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Research Article

Examining the stress, depressive thoughts, and working memory capacities of the university students

Eid Abo Hamza[1*]& Ahmed Helal[2]

Department of Mental Health, Faculty of Education, Tanta University, Egypt and College of Graduate Studies, Arabian Gulf University, Bahrain

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Abstract

The objective of the study is to measure the capacity of the working memory, and also to investigate its relationship to life stress and depressive thoughts. The study sample consisted of 50 college students studied on Science and Art major. A cognitive task was designed to measure the working memory capacity based on the determinants found in previous research. The results indicated that there were statistically significant differences in the level of life stress events (high/low) on the task of measuring the working memory capacity. The results also showed that there were no statistically significant differences neither between genders nor between majors on the task of measuring the working memory capacity. Furthermore, the results reported that there was no statistically significant effect of the interaction of the level of life stress (high/low) and gender (male/female) on the task of measuring working memory capacity. Finally, the results reported that there were significant differences in the level of depressive thoughts (high/low) on the task of measuring working memory. The current research concludes that neither the interaction of stressful life events, gender, and academic major, nor the interaction of depressive thoughts, gender, and academic major have an effect on working memory capacity.

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Introduction

Working memory is one of those processes indicating how to preserve and process information that is essential for understanding different aspects of human cognitions. Miller (1956) claimed that working memory is targeted by an integer in a well-known paper humorously defining "the mysterious number seven plus or minus two." He showed that a sequence of no more than about seven arbitrarily arranged significant objects or bits (which could be letters, digits, or words) can be replicated again. However, other work has produced varying findings. Young adults can only recall three or four longer verbal chunks, such as idioms or short sentences (Martinez & O'Rourke, 2020; Vijay, Himanshu, 2017; Thalmann, Souza & Oberauer, 2019). Some have shrugged their shoulders, concluding that the "just depend" limit is based on the details of the memory task, but new work demonstrates where and how the cap can be expected.

Working memory is an essential element in understanding a task or cognitive activity; it is this virtual cognitive system that is responsible for entering the information required to continue in the activity, and is often what constitutes the limiting factor in the performance of this task. Despite its limited capacity, it is the system mainly responsible for attention distribution, planning, strategic choices, and thinking.

Theoretical Background

[1] * Corresponding Author: Professor, Department of Mental Health, Faculty of Education, Tanta University, Egypt and College of Graduate Studies, Arabian Gulf University, Bahrain. Email: eidhamza@edu.tanta.edu.eg ORCID: 0000-0001-5971-6757
[2] Department of Mental Health, Faculty of Education, Tanta University, Egypt. E-mail: ahelal1970@yahoo.com

On examining the literature, prior studies have tried to visualize this relationship by examining the effect of emotional substances on the working memory capacity. In the field of studying pressures or external stressful events, Goller, Banks and Meier (2020) described that working memory ability was found to be negatively associated with perceived negative life event stress and hypothesized that the relationship can be driven by ideas created from those experiences. Several studies such as Abo Hamza et al. (2020), Metz et al. (2018), and Goller et al. (2020) mentioned that the relationship between life difficulties/problems and working memory processes concluded that authoritarian ideas resulting from life problems are reflected in the efficiency of working memory processors ,whereas the results of a study by Legaa, Gidlowa, Jones, Ellisa, and Hurst, (2021) on stressors and the elements of working memory showed that an average level of stress is related to the improvement of processing elements on working memory tasks.

Gotlib, Jopling, Gotlib and LeMoult (2020) have discussed the association between psychological stress and working memory, and the results showed that stress affects the treatment of a task and the accuracy of the performance of its components. However, Lukasik, Waris, Soveri, Lehtonen, and Laine (2019) acknowledged that working memory is negatively associated with anxiety , but the same association does not exist with stress.

On the other hand, Violaa et al. (2019), and Xu, Guan, Li, Zhang & Xu (2020) realize that early life stress is linked with altered neuroimmune signaling trajectories that have cognitive development implications and negatively affect working memory. Results showed that the pressure caused a severe impact, through neurological mechanisms, on performance of the tasks of working memory. The results of the study by Banks (2011) and Abo Hamza, et al. (2020) indicated that mental questions (authoritarian ideas) constitute an intermediate variable in the relationship between stress and dysfunction on the tasks of working memory, and Metz, etal. (2018); Lukasik et al. (2019); and Legaa et al. (2021) supported the same conclusion regarding post-traumatic stressors on elements stored in working memory. Legaa et al. (2021) found that there is a weak ability to update the emotional information in working memory for a range of high pressures. Finally, Edwards et al. (2015), Petkus et al. (2017), Lukasik et al. (2019), Li et al. (2018), and Beloe & Derakshan (2019) relate that there was an effect of anxiety, depression and dysphoria on the efficiency of working memory processing and the absence of an effect of situation pressures on the processing capacity.

According to WHO (2017) , in 2015, over 300 million individuals worldwide(up to 4.4% of the world's population) suffered from major depressive disorder, a leading worldwide illness (Radell, Abo Hamza & Moustafa, 2020). Therefore, mechanisms that lead to the persistence of depressive disorders are crucially important to recognize. Jopling et al. (2020), and Gärtner et al. (2018) studied the effect of clinical depression on working memory and concluded that depression affects the distribution of sources of attention associated with the central outlet and patients with depression need to spend more efforts comparing with healthy groups.

Studies by Manelis et al. (2020), Gray et al. (2021) and Zhang et al. (2018), investigating the effect of emotional substance, such as depression, on updating the content of working memory found that there is an effect of depression on the content of working memory with the influence of authoritarian ideas. Moreover, in a study by Yoon, Le Moult and Joormann (2014) on the defective updating of the working memory content related to depression, the results concluded that depressed patients have difficulty in removing information that is not related to the task from the content of the memory. The studies by Hubbard et al. (2015) and Jopling et al. (2020) on depressive thinking and limited working memory capacity express an association between high depressive thinking and the speed of information processing in working memory. The same studies state that there is a strong influence of depressive thinking on working memory and that ruminants of depression constitute an intermediate variable in the relationship between depressive thinking and performance on the tasks of working memory.

Lukasik et al. (2019) indicated that working memory is a limited capacity system and is responsible for the active retention and processing of information necessary to carry out complex, cognitive tasks and functions such as thinking, learning, understanding, and problem solving. Li et al. (2018) and Legaa et al. (2021) indicated that working memory is a system of limited capacity reflecting the temporary activation of perceptions that constitute the content of consciousness. Furthermore, all of the definitions of working memory have agreed that it is a component of the utmost importance compared to the rest of the other elements of the cognitive system. Lukasik et al. (2019) emphasized that the dysfunction of working memory affects an individual's ability to understand, code, and retrieve information, perform complex cognitive tasks, and speak logically, and many studies have agreed that working memory is a central mechanism in conducting basic cognitive activities, including planning - life is difficult without all of these abilities.

van Abswoude, Buszard, van der Kamp & Steenbergen (2020), Thalmann et al. (2019), and Cansino et al. (2018) pointed to factors that can lead to an increase in the working memory capacity and the presence of differences in capacity between individuals, as some of these factors were classified into strategic factors, such as repeated training and the number of chunks, and non-strategic factors, such as the processing speed and perseverance in the face of the confusing elements.

The Current Study and Research Hypotheses

The current study is an attempt to examine the effect of some external stimuli (stressful life events) and internal stimuli (depressive thoughts) on the capacity of the working memory system. This study is focused on the capacity of working memory in storage and processing which should be studied in the clinical context. The cognitive tasks such as thinking, being attentive, and gaining academic achievement are only completed through the ability of the working memory. Therefore, working memory is deemed to be the main component of intelligent behavior. Consequently, understanding the way this system works is worth studying. The implications for understanding the process of human cognitions support positive changes for healthy psychological development. The scientific understanding of the interaction of clinical and cognitive variables can be used on the development of psychotherapy programs for clinical variables. Studying working memory is a necessary element for self-organization related to decision-making and behavior towards goals. There is an apparent scarcity of Arabic studies, dealing with the variables of the current study. The study pointed out that time is not a sufficient factor to influence the work of working memory. Based on the previous theoretical foundation, research suggests the following study hypotheses.

H1: There are significant differences supported by statistical evidence between the average scores of the high and low stressful life event groups on the process of measuring the working memory capacity.

H2: There are significant differences supported by statistical evidence between the average scores of males and females on the process of measuring the working memory capacity.

H3: There are significant differences supported by statistical evidence between the average scores of the arts major group and the science major group (in Egypt's high school system) on the process of measuring the working memory capacity.

H4: There is a statistically proven effect on the interaction between the level of pressure in life (high/low) and gender (male/female) on the process of measuring the working memory capacity.

H5: There is a statistically proven effect on the interaction between the level of stressful life events (high/low) and the study group major (science/arts) on the process of measuring the working memory capacity.

H6: There is a statistically proven effect on the interaction between gender (male/female) and the study group major (science/arts) on the process of measuring the working memory capacity.

H7: There is a statistically proven effect on the interaction between the level of stressful life events (high/low) and gender (male/female) and the study group major (science/arts) on the process of measuring the working memory capacity.

H8: There are significant differences between the average scores of participants having depression and negative thoughts (high/low) on the process of measuring the working memory capacity.

H9: There is a statistically proven effect on the interaction between the level of depressive thinking (high/low) and gender (male/female) on the process of measuring the working memory capacity.

H10: There is a statistically proven effect on the interaction between the level of depressive thinking (high/low) and the study group major (science/arts) on the process of measuring the working memory capacity.

H11: There is a statistically proven effect on the interaction between the level of depressive thoughts (high/low), gender (male/female), and the study group type (science/arts) on the process of measuring the working memory capacity.

Method

Participants

The study sample consisted of 50 participants from College of Education students – Tanta University in Egypt – from all four academic standings (freshmen, sophomores, juniors, and seniors) from the arts and sciences majors in the second semester of the year 2018/2019.

Table 1.

Descriptive Statistics of Sample

Major /Gender	Sciences	Arts	Total
Male	13	12	25
Female	13	12	25
Total	26	24	50

Data Collection Tools and Procedures

The study used the following assessments and procedures:

The Process of Measuring the Working Memory

A cognitive task was designed and prepared to measure the capacity of the working memory based on the variables found in previous studies, which stated that cognitive tasks are the best measures to determine the functions and capacity of the working memory. The purpose for measuring the capacity here was to determine the maximum number of elements that can be remembered and recalled in the working memory and that was done by measuring the main functions of the working memory, i.e. stopping, diversion, and updating, which are the functions of the central executive. Task description;

The task consisted of two experimental conditions, which were:

- Recalling of numbers
- Processing of letters

A facial emotional stimulus was introduced along with the two experimental conditions.

The First Experimental Condition

This condition was concerned with recalling numbers, and consisted of number chains varying from the simple to the more complicated, starting from two numbers all the way up to ten numbers. Every number chain was presented in a blank cell, as follows:

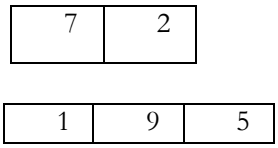

Figure 1.

Experiment Card

The card was presented to the person for a time interval that increased in line with the amount of numbers presented on the card, so the card that contained two numbers was displayed for two seconds with the time increasing by one second for each number added to the sequence, until the final card was reached, which was displayed for 10 seconds. After displaying each card, a facial emotional stimulus (sad face icon) representing depressed or stressed facial features was displayed for 3 seconds. This emotional stimulus acted as a provoking factor.

After displaying the card with the number sequence and then the photo, the person was asked to recall the number chain previously displayed, and they were allowed a number of seconds equal to the number of numbers displayed on the cards. For example, the card that contained five numbers was allocated a time interval of 5 seconds for recall.

Calculating the Results

The person was given one mark for every correct number they managed to recall.

The Second Experimental Condition

This condition was concerned with processing letters and it consisted of two cards. One card contained three letters, such as (O, G, T), for example, and the other card contained rows of letters, each of which may or may not have included the previously displayed letters. The three letters on the first card were displayed to the person for 3 seconds followed by a picture of a sad face for 3 seconds. The person was then asked to cross out on the second card the letters that were present on the first one, within a time interval of 10 seconds. This second condition aimed to determine the processing speed of the central executive, which consists of stopping, diversion, and updating as follows:

Stopping: one's ability to stop crossing out letters that did not appear on the first card.

Diverting: one's ability to divert attention from the stimulus that has no connection to the task (the letters that did not appear on the first card).

Updating: replacing the letters seen on the first card with the letters on the second card, which acts as a confusing factor. If the person did not complete the task within the 10 second time interval, the test was stopped.

Calculating the results

The examinee was given one mark for every letter that was crossed out. The total score was calculated by adding the result of the first and second test to make up the final result of measuring the working memory

Validity and Reliability of the Task

Validity; the task's validity was calculated by following the method proposed by Al-Zoghbi (2016), who used a calculated cognitive task with almost the same steps to measure functions of the working memory. The correlation among the validation sample (N=50) was r = 0.71, which indicates a high degree of validity.

Reliability; the reliability of the task was calculated in several ways: test-retest for a sample size of 50 with a time interval of two weeks, and by using Cronbach's alpha and Guttmann's assessment methods.

Table 2.

Reliability factors for the process of measuring the capacity of the working memory

Reapplying test	Cronbach's alpha	Guttmann's assessment
0.74	0.722	0.6911

Assessment of Stressful Life Events

The assessment used (Shokair, 2013) consisted of 70 statements that presented possible stressful life events. Participants indicate their level life events stress on a Likert scale of 4 points ranging from 1 ("often", "sometimes", "rarely", or "never", describing the person's feeling regarding that stressful life event. The scoring was carried out ("3", "2", "1", or "0" respectively) and the total possible score of the test was 210. The assessment dimensions, with the associated statements numbers, were as follows:

Family pressure (1, 8, 15, 22, 29, 36, 43, 50, 57, 64)
Economic pressure (2, 9, 16, 23, 30, 37, 44, 51, 58. 65)
Academic pressure (3, 10, 17, 24, 31, 38, 45, 52, 59, 66)
Social pressure (4, 11, 18, 25, 32, 39, 46, 53, 60. 67)
Emotional pressure (5, 12, 19, 26, 33, 40, 47, 54, 61, 68)
Health pressure (6, 13, 20, 27, 34, 41, 48, 55, 62, 69)
Personal pressure (7, 14, 21, 28, 35, 42, 49, 56, 63, 70)

The validity was confirmed through internal consistency by calculating the correlation coefficient between the total score and the score of the sub-dimensions, with the following results: Family pressure 0.63, Economic pressure 0.58, Academic pressure 0.93, Social pressure 0.84, Emotional pressure 0.84, Health pressure 0.71, and Personal pressure 0.66. These were all significant correlation coefficients at the 0.05 level. The reliability of the assessment was also calculated test-retest with a time interval of 21 days on two administrations (r = .72). Therefore, the assessment was reliable enough to be used in the current study.

Validity Assessment

The assessment validity was calculated by calculating the criterion validity of the test using the "Facing daily stressful life events" method (Abdul Salam, 2008), which is an assessment conducted to measure daily stressful life events through various dimensions. The correlation coefficient between individuals' scores was 0.68, indicating high validity.

The assessment validity was revalidated in several ways: including test-retest on the same validating sample (N=50) with a time interval of two weeks, as well as calculating reliability using Cronbach's alpha and Guttmann's assessment methods to each of the assessment's dimensions.

Table 3.

Stress coefficient for stressful life events (n=50)

Test-retest	Cronbach's alpha	Guttmann's assessment
0.76	0.7712	0.71

Depressive Thoughts Assessment

The assessment aimed to measure depressive thoughts or cognitive dimensions of major depressive disorder or what is also known as "rumination of depression." After reviewing the literature regarding depressive thoughts, 18 statements were rephrased and assembled to make up this assessment considering the local culture. Participants indicate their level of depression on Likert scale of 5 points ranging from 1 (never) to 5 (always) and 4 statements (1, 2, 3, 17, 18) have reversed scoring.

Validity

The validity of the assessment was conducted using vocabulary validity, by calculating the correlation coefficient between the score of every item and the total score of the assessment after deleting that item's score from the total mark; the correlation coefficient here indicates the validity of every single item, using the same validating sample (N=50). The results of this test are shown in table (4).

The researcher calculated the validity of the current assessment (face validity of the vocabulary) by finding out the correlated correlation coefficient between the degree of each individual and the total score of the scale after deleting the individual score from the total.

Table 4.

Correlation between Items

Depressive thoughts assessment			
Item number	**Correlation coefficient**	**Item number**	**Correlation coefficient**
1	0.6307	10	0.4511
2	0.4213	11	0.6125
3	0.3001	12	0.5112
4	0.2801	13	0.7242
5	0.3115	14	0.3180
6	0.4117	15	0.2917
7	0.718	16	0.6512
8	0.5316	17	0.7401
9	0.7531	18	0.6315

Reliability

Assessment reliability was calculated in the following ways: test-retest with time interval of two weeks, and also calculating the reliability coefficient using the Cronbach's alpha and Guttmann methods. After validating the psychometric properties of the study assessments, these assessments were applied on the main study sample. Then statistical analysis was carried out, based on the hypotheses of the current study.

Table 5.

Realibility Test Results of Depressive Toughts Test

Reapplying test	**Cronbach's alpha**	**Guttmann's assessment**
0.82	0.6819	0.7415

Results

To test the study hypotheses, a three-dimensional variance analysis was performed. Tables (6) and (7) show the results of the variance analysis of the stressful life events (high/low), gender (male/female), type of specialized study (science/arts), and level of depressive thoughts (high/low) on the individual's scores on the process of measuring the capacity of the working memory.

Table 6.

Descriptive Statistics of Students' Stress Level

Variable	**Sum of squares**	**Degrees of freedom**	**Average of squares**	**F-test**
Stressful life events (high/low)	931.548	1	931.548	21.602*
Gender (male/female)	34.806	1	34.806	0.807
Major category (science/arts)	6.197	1	6.197	0.144
Stressful life events × gender	18.171	1	18.171	0.421

Stressful life events × major category	0.727	1	0.727	0.017
Major category x gender	73.267	1	73.267	1.699
Stressful life events × gender × major category	103.968	1	103.968	2.411
Error	1811.208	42	43.124	-

*Function

There are no significant differences between the average scores of the science and arts groups on the process of measuring the capacity of the working memory. There is no significant difference of the interaction between stressful life events (high/low) and gender (male/female) on the process of measuring the capacity of the working memory. There is no significant difference on the interaction between stressful life events (high/low) and major category (science/arts) on the process of measuring the capacity of the working memory.

There is no significant difference on the interaction between gender (male/female) and major category (science/arts) on the process of measuring the capacity of the working memory. There is no significant difference on the interaction between the stressful life events (high/low), gender (male/female), and the major category (science/arts) on the process of measuring the capacity of the working memory.

Table 7.

Three-Way Variance Analysis of the Level of Depressive Thoughts, Gender, and Major Category on the Individual's Scores on the Process of Assessing the Capacity of the Working Memory

Variable	Sum of squares	Degrees of freedom	Average of squares	F-test
Depressive thoughts level (high/low)	103.345	1	103.345	25.548*
Gender (male/female)	43.168	1	43.168	0.841
Major category (science/arts)	5.088	1	5.088	0.125
Depressive thoughts × gender	12.072	1	12.072	0.297
Depressive thoughts × major category	2.554	1	2.554	0.063
Major category x gender	9.540	1	9.540	0.235
Depressive thoughts × gender × major category	78.258	1	78.258	1.927
Error	1705.342	42	40.603	-

*Function

There are no significant differences between the average scores of males and females on the process of measuring the capacity of the working memory.

There are no significant differences between the average scores of the science and arts groups on the process of measuring the capacity of the working memory.

There is no significant difference on the interaction between the level of depressive thoughts (high/low) and gender (male/female) on the process of measuring the capacity of the working memory.

There is no significant difference on the interaction between the level of depressive thoughts (high/low) and the major category (science/arts) on the process of measuring the capacity of the working memory.

There is no significant difference on the interaction between gender (male/female) and the major category (science/arts) on the process of measuring the capacity of the working memory. There is no significant difference on the interaction between the level of depressive thoughts (high/low), gender (male/female), and major category (science/arts).

H_1: There are significant differences between the average scores of the high and low stressful life event groups on the process of measuring the capacity of working memory.

Table 8.

Descriptive Statistics of the High and Low Stressful Life Event Groups on the Process of Measuring the Capacity of Working Memory

Group	n	Average	Standard deviation
High stressful life events	25	18.400	8.602
Low stressful life events	25	9.840	3.619

Table 8 illustrates the significant differences of the level of stressful life events (high/low) on the process of measuring the capacity of the working memory thereby making the hypothesis acceptable.

H_2: There are significant differences between the average scores of males and females on the process of measuring the capacity of the working memory.

Table 9.

Descriptive Analysis of the Scores of Males and Females on the Process of Measuring the Capacity of the Working Memory

Groups	n	Average	Standard deviation
Males	25	14.00	8.109
Females	25	14.24	7.463

Table 9 shows that there are no significant differences between the average scores of males and females on the process of measuring the capacity of the working memory. Thus, this hypothesis is rejected.

H_3: There are statistically significant differences between the average scores of the science major group and the arts major group on the task of measuring the capacity of the working memory.

Table 10

Descriptive analysis of the scores of the scientific and arts groups on the process of measuring the working memory

Groups	n	Average	Standard deviation
Science	26	12.808	7.93
Arts	24	15.542	7.38

It is clear from table (10) that there are no statistically significant differences between the scores of the science and arts group. Therefore, this hypothesis is rejected.

H_4: There is a statistically significant effect of the interaction between the level of pressure in life (high/low) and gender (male/female) on the task of measuring capacity of the working memory.

Table 11.

Descriptive statistics of the interaction between the level of stressful life events (high/low) and gender (male/female) on the task of measuring the working memory capacity

	High stressful life events		Low stressful life events	
Gender	**Males n=14**	**Females n=11**	**Males n=11**	**Females n=4**
Average	10.00	9.637	19.909	17.857
Standard deviation	3.496	2.582	9.670	7.999

Table 11 indicates that there is no statistically significant effect of the interaction of the level of stressful life events (high/low) and gender (male/female) on the task of measuring the working memory capacity. As a result, this hypothesis is rejected.

H_5: There is a statistically significant effect of the interaction between the level of stressful life events (high/low) and the study group major (science/arts) on the task of measuring the working memory capacity.

Table 12.

Descriptive Statistics Of The Interaction Between The Level Of Stressful Life Events And Study Group Major On The Task Of Measuring The Working Memory Capacity

	High stressful life events		Low stressful life events	
Major	Science n=17	Arts n=8	Science n=9	Arts n=16
Average	10.000	9.500	18.111	18.562
Standard deviation	3.602	3.207	11.374	7.023

According to table (12) there is no statistically significant effect of the interaction of the level of stressful life events (high/low) and the study group major (science/arts) on the task of measuring the working memory capacity. Accordingly, this hypothesis is rejected.

H_6: There is a statistically significant effect of the interaction between gender (male/female) and the study group major (science/arts) on the task of measuring the working memory capacity.

Table 13.

Descriptive Statistics for Male And Female Scores in Science and Arts on the Task of Assessing the Working Memory Capacity

		Males	Females
Science n=26	Mean	13.231 (n=13)	12.385 (n=13)
	Deviation	9.355	3.051
Arts n=26	Mean	14.833 (n=12)	16.250 (n=12)
	Deviation	6.820	8.125

As table (13) reported , there is no statistically significant effect of the interaction between gender (male/female) and the study group major (science/arts) on the task of measuring the working memory capacity. Therefore, this hypothesis is rejected.

H_7: There is a statistically significant effect of the interaction between the level of stressful life events (high/low), gender (male/female), and the study group major (science/arts) on the task of measuring working memory capacity.

Table 14.

Descriptive Statistics of Stressful Life Events for Males and Females from the Science and Arts Majors on the Task of Measuring the Working Memory Capacity

		High stressful life events		**Low stressful life events**	
		Males	Females	Males	Females
Science	Mean	10.00 (n=1)	10.00 (n=7)	24.00 (n=3)	15.167 (n=6)
	Deviation	3.496	2.582	15.621	8.841
Arts	Mean	10.00 (n=4)	9.00 (n=4)	17.250 (n=8)	19.863 (n=8)
	Deviation	2.8284	3.9158	7.046	7.220

According to Table 14 there is no statistically significant effect of the interaction between the level of stressful life events (high/low), gender (male/female), and the study group major on the task of measuring the working memory capacity. As a result, this hypothesis is rejected.

H_8: There are statistically significant differences between the average scores of people having depression and negative thoughts (high/low) on the task of measuring working memory capacity. According to Table 7 results, there are statistically significant differences between high and low depressive thoughts on the task of measuring the working memory capacity.

Table 15.

Descriptive statistics for high and low levels of depressive thoughts on the task of measuring the working memory capacity

Group	**N**	**Average**	**Standard deviation**
High depressive thoughts	25	9.440	2.551
Low depressive thoughts	25	18.800	8.327

It is clear from Table (15) that there are differences between the levels of high and low depressive thoughts. Accordingly, this hypothesis has been accepted.

H_9: There is a statistically significant effect of the interaction between the level of depressive thinking (high/low) and gender (male/female) on the task of measuring the working memory capacity. According to table (7) that there is no statistically significant effect of the interaction between the level of depressive thinking (high/low) and gender (male/female) on the task of measuring the working memory capacity.

Table 16.

Descriptive statistics of male and female high and low depressive thoughts on the task of measuring the working memory capacity

	Depressive thoughts level		**Gender**	
	High (n=25)	Low (n=25)	Males (n=25)	Females (n=25)
Average	9.440n	18.800	14.000	14.240
Standard deviation	2.551	8.327	8.109	7.463

Table 16 shows that there is no statistically significant effect on the interaction between the level of depressive thoughts (high/low) and gender (male/female) on the task of measuring working memory capacity. As a consequence, this hypothesis is rejected.

H_{10}: There is a statistically significant effect on the interaction between the level of depressive thinking (high/low) and the study group major (science/arts) on the task of measuring the working memory capacity. Table (7) indicates that there is no statistically significant effect on the interaction between the level of depressive thinking (high/low) and the study group major (science/arts) on the task of measuring the working memory capacity.

Table 17.

Descriptive Statistics of High and Low Depressive Thoughts from the Science and Arts Majors on the Task of Measuring the Capacity of the Working Memory

	Depressive thoughts level		Gender	
	High (n=25)	Low (n=25)	Science (n=26)	Art (n=24)
Average	9.440	18.8000	12.808	15.542
Standard deviation	2.551	8.327	7.930	7.372

Table 17 reflects that there is no statistically significant effect on the interaction between the level of depressive thoughts (high/low) and the study group major (science/arts) on the task of measuring the working memory capacity. Consequently, this hypothesis is rejected.

H_{11}: There is a statistically significant effect on the interaction between the level of depressive thoughts (high/low), gender (male/female), and the study group type (science/arts) on the task of measuring the working memory capacity**.**

Table 17 indicates that there is no statistically significant effect on the interaction between the level of depressive thoughts (high/low), gender (male/female), and the study group type (science/arts) on the task of measuring the working memory capacity.

Table 18

Descriptive statistics of males and females with high and low depressive thoughts from the scientific and arts specialties

		High depressive thoughts		Low depressive thoughts	
		Males	Females	Males	Females
Science	Mean	9.2222 (n=9)	10.2500 (n=8)	22.2500 (n=4)	15.8000 (n=5)
	Deviation	2.635	2.493	13.226	9.731
Arts	Mean	9.800 (n=5)	7.333 (n=3)	19.818 (n=7)	18.00 (n=9)
	Deviation	2.490	2.517	9.119	7.903

According to Table 18 there is no statistically significant effect on the interaction between the level of depressive thoughts (high/low), gender (male/female), and the study group type(science/arts) on the task of measuring the working memory capacity. Consequently, this hypothesis is rejected.

Discussion

It is proposed that the result regarding the first hypothesis is in line with definitions of the working memory in the literature, in that it is a system with limited capacity that presents a workspace for the other elements in the cognitive system to keep the information and process it. This system is made up of several elements, the most important of which is the central executive. It is the element responsible for the many important functions concerned with processing information, including stopping, diverting, and updating, and is responsible for dealing with the cognitive demands of a task. When an external burden is placed on the working memory, such as stressful life events, this burden leads to a dysfunction in the work of the central executive. These results also show that stressful life events require more space to be processed than the space available in the working memory, which has a limited capacity of 7±2 (approximately 5 to 9 chunks of code).

From a biological point of view, it is possible that the available elements fail because the task requires a high degree of extended activation, which places a burden on the working memory. Several studies such as Beloe & Derakshan (2019), Metz et al. (2018), Viola et al. (2019), Lukasik et al. (2019), and Manelis et al. (2020), and Gray et al. (2021) all stated that it would be biologically costly to have a working memory capacity larger than the one already available in which to process burdens, or excessive stimuli, that are not connected to the task. Fenn and Hambrick (2012), and Xie, Berry, Lustig, Deldin, & Zhang (2019) acknowledged that the capacity of the working memory is affected by fatigue or sleep deprivation, which can result from stressful life events; these events represent

a source of threat, which is the main element in anxiety disorders, thus leading to an increased burden on the working memory.

This result agrees with the model of Beloe & Derakshan (2019) where stressful life events lead to increased work of cognitive perceptions, which creates a burden on the limited capacity of the working memory. Also, stressful life events ease the access and entry to the working memory of controlling ideas associated with these events, thus using up the limited resources of the working memory and affecting the sources of attention as one of the cognitive inputs affecting information processing. This result is consistent with the studies of Goller et al. (2020), Xu et al. (2020) and Zhang et al. (2018), who explained that high levels of pressure are connected to a change in the capacity of the working memory, and also with the study of Blasiman and Was (2018) who stated that pressure level instructions are related to fluctuations in the level of capacity of the working memory.

Moreover, the study by Adams, Nguyen and Cowan (2018) showed that the difference in individuals' perception of stress and the difference in their knowledge assessment lead to differences in the level of working memory capacity. Pe et al. (2013) and Zhang et al. (2018) indicate that psychological stress affects performance on working memory tasks, explaining that pressure affects individuals' ability to update information in the working memory. However, this result disagreed with the result of the study by Edwards et al. (2015) who note no any effect of pressure on the capacity of processing information in the working memory.

Regarding the second hypothesis, as shown in these results, the working memory is one of the elements of the human cognitive system, and it is available to all of mankind (ie. males and females). It is the necessary component for performing cognitive processing of information, and the differences that occur in the working memory system may be due to reasons other than the difference in gender, such as the structural defect that occurs in the nervous system underlying the performance of the working memory system, or due to reasons specific to the context, such as cultural and social factors. Therefore, the assumption of differences in the performance of working memory due to gender might be related to the social and cultural context in which males and females are raised. A context having higher life stress events influences the performance of working memory by directly affecting the capacity available for retention and processing. This result is consistent with the results of studies by Adams et al. (2018), Lukasik et al. (2019), and Blasiman and Was (2018).

Results regarding the third hypothesis is attributed to the fact that the science and arts academic content does not affect the performance of the working memory. All academic curricula offered within universities are purely exam oriented, such as providing tools to assist memorization, and working towards the exam itself, which measures retrieval. They are only brief curricula that do not require the student to plan procedures, but rather are aimed at the student's automatically blind processing that retrieves specific information and then retains it as a result of its continuous repetition in the content of working memory (memorization and repetition). This result is also due to the cognitive style of students, who are accustomed from the beginning of the educational system to memorizing, and memorizing only, and the final mark is their ultimate goal. There are no differences in the type of procedure used. The important part is only to retrieve the information and write it in the examination paper. Therefore, the type of major is subject to society's philosophy of education, which is that the exam and the grade are the priority. This result contrasts with the result of a study by Wilding et al. (2007) who express that science students showed more difficulty in the tasks of retrieving words than arts students.

The result for fourth hypothesis can be attributed to the fact that gender (male/female) is an element that does not affect the performance on the tasks of measuring the working memory capacity because it is a basic function that exists in the human species, and that context factors are the biggest influence, but the effect of context factors here is subject to the principle of individual differences. The result is consistent with Unsworth and Robison (2020) regarding this hypothesis and is specific to the study sample in terms of characteristics, conditions of application, and the tools used. It is possible that this result differed in the different samples due to differences in age and characteristics, especially with the previously known impact of stressful events on the working memory capacity, as well as the absence of gender impact on the working memory capacity.

The results for fifth hypothesis can be attributed to the effect of stressful life events on the working memory capacity as a situational component that actually affects the working memory capacity, while at the same time being subject to the principle of individual differences (Unsworth & Robison, 2020) in the study samples, in terms of age and demographic characteristics, and the tools used to measure the variables. As for the effect of the academic major, it is an authentic cultural factor, especially as society has only one philosophy for all academic disciplines,

which is exam grades, and therefore only one side of the working memory is activated, which is memorization and retrieval.

Regarding the sixth hypothesis, this result can be attributed to specific factors related to individual differences. Gender was an ineffective variable because the working memory system is present in all humans with its limited capacity in both males and females. Regarding to the academic major, it is related to the curricula and education system activating just one of the elements of the knowledge system, as they focus on memorization. With regard to seventh hypothesis, this result is attributed to the influence of the level of stressful life events related to the individual differences of the study samples (Unsworth & Robison, 2020). The result of the current study might differ if it was conducted on another sample, with different age and demographic characteristics, but the gender result (male/female) is logical because the working memory system is present in the human species as a whole and the differences that occur between males and females might be due to attitude or context factors, rather than gender. This result is consistent with the results of Cansino et al. (2018), and Beloe & Derakshan (2019) as for the effect of the academic major, it is also a cultural influence in a society whose educational system is concerned with activating only one aspect of the working memory, i.e. related to memorization and retrieval, with the sole aim of exams and grades.

Additionally, the result for eighth hypothesis can be attributed to the depressive thoughts that constitute the cognitive component of depression, leading to a dysfunction in the three functions of the working memory (stopping/diversion/updating) and thus individuals' inability to stop information not related to the task from entering their working memory or individuals' inability to replace old information with new information related to the task, and individual's inability to convert negative variables to other positive or neutral ones. Depressive thoughts affect the vocal circle, which is one of the elements of the working memory, due to the state of fear associated with these ideas, and therefore affect internal verbal activity (self-talk). Lukasik et al. (2019) indicated that the effect of depression on one of the subsystems in the working memory, the "discoverer of happiness", which is a system that organizes the relationship among a complex set of stimuli found in the environment, and helps to evaluate options with positive and negative characteristics in our lives. Therefore, it helps us to accurately visualize the negative and positive stimuli, and reach quick and final conclusions regarding the stimuli in order to make a sound and correct decision. The presence of depressive thoughts leads to difficulty in weighing the conflicting characteristics among the stimuli, and a difficulty in the evaluation resulting from an individual's inability to cope with the semantic elements required for this evaluation. As a result of research of Baddeley (2013); Gärtner et al. (2018), Noreen, Cooke and Ridout (2020), an individual who suffers from depressive thoughts will be considered to suffer from:

- Difficulty in measuring equivalence between negative and positive stimuli.
- Weak ability to distinguish between options already stored.
- Lack of sensitivity in detecting any change in the previous equivalence levels.

Furthermore, hypotheses from nine to eleven have been rejected. The resulting symptoms of depressive thoughts, as discussed above, lead to the depletion of the knowledge sources of working memory and thus constitute a burden on the working memory because the difficulties facing the discoverer of happiness system in assessing environmental stimuli lead to more rumination of depressive ideas, which leads to further burden on the work of cognitive abilities. This result is consistent with the findings of Noreen et al. (2020), Adams et al. (2020), and Zhang et al. (2018) associating depression with defective elements of working memory and confirm that depressed patients have a problem in controlling the working memory content. This result also agrees with the results of Jopling et al. (2020) who show that depression affects the distribution of sources of attention associated with the central executive of working memory, and a study by Yoon et al. (2014) showing that patients with depression have problems removing information unrelated to the task from the content of working memory. Further, the result also agrees with the findings of Hubbard et al. (2015), Gärtner et al. (2018) who state that there is a correlation between a high degree of depression and limited working memory capacity, and with the findings of Hubbard et al. (2016) showing a relationship between ruminants of depression and performance on working memory tasks.

Conclusion

There is an agreement between the studies and models in the theoretical framework, which state the existence of an effect of external emotional stimuli (such as stressful life events) and internal stimuli (such as depressive thoughts)

on the amplitude of working memory, and the results of the current study, which determined the existence of this effect, especially in the first and eighth hypotheses. The maxim of the mutual influence between emotional elements and working memory capacity was not affected by gender. The mutual effect between emotional elements and the working memory capacity was not affected by the difference in the academic majors (science/arts), and the reason was considered to be a cultural factor related to the type of curricula, and the way students activate the working memory.

Finally, the general conclusion is that there is a mutual and strong relationship between our cognitive system, represented here in the working memory, and our emotional system, represented in the variables of stressful life events and depressive thoughts.

Clinical Implications

The current study recommends the following:

- Giving attention to the elements of activating the working memory in the context of the educational process in general, whether in the context of parenting or in the context of education within the school, and in the context of the interaction between teachers and students, as it is the most important component of the educational system in influencing intelligence, learning, and abilities.
- Paying attention to the presentation of the academic curricula, whether at school or university, taking into account the limited capacity of the working memory, by presenting the curricula in the form of chunks, packages, or groupings where the elements of a curriculum subject are organized in a coherent and logical way. This is especially the case in university curricula for a subject, where it was noticed that most are presented randomly, in unregulated and unorganized university notes, thus placing a cognitive burden on students' working memory.
- Activating the role of psychological counseling centers within universities to help deal with stressful life events and depressive thoughts among university students, which constitute a burden on the working memory capacity according to the results of the current study.
- Reflecting a major improvement in the perception of diminished forgetting in depression and also indicating that instruction in working memory could be a promising intervention to enhance stressed people's capacity to prevent unwelcomed memories from coming to mind as supported by Noreen et al. (2020).
- Reflecting a major improvement in the perception of diminished forgetting in depression and also indicate that instruction in working memory could be a promising intervention to enhance stressed people's capacity to prevent unwelcomed memories from coming to mind as supported by Li et al. (2019).

Limitations

The study has potential limitations, we used small random from university study which put limitations for the ability of generalizability of results. Additionally, the assessments that have been used in the two experiments should be computerized. Furthermore, we were supposed to start by examining the relationship between working memory capacity and depression and stress, not depressive thoughts and stressful life events.

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