skewness is not statistically significant in all variables (P <0.05), so the condition of normal distribution of research variables is established.

Table 2: Correlation coefficient of relationship between executive functions/prospective memory and anxiety and depression

		Stable attention	Planning	Number of classes	Error in perseveration	Prospective memory
Anxiety	Correlation	-0.09	-0.11	-0.10	0.04	-0.57
	Significance level	0.14	0.07	0.13	0.47	0.001

Depression	Correlation	-0.000	-0.18	-0.22	0.23	-0.66
	Significance level	0.89	0.01	0.001	0.001	0.001

According to the information obtained from the table, there is a significant negative relationship between depression and executive functions of planning and the number of classes at the level of 0.01 and there is a significant positive relationship at the level of 0.01 between depression and executive function of error of perseveration. We do not see a significant relationship between anxiety and any of the executive functions. In the following, we used regression to determine the role of each of the executive functions in predicting and explaining the variance of depression and anxiety. There is also a significant negative correlation between prospective memory and depression at the level of 0.01 and a significant negative relationship between prospective memory and anxiety at the level of 0.01.

Table 3: Summary of depression and anxiety prediction model based on prospective memory

Predicting variables of model	Non-standard coefficients		Standard coefficients	Statistic t	Significance level
	B	S.E.	Beta		
Constant value	51.261	0.537		95.475	0.000
Anxiety	-0.396	0.087	-0.307	-4.565	0.000
Depression	-0.649	0.100	-0.438	-6.517	0.000
Multiple regression coefficient (R): 0.695					
R-square: 0.483			Adjusted R-square coefficient: 0.478		

Based on the results of the above table, we inferred that prospective memory has a correlation with anxiety and depression by 0.695. This indicates a very strong relationship between prospective memory and anxiety and depression.

We also deduce from the adjusted R-square coefficient (equal to 0.478) that 4.7% of the variables of anxiety and depression are explainable by prospective memory. In other words, about 5% of the total variable change in the criterion depends on the predicting variables. In the table above, the standardized regression coefficient (beta) determines the relative share of prospective memory in explaining changes in anxiety and depression. In other words, prospective memory was able to predict and explain anxiety and depression. This variable explains 0.30% of anxiety variance and 0.43% of depression variance.

Table 4: Summary of depression and anxiety prediction model based on executive functions

Predicting variables of model	Non-standard coefficients		Standard coefficients	Statistic t	Significance level
	B	S.E.	Beta		
Constant value	7.662	0.695		11.032	0.000
Anxiety	-0.347	0.112	-0.276	-3.093	0.000
Depression	0.621	0.129	0.431	4.827	0.000
Multiple regression coefficient (R): 0.296					
R-square: 0.088			Adjusted R-square coefficient: 0.080		

According to the information in the table, when all the variables of the executive functions entered the equation, none of them was able to predict the criterion variable. But in predicting depression, only the variable of perseveration error was able to predict the criterion variable, and other variables were excluded from regression. According to the residual variable (perseveration), we conclude that the error of perseveration has a correlation with anxiety and depression by 0.296. This indicates a very strong relation of error of perseveration with anxiety and depression.

We also infer from the adjusted R-square coefficient (equal to 0.080) that the prospective memory explains 8% of the variables of anxiety and depression. In the table above, the standardized regression coefficient (beta) determines the relative share of the error of perseveration in explaining changes in anxiety and depression. In other words, the error of perseveration was able to predict and explain anxiety and depression, so that this variable explained 0.27% of anxiety variance and 0.43% of depression variance.

IV. Discussion and conclusion

The findings showed that there is a significant negative correlation between prospective memory and depression at the level of 0.01 and a significant negative relationship between prospective memory and anxiety at the level of 0.01. Prospective memory was also able to predict and explain anxiety and depression, so that this variable explained 0.30% of anxiety variance and 0.43% of depression variance. These findings are in line with the findings of Harris & Cumming (2003), Cuttler & Graf (2008), Kliegel & Jäger (2006), Alderkin et al. (2007), Wanga et al. (2008), Rajandram et al. (2011) and Retnowati et al. (2015).

Concerning the relationship between prospective memory and anxiety, using dual homework methods, Harris and Cumming (2003) found that participants with high anxiety perform in their event-centered tasks of prospective memory worse compared to those with lower anxiety. Kliegel & Jäger (2006) reported similar results on the performance of prospective memory in an experimental space.

About 10 percent of people with memory loss have depression. When adverse conditions are removed and human mood improves, there is a possibility of memory recurrence (Vitaker and Vedvis, translated by Sheikh Javadi, 2002). Memory is impaired in patients with depression; they regularly complain of absent-mindedness and lack of concentration (Alderkin et al., 2007).

The results of a research done by Wanga et al. (2008) showed that people with depression were mostly of absent-mindedness than normal people. The inability to remember people's names has been a cognitive complication of depression. The anterior temporal cortex is for retrieval of names. Damage to this leads to inability to recover names. The results of Firoozi et al.'s (2010) research showed that there is a significant relationship between memory and anxiety. In other words, as anxiety increases, memory function decreases. In the early stages of anxiety, patients gradually realize that their memory is not as good as before. As the disease progresses, memory problems become more severe: they become more forgetful and may even forget the names of their loved ones (Christopher and Catherine, translated by Saadat, 2010).

Depression-related disorders may be problematic in tasks that require self-initiation and controlled cognitive processing, such as prospective memory tasks (Kliegel & Jäger, 2006). In general, depressed people show more disturbances in their prospective memory. Despite retrospective memory impairment and executive function in people with depressive disorder, we can expect impaired prospective memory function in patients with emotional impairment. Time-centered prospective memory was associated with disorder in the ability to accomplish a goal in the future at a specific time, in a sample of depressed adults compared to a non-depressed sample. Non-depressed participants controlled and monitored mostly the time (Rude et al., 1999).

On the other hand, severe anxiety may impair the function of prospective memory. Harris and Cumming (2003) found that participants with high anxiety performed worse than those with lower anxiety in the event-centered prospective memory. According to various researches in this field, we can explain that the presence of impairment in prospective memory can lead to increased anxiety in the individual. When a person forgets the goals and objectives s/he has set for his/her future or is unable to remember the plans s/he has to achieve them, s/he naturally experience stress. This causes severe anxiety symptoms in the person that if the person does not stop in time, they will turn into anxiety disorders. Researches have shown that people with high levels of state anxiety perform much weakly the prospective memory tests than people with lower levels of anxiety. The results showed that state anxiety has a direct effect on the execution of prospective memory, which is independent of its effect on working memory capacity (Harris and Cumming, 2003).

Based on the findings of our research, we can conclude that dysfunction of prospective memory can predict the onset of depressive and anxiety symptoms in individuals. So we can help prevent these symptoms by helping people with prospective memory function.

Another finding of our research: there was a significant negative relationship between depression and executive functions of programming and the number of classes at the level of 0.01, and there was a significant positive relationship between depression and executive function of perseveration error at the level of 0.01. However, among the executive functions, only the executive function of perseveration was able to predict and explain depression and anxiety among students, so that this variable explained 0.27% of anxiety variance and 0.43% of depression variance. The findings of this research are consistent with some researches such as Hekmati et al. (2012), Ajilchi et al. (2013) and Molaei et al. (2014). In the case of anxiety disorder, it was consistent with Castaneda's (2010) research, but inconsistent with most ones such as Iraxinin (2006), Firoozi et al. (2011), Mahmoud Aliloo et al. (2011) and Nejati et al. (2013).

One of the explanations for the poor performance of executive functions in depressed people is that people with depression are constantly exposed to negative thoughts and unpleasant situations. In fact, depression is associated with a tendency to be preoccupied with mental health problems. On the other hand, decreased motivation and energy in depressed people makes them unable to use problem-solving skills in dealing with obstacles, difficulties and mental worries; also, due to pessimism about the future, they are not able to plan for future goals, and consequently, their ability to plan and solve problems is very low. This can lead to memory impairment and poor attention to future goals in depressed people. Of course, this causes a person to enter a vicious cycle, one side of which is executive functions and the other side is depression.

On the other hand, according to a study conducted by Belli (2012), high levels of anxiety have devastating effects on memory function and executive function in a society where older adults live. In addition, anxiety care theories have shown that people who are more anxious are more likely to be absent-minded due to concern and cognitive anxiety than those who are less anxious. As for the inconsistencies in the results of some researches with our research, we can say that most of them have been performed on samples with clinical disorders, but the samples of this research are not clinical samples and all of them are usual individuals of the society. Probably, if we had chosen clinical samples with different types of anxiety disorders, the results would have been consistent with other researches. In connection with the explanation and prediction of depression based on the error of perseveration, we can state that the error of perseveration is a score that shows the extent of the ability to solve the problem. Based on the results shown, we can conclude that the ability to solve problems is able to predict the rate of depression in individuals. In fact, when a person is able to find the right solutions to possible problems and obstacles in daily life and determine or devise compromised strategies to deal with problems, he or she will be more motivated to move toward personal goals. This creates a driving force and hope for the future and reduces the risk of depression.

Spending too much time answering questions (questionnaires and computer tests) caused fatigue in subjects. Therefore, the accuracy of answering the questions was low; this was one of the limitations of our research. On the other hand, according to the results of research, by strengthening the cognitive functions of the brain and rehabilitation interventions that will play an effective role in increasing performance and prospective memory capacity, we should help reduce the symptoms of anxiety and depression.

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