Research Paper: Comparison of Episodic Future Thinking and Working Memory in Adolescents With Internalizing Problems and Non-clinical Adolescents

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ABSTRACT

Objective: The present study aimed to compare the adolescents with internalizing problems and non-clinical adolescents with respect to their episodic future thinking (EFT) and working memory (WM). Furthermore, this study examined the role of WM in the prediction of EFT.

Methods: This cross-sectional study encompassed a population of female students studying in third grade in Azarshahr Girl's High Schools (East Azerbaijan Province) in the academic year of 2015-2016. Using multistage cluster sampling method, 40 adolescents with internalizing problems and 42 non-clinical adolescents were selected. The participants were asked to fill out the autobiographical and WM tasks and depression, anxiety, and stress scale. The study hypotheses were tested using multivariate analysis of variance test (MANOVA) and the multiple regression analysis by SPSS V. 22 at P<0.05.

Results: The results showed a significant difference between the two groups regarding WM and subscales of future specificity and future details (P<0.05). However, no significant differences were observed between the two groups regarding future fluency subscale (P<0.05). The current results also showed that working memory predicts EFT (β=-0.19; P<0.01).

Conclusion: The EFT impairment and WM deficits are associated with internalizing problems. Thus, internalizing problems are associated with cognitive dysfunction.

1. Introduction

T he most prevalent forms of adolescent psychopathology are internalizing problems (Merikangas et al., 2010) that have effective, behavioral, and cognitive components. These problems might manifest as fear, guilt, worry, anxiety, and depression. Hence, focusing on the biological, psychosocial, and cognitive foundations of these problems is imperative (Rabinowitz, Osigwe, Drabick, & Reynolds, 2016; Zahn-Waxler, Klimes Dougan, & Slattery, 2000).

Internalizing problems are often developed in adolescence and may continue into adulthood (Lösel and Stemmler, 2012; Rabinowitz et al., 2016). Risk factors for the development of adolescent mood and anxiety symptoms or disorders include parental mental health and educa-

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tion, distressed parental relationships, and being female (Daughters, Gorka, Magidson, Macpherson, & Seitz-Brown, 2013). The major risk factor for internalizing problems is female sex. During adolescence, girls exhibit more internalizing problems than boys, such as symptoms of anxiety and depression (Daughters et al., 2013). Some studies proposed that circuitry of the amygdala, striatal, and medial prefrontal cortex (PFC) regions are involved in anxiety and depression symptoms and disorders (Kerestes, Davey, Stephanou, Whittle, & Harrison, 2014).

These problems are associated with negative consequences (for example, peer rejection) (Rabinowitz et al., 2016) and may change cognitive abilities (for example, memory, thinking, and attention) (Wu, Szpunar, Godovich, Schacter, & Hofmann, 2015; Zlomuzica et al., 2014). For instance, researchers indicated that depressed and anxious individuals show changes in the episodic memories of past and future (Miloyan, Bulley, & Suddendorf, 2016; Van Daele, Griffith, Van den Bergh, & Hermans, 2014).

Individuals can use episodic memories to predict the future events. The patterns for remembering past experiences and prediction of future episodes are rather similar. Generally, the episodic memory is a system that can remember past experiences and imagine events which might occur in the future (Atance & O'Neill, 2001). Thus, Episodic Future Thinking (EFT) and episodic memory are different sides of the same coin (Dere, Pause, & Pietrowsky, 2010; Tulving, 2002). Future thinking is a vital element of human cognition ability, which distinguishes the humans from other species. EFT is the mental ability to construct the imagined future events (Atance & O'Neill, 2001). Awareness of the future emerges at the age of 3 years. When children turn into adolescence, the richness of thinking about the future increases (Gott & Lah, 2014). Previous neuroimaging studies revealed remarkable functional overlaps in the neural regions underlying remembered past events and imagined future events (for example, prefrontal, medial temporal, and parietal cortices). The observations of amnesic patients indicate that they exhibit deficits in making future episodic plans (Schacter et al., 2008; Spreng, Mar, & Kim, 2009).

The involvement of prefrontal regions in the construction of future events suggests that a combination of executive functions may contribute to this ability. One of these executive functions that might influence the EFT is Working Memory (WM) system. It presents limited information for a temporary duration that might be essential for complex cognitive operations (Baddeley, 2000). This cognitive ability during puberty and ado-

lescence improves with the growth and alteration of brain function (Blakemore and Choudhury, 2006). Anxiety (Moran, 2016), stress (Wingenfeld & Wolf, 2014), and depression (Hubbard et al., 2016) might affect the WM capacity. Hubbard et al. (2016) speculated that an increase in the depressive thoughts is associated with a decrease in the WM capacity. Kizilbash et al. (2002) revealed that anxiety symptoms (without depression) do not have any significant effect on memory, but when depression and anxiety coexist, an additional deleterious effect is detected.

Although the relationship between internalizing problems and cognitive dysfunction has been demonstrated in the adult population, only a few studies have focused on the relationship between internalizing problems and cognitive dysfunction in the adolescent population. For example, some studies have shown that adults with anxiety symptoms have a poor future thinking (Wu et al., 2015). Depressed adults also report fewer positive future events (Anderson & Evans, 2015). On the other hand, depressive thoughts have adverse effects on the WM in the adults (Hubbard et al., 2016). Also, the WM performance reduces in college students with high anxiety (Bahri, Ahmadi, & Bahri, 2015).

Since the internalizing problems are common in adolescence and might some cognitive dysfunction regarding biological and psychosocial underpinnings, the mechanism underlying these disorders develop during adolescence, and their effect on cognitive function needs to be deciphered. Most of the previous studies have been conducted in adult populations (Anderson & Evans, 2015; Hubbard et al., 2016; Wu et al., 2015). Nonetheless, studies focusing on the correlation between internalizing problems and EFT and WM in adolescents are extremely rare in Iran. To the best of our knowledge, this is the first study comparing the EFT and WM in adolescents with internalizing problems and non-clinical adolescents in Iran. Since internalizing problems are recognized as one of the most disabling disorders, especially in adolescents who are in a critical period of life, study about the etiology of such a disorder should be a priority. On the other hand, studying the effect of internalizing problems with respect to the cognitive function of adolescent girls has practical values both for schools and families. The result of the present study could be beneficial worldwide in mental health institutions, juvenile correctional centers, and female study centers.

Therefore, we assessed the EFT and WM in adolescents with internalizing problems and non-clinical adolescents. In summary, the present study aimed was to

1) identify the differences in EFT between non-clinical adolescents and adolescents with internalizing problems; 2) examine the differences in WM between non-clinical adolescents and adolescents with internalizing problems; and 3) investigate the role of WM in predicting the EFT.

2. Methods

The cross-sectional study was carried out in spring 2016. The statistical population consisted of female students studying in third grade at Azarshahr Girl's High Schools, in the academic year of 2015-2016. All participants had Turkish as their first (native) language. They did not receive any credits for participating in the study. All the participants completed the screening measures of the Depression, Anxiety, and Stress Scale (DASS) (Lovibond & Lovibond, 1995) one week before the study. Moreover, they were selected from a large sample size of 220 volunteers.

The study was approved by the local ethics committee and conducted in randomly selected six high schools in Azarshahr city. Subsequently, two classes from third grade in the selected schools were randomly recruited. All the participants were assessed individually in the school's laboratory. Participants first gave informed consent to participate in the study. After the DASS was completed, the participants were categorized into low- and high-internalizing problems groups based on the sample norms (one Standard Deviation (SD) scores above and below the mean; internalizing problems group n=40, and non-clinical group n=42). Therefore, a total of 82 students were selected and divided into two groups of adolescents with internalizing problems (M=33.28, SD=6.81) and non-clinical adolescents (M=4.12, SD=1.94). The two groups did not differ with respect to any demographic variables.

The inclusion criteria were as follows: age 16-17 year (third grade of high school) and having Turkish as their first (native) language. Any participants with a current or history of neurological or psychiatric problems in either of the groups were excluded from the study. All study procedures were compiled based on APA ethical guidelines and approved by the Ethics Committee of the University of Azerbaijan Shahid Madani. Moreover, all students involved in this study were informed about the purpose and execution of this study. Also, the general school department professionals carefully reviewed the questionnaires and tasks used in this study, and informed consent was taken from all study participants.Next, the autobiographical measures (D'Argembeau, Ortoleva, Jumentier, & Van der Linden, 2010) and the WM task (Francis, Neath, & Surprenant, 2000) were administered that lasted 25 min for each person.

For measuring autobiographical tasks, participants accomplished a series of autobiographical memory measures (D'Argembeau et al., 2010). This task consisted of fluency, specificity, and details tasks. According to the fluency task, the participants were asked to think and write about the events that might happen to them within two specified time periods in their future (within the next year and the next 5–10 years) (MacLeod & Byrne, 1996). The expected responses could be general or specific, and details were not needed. The time limit was 60 s each time to list as many general events as possible. According to the future specificity task (Williams et al., 1996), the participants were asked to imagine and write specific events that might reasonably occur to them in the future in response to cue words. They were told to generate specific events that might happen in unique place and time, lasting from a few minutes to 24 h. Sets of five cue words were selected with regards to length, the frequency of use, and imageability (Tse and Altarriba, 2007).

The participants were given 30 s to produce a specific event in response to each cue. If their first event was not specific, they were told: "Can you write about a specific event?" The future details task was adjusted from Hassabis et al. (2007). In this task, the participants were given two cues (for example, "imagine the next time you will meet a friend"; "imagine something you will do on your next vacation") and were given 60 s for each cue to generate episodic details of future events including sensory and introspective details. They were instructed to generate events that might happen in a unique place and time and last from a few minutes to 24 h. Additionally, the future events should be both reasonable and novel.

For scoring, two trained independent raters, blinded to the experimental hypotheses, scored each of the autobiographical tasks. In the future fluency task, the scoring was based on the number of events written for the future period. Finally, the two time periods for one year and 5–10 years were gathered to construct a total future fluency score (D'Argembeau et al., 2010). In the future specificity task, the scoring was based on the number of specific events produced (D'Argembeau et al., 2010) that might occur at a unique place and time and last for a few minutes to 24 h. The maximum score was 5. In the future details task, the scoring was based on six categories, including spatial reference, entity presence, sensory description, thoughts and emotions, actions, or temporal reference and adopted by D'Argembeau et al. (2010). Nonetheless, each event description secured 1 score

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for each category. The maximum score for each future event was 6. The psychometric properties of the auto-biographical task were reasonable. The reliability of the subtests of this task was reported between 0.75 and 0.91 (D'Argembeau et al., 2010). Furthermore, in the Iranian study, the Cronbach's alpha for the autobiographical tasks was obtained as 0.83. In the present study, Cronbach's alpha coefficient for the three subscales was as follows: future fluency 0.91, future specificity 0.72, and future details 0.78.

Working memory task is a reliable assessment test of Cognitive Psychology Laboratory Software (CogLab) (Francis et al., 2000). It consists of a variety of classical and current experiments that demonstrate the workings of the mind. This task consists of 18 trials. On each trial, a sequence of math problems and words appear in the middle of the computer screen. The example of a math problem is as follows: "8.2+3=6?", and the participant will be asked to read it out loud, followed by deciding whether the given answer is correct or incorrect. Then, a word will appear in the middle of the computer screen; the words and math problems will alternate. On each trial, a maximum of six sequences will appear, and at the end of the experiment, the participant will be asked to remember the order of the words. The minimum and maximum scores for WM task are 0 and 60. The validity of this test has been approved by the criterion validity and the reliability reported between 0.71 and 0.93 (Francis et al., 2000). Furthermore, in the Iranian study, the reliability index was 0.71. In the present study, the Cronbach's alpha coefficient was obtained as 0.73.

Depression, anxiety, and stress scale (DASS-21) was designed by Lovibond and Lovibond (1995) for measuring the negative emotional states of depression, anxiety, and stress. It consists of 21 questions designed based on 4-point Likert-scale (from 0=strongly disagree to 3=totally agree). This questionnaire consists of three main subscales: depression, anxiety, and stress, each with 7

questions. The Cronbach's alpha coefficient for all the three scales of depression, anxiety, and stress was 0.91, 0.84 and 0.90, respectively (Lovibond and Lovibond, 1995). The Persian version of DASS-21 was developed by Sahebi et al. (2005). The correlation of DASS-21 subscales was 0.70 between DASS depression subscale and Beck's depression questionnaire; 0.67 between DASS anxiety subscale and Zung's anxiety questionnaire; and 0.49 between DASS stress subscale and perceived stress test in Iran. In this study, Cronbach's alpha coefficient was obtained as 0.90.

The findings were entered into SPSS version 22 to analyze the data. Descriptive statistics were used to calculate the mean and standard deviation. Multivariate analysis of variance (MANOVA) test was used to compare the EFT and WM in adolescents with internalizing problems and healthy adolescents. Multiple regression analysis was used to examine the role of WM in prediction of episodic future thinking.

3. Results

Demographic characteristics were analyzed using chi-square and t-test. Non-clinical group and internalizing problems group did not differ in age and years of education. Table 1 demonstrates the mean and standard deviation of participants in the EFT subscales and WM. The mean scores of students in non-clinical group are higher than that of students in internalizing problems group in all variables.

MANOVA was used to show the difference between the groups. However, before the statistical analysis, investigating the assumptions was essential. One of the assumptions of multivariate analysis of variance was the homogeneity of covariance matrices. Based on the Boxes Test results, which showed statistical significance, the observed covariance matrices of the variables were not equal for the different levels of independent vari-

Table 1. Mean and standard deviation of participants

Variable	Internalizing Problems Group		Non-Clinical Group	
	Mean	SD	Mean	SD
Working memory	31.18	11.77	37.45	13.95
Future fluency	2.98	1.39	3.26	1.52
Future specificity	0.20	0.41	0.64	0.79
Future details	1.63	0.71	2.07	1.09

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Table 2. Results of the multivariate analysis for working memory and EFT subscales

Effect	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's Trace	0.152	3.462	4	77	0.01	0.152
Wilks's lambda	0.848	3.462	4	77	0.01	0.152
Hotelling's Trace	0.180	3.462	4	77	0.01	0.152
Roy's largest Root	0.180	3.462	4	77	0.01	0.152

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ables, including non-clinical and internalizing problems group (P<0.001, Box's M=44.97). Similarly, Levene's test was used for verifying the assumption of equality of error variances. These results confirmed the assumption of equality of error variances for all variables except the future specificity in the autobiographical task (P>0.05).

The results of multivariate analysis of variance are shown in Table 2. The Pillai's trace value was equivalent to 0.152, which was significant at the error level <0.05 and F=3.462. Therefore, the difference between the non-clinical and internalizing problems groups was significant regarding WM and subscales of future specificity and future details. Also, partial eta squared was 0.152, i.e., 0.152 of the dependent variable variance was explained by the non-clinical and internalizing problems groups.

In Table 3, the results of the multivariate analysis are presented according to the scales of the dependent variables. A difference between the non-clinical and internalizing problems groups was observed regarding WM and subscales of future specificity and future details, i.e. the non-clinical group had a higher number of accurate answers and better performance. Moreover, no significant difference was noted between the non-clinical and internalizing problems groups regarding the future fluency.

To investigate the role of WM in the prediction of EFT, we employed Pearson's correlation test. The results

showed a significant positive correlation between the total score of EFT and WM (r=0.19, P<0.01). The results of the regression equation and the overall summaries are shown in Table 4. The WM with a correlation coefficient of about 0.19 could define 4% changes in the EFT.

4. Discussion

The present study compared the adolescents with internalizing problems with the non-clinical adolescents in terms of EFT and WM.The results showed significant differences between the two groups regarding WM, subscales of future specificity, and future details; however, no significant difference was observed between the two groups regarding future fluency subscale. The current results also showed that WM predicts the EFT.

The findings support the first hypothesis. This finding is consistent with the result by Wu et al. (2015). The study demonstrated the effect of generalized anxiety disorder on EFT and showed that the healthy group spontaneously produced more detailed EFT as compared to the patient group that generated fewer vivid EFT. The findings in the non-clinical group replicated that of the previous study in the healthy individuals (Szpunar & Schacter, 2013). Consistent with this study, Stöber (2000) indicated a poor future thinking in individuals with anxiety. Other studies Anderson and Evans (2015) showed that

Table 3. Results of MANOVA for WM and EFT subscales in adolescents with internalizing problems and non-clinical adolescents

Variable	Type Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Working memory	807.33	1	807.33	4.823	0.031	0.057
Future fluency	1.68	1	1.68	0.798	0.374	0.010
Future specificity	4.01	1	4.01	10.032	0.002	0.111
Future details	4.08	1	4.08	4.792	0.031	0.057

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Table 4. Multiple regressions summary for EFT in adolescents with internalizing problems and non-clinical adolescents

	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	R	R²
	B	Std. Error	Beta				
Constant	4.38	0.49		8.93	0.000		
Working memory	0.03	0.01	0.19	2.87	0.005	0.19	0.04

Dependent Variable: EFT

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dysphoric individuals reported fewer positive events in the future and past event tasks. Additionally, Lemogne et al. (2006) indicated that depressed individuals generated more negative memories as compared to the control group that generated more positive memories. This phenomenon could be attributed to the impaired goal-directed attention in internalizing problems, and thus, reducing this kind of attention would result in lessened focus of the adolescents on future events and their details. Similarly, the findings support the second hypothesis. Moran (2016) found that anxiety was related to reduced WM, which was in agreement with the present results. According to Bahri et al. (2015), WM performance in college students with high anxiety was significantly different from WM performance in college students with low anxiety.

In anxiety conditions, the activity of the hormonal systems related to the stress is increased. One of these hormones is cortisol that influences the hippocampus-based memory performance. Cortisol hormone improves the consolidation of the memory but impairs the retrieval of memory (Wingenfeld & Wolf, 2014). According to Hubbard et al. (2016), dysphoric individuals showed cognitive deficits, such as reduced WM. If the memory deficit increased over the adolescent period with depression symptoms or comorbid depression/anxiety, it might exert significant implications in the adolescents' adaptive functioning (Kizilbash et al., 2002).

These findings also support the third hypothesis as it is consistent with the result of Hill and Emery (2013). The study showed that WM capacity contributes to the aspects of episodic future thoughts in healthy college students. Construction and expansion of future events rely on additional cognitive functions such as WM that acts as a workspace to retain information for a short period in an active state. Thus, this cognition ability contributes to the production of a clear, single, future event depiction (D'Argembeau et al., 2010).

There are several explanations for these results. During adolescence, the cognitive abilities that are needed for mechanisms of future thought begin to boost. On the

other hand, internalizing problems can affect sleeping, energy level, focus/attention, and self-image in adolescents. Also, these problems might affect the cognitive abilities such as WM. Since WM is essential for constructing the future-oriented thoughts, its deficit can be associated with future thinking impairment, i.e., WM capacity contributes to producing futuristic thinking. Hence, individuals with internalizing problems tend to generate general experiences (without much details) about the future events but not as abundantly as they might supposedly yield negative consequences. Notably, the adverse effects of internalizing problems on prefrontal regions and cognitive function, including EFT and WM, have implications for adolescents. Therefore, the present study offers additional evidence that internalizing problems may place the adolescents at risk for psychopathological and cognitive dysfunction.

In conclusion, the results of this study showed a significant difference between the adolescents with internalizing problems and non-clinical adolescents regarding WM, subscales of future specificity, and future details; however, no significant difference was observed between the two groups regarding future fluency subscale. These results also showed that WM predicts EFT. Thus, it can be said that internalizing problems might affect the cognitive abilities, suggesting significant implications for the adolescents' adaptive functioning that might cause other problems in future. Hence, the effects of internalizing problems on the brain regions responsible for high-order abilities (for example, memory and thinking) represented a potential neural pathway by these problems that placed the adolescents at risk. Due to the negative outcome associated with internalizing problems during adolescence and its critical role in cognitive dysfunction, identifying the intervention and prevention is imperative. Taken together, factors such as prevention, early identification, and intervention of adolescents' psychological dysfunctions are vital for establishing future patterns of adult health. On the other hand, cognitive empowerment programs such as WM training can be useful for improving the cognitive function, Nevertheless, this study has

some limitations. The sample consisted of adolescent students, and hence, the results for other groups should be generalized cautiously. Thus, future studies should investigate the results on both genders and various age groups, as well as, assess the relationship between internalizing problems and other cognitive components.

Overall, the present study indicated a significant difference between the two groups with respect to WM and subscales of future specificity and future details. The results also showed that WM predicts EFT. Therefore, impairment of the EFT and WM deficits are associated with internalizing problems that in turn, are associated with cognitive dysfunction.

Ethical Considerations

Compliance with ethical guidelines

All procedures performed in research involving human participants were in accordance with the local ethics committee.

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Conflict of interest

All authors certify that this manuscript has been published neither in whole nor part and is not being considered for publication elsewhere. The authors have no conflicts of interest to declare.

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