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# Effect of Relaxation Training on Working Memory Capacity and Academic Achievement in Adolescents

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**Abstract**

In an experimental study 40 girl students of 7th grade were selected using random cluster sampling from one middle school in Tehran and divided into test and control groups by random assignment. Initially they were assessed by working memory capacity test (Daneman & Carpenter, 1980). Then, the test group through 12 educational sessions (one hour sessions, 3 sessions per week) was taught relaxation techniques, and it is noteworthy that no education was given to a control group. Upon completion of educational sessions, both test and control groups were assessed again with the working memory capacity test. In the case of the academic achievement, the Grade Point Average (GPA) of the first semester for pre-test and the GPA of the second semester for post-test were used. Multivariate analysis of covariance showed that relaxation training increase working memory capacity and its components, storage and processing, and academic achievement. Therefore, relaxation training is a useful technique for student progress.



*Keywords*: Relaxation, Working Memory, Academic Achievement, Adolescents.

## 1. Introduction

Working memory as a part of the mental system which has responsibility for data processing and interim storage needed for complicated cognitive activities like learning, understanding and reasoning. Working memory focuses not only on data storage and processing, but also on the active manipulation and using the data (Daneman & Carpenter, 1980). Many surveys have shown that high capacity of working memory helps individuals to utilize more cognitive resources and improve their learning skills (Daneman & Carpenter, 1980; Mousavi, Low, & Sweller, 1995). Many studies showed the significant relation between reading and working memory capacity (Daneman & Carpenter, 1980), reading comprehension (Daneman & Merikle, 1996), mathematics performance and verbal arithmetic (Bull & Scerif, 2001), learning sciences (Johntson & El-Banna, 1986) and scholastic aptitude (Turner & Engle, 1989). These studies also demonstrate a close relationship between the low scores in

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working memory and poor performance in all fields of education. According to these findings as well as meta-analysis studies (Daneman & Merikle, 1996; Akerman & Beier, 2005) it could be inferred that working memory affects cognitive competence resulted from processing requirements and necessary storage for solving mental issues (Hoffman & Schraw, 2009) and enjoys considerable predictive power in measuring many cognitive functions (Unsworth & Spillers, 2010) and educational progress.

According to many models of working memory, attention and working memory are closely linked. The models also reveal that the predictive power of working memory capacity is mainly determined through attentional abilities. Attentional control as a main element in the basic theory of data processing (Atkinson & Shiffrin, 1986) relates to the central administration of working memory (Baddeley, 1986). Most of the recently conducted surveys agree on the importance of attentional control in the implementation of different kinds of standard tasks of working memory including separating components of processing and storage.

According to the theories of working memory capacity based on attentional control, attentional control abilities are considered as the main differentiating elements of personal differences in terms of working memory capacity in addition predictive power of working memory capacity in performance (Kane & Conway, 2007). In accordance with this theory those with high capacities of working memory who possess more attentional control abilities could manage to store data in chaotic conditions more active than those with low capacities of working memory (Unsworth & Spillers, 2010).

Attention is considered as one of the important and influential factors in academic achievement alongside general intelligence (Mayes & Calhoun, 2007). Attention plays an intermediary role in turning potential abilities of student to function and achieving academic achievement (Barkley, 1988).

Anxiety is among those factors that could disrupt attention. The Attentional Control Theory (ACT; Eysenck, Drakshan, Santos, & Calvo, 2007) resulted from theoretical development of cognitive psychology can lay the groundwork for this issue ACT is the developed form of the Processing Efficiency Theory (PET; Eysenck & Calvo, 1992) which had been used in the literature relevant to the relationship between anxiety and function. The theory states that anxiety has no direct impacts on cognitive abilities, rather affects processing efficiency that is employed in undertaking cognitive tasks. While PET predicts the impact of anxiety on the general efficiency through data processing, ACT discloses special attentional procedures of this process. Indeed, the main hypothesis of the ACT states that in anxiety-inducing situations, more attentional resources are allocated to identify threatening stimuli (Eysenck et al., 2007).

It could be concluded that to avoid the destructive effects of anxiety, some measures need to be taken. Relaxation use as an effective method to reduce anxiety and including two different techniques, i.e. deep breathing and muscle relaxation have proved to be effective in relieving anxiety and increasing concentration of children and adults on their tasks at hand (Zuercher-White, 1998; Paul, Elam, & Verhulst, 2007). Deep breathing is a relaxed abdominal breath that maintains a balance between levels of the carbon dioxide and oxygen gases in the body (Nassau, 2007). In this kind of breathing, inhale and exhale carry out through the nose and the mouth, respectively which create a good feeling and relieves physical symptoms of anxiety (Zuercher-White, 1998). The objective of the method and its expected outcomes need to be elaborated in the training session. Another technique, i.e. Progressive Muscle Relaxation (PMR) is a process that reduces physical aspects of anxiety by making the person aware of his anxious feelings (Nassau, 2007). PMR is a technique for alternately tensing and relaxing large muscles. It usually starts with the muscles over head and neck and ends with the muscles of the lower body and legs, and vice versa (Larson, Ramahi, Conn, Estes, & Ghibellini, 2010).

The aim of this study is included to improve the working memory capacity and the academic achievement by the relaxation training in adolescents.

## 2. Method

### *2.1. Procedure*

Initially, one of the middle schools of Tehran was chosen by random cluster sampling. Then, 13 years old 40 students were screened by using two factors including Daneman and Carpenter test (Daneman & Carpenter,

1980) and the Grade Point Average (GPA) of the first semester. The GPA was considered as the pre-test. The students were divided into the two groups of 20-students as the test group and the control group according to simple random sampling. Then, the test group participated in relaxation training course for 12 sessions (one hour session, three times a week). It was followed by asking both groups to take a working memory test for the second time. For academic achievement, the GPA of the second semester was considered as the post-test in both of the groups. Finally, the results were statistically analyzed.

### *2.2. Measures*

#### *2.2.1. Working memory test of Daneman and Carpenter (1980)*

According to the Baddeley and Hitch`s definition of working memory, Daneman et al. (Daneman & Carpenter, 1980; Daneman & Tradif, 1987) extended a series of dual-tasks that needed synchronous data storage and processing. The dual-tasks included in the processing and the memory tasks. However, the method of processing task in reading-span dual task is reading a several sentences but the memory task is recalling the last word of each sentence. Routinely, in the reading-span dual task 27 unrelated sentences that are finished with the different words.

However, the method of processing task in reading-span dual task is reading a several sentences but the memory task is recalling the last word of each sentence. Generally, in the reading-span dual task 27 unrelated sentences that are finished with the different words and they are divided into 6 levels and each including 2-6 sentences. There are 2,3,4,5,6 and 7 sentences in the levels of 1 to 6, respectively. The examiner reads the sentences of the each level, then after 30-60 second the participant has a fortune to record the last word of the each sentence and to sign the true and false of the sentences in the answer sheet. According to this trend, the examiner finishes all of the levels and the Working Memory Capacity (WMC) of that participant is recorded.

The correlation of this test with the verbal aptitude test is 0.59, with special comprehensive tests such as actual questions is 0.72, and with indicate the pronoun test is 0.90 (Daneman & Carpenter, 1980). Reliability coefficient was 0.88, one pilot study has been done on eighty four students (Asadzadeh, 2004).

## 3. Results

Table 1. Descriptive statistics for working memory capacity, storage, processing and academic achievement.

| Variables | Test group | | | | Control group | | | |
|---|---|---|---|---|---|---|---|---|
| | Pre test | | Post test | | Pre test | | Post test | |
| | Mean | Sd* | Mean | Sd* | Mean | Sd* | Mean | Sd* |
| Working memory capacity | 37.58 | 10.73 | 47.67 | 9.34 | 39.24 | 10.95 | 36.46 | 10.56 |
| Storage | 32.21 | 10.13 | 45.18 | 9.73 | 33.88 | 11.16 | 31.47 | 11.55 |
| Processing | 42.95 | 13.13 | 50.84 | 13.02 | 44.62 | 11.86 | 41.47 | 10/98 |
| Academic achievement | 15.54 | 2.22 | 16.94 | 1.73 | 15.35 | 2.11 | 15.11 | 2.27 |

*Sd. = Standard deviation

As it is seen in Table 1, post-test scores of the test group have increased in the whole variety of working memory, storage, processing and academic achievement.

Table 2. Multivariate Analysis of Covariance (MANCOVA) for variables and groups

| Effect | Value | F(4,31) | P < | effect size |
|---|---|---|---|---|
| working memory capacity | 0.702 | 3.292 | 0.023 | 0.298 |
| Storage | 0.480 | 8.387 | 0.001 | 0.520 |
| Processing | 0.324 | 16.150 | 0.001 | 0.676 |
| academic achievement | 0.096 | 73.066 | 0.001 | 0.904 |
| Group | 0.467 | 8.847 | 0.003 | 0.533 |

Note: F values gained by Wilks` Lambda.

As it is observed in Table 2, omission of pre-test effect causes a significant difference of $P < 0.05$ in working memory and its components (storage and processing) as well as academic achievement between the test and control groups. The means show that this significant difference has resulted from increasing post-test scores of the test group. Effect sizes of working memory, storage, processing, academic achievement and group are 0.298, 0.520, 0.676, 0.904 and 0.533 respectively. The Cohen's guidelines (1988) introduced 0.01, 0.06 and 0.14 as the small, medium and large effect sizes, respectively, and show the major impact of training on the variables. The table also pinpoints academic achievement as the most affected variable.

## 4. Discussion

The findings of this research and relevant tables reveal that relaxation training and exercises have led to a significant increase of working memory capacity and its components (storage and processing) as well as academic achievement at in $P < 0.05$. The findings help verify the research hypotheses. Our results are in agreement with the reported studies about the relaxation on working memory. The results of research are in consonance with many studies that addressed the impact of relaxation on working memory (Hirokawa, 2004; Hudetz, Hedetz, & Reddy, 2004), storage (Riding, Grimley, Dahraei, & Banner, 2003; Hopko, Ashcraft, Kenneth, Ruggiero, & Lewis, 1998; Reinecke, Rinck, & Becker, 2008) processing (Derakshan & Eysenck, 1998; Ashcraft & Kirk, 2001; Wood, 2006) and academic achievement (Keogh, Bond, & Flaxman, 2006; Fonseca, Cury, Fakra, Rufo, Poinso, Bounoua, & Huguet, 2008; Curtis, 2009).

Relaxation training paves the way for improving the capacity of working memory by relaxing tense muscles and reducing anxiety. Many researches showed that the working memory capacity decrease with the increase of the anxiety (Mayes & Calhoun, 2007; Wood, 2006). The ACT explains that anxiety decreases a working memory capacity needed for the task in hand and disrupts its function by paying attention to threatening stimuli and involving central executor. Relaxation could enhance the capacity of the working memory and improve its function by helping individuals avoid sources of anxiety and notice to the task.

According to the current theories as well as many conducted researches there is a negative and significant relationship between the level of anxiety and storage. By allocating capacity of the storage component of the working memory to its own stimuli, anxiety either discharges other stimuli and data or restricts the capacity and avoids the flow of new data to the working memory. Relaxation eliminates extra and disruptive anxiety-inducing stimuli from the storage component of the working memory and leaves the room for the new data.

Some researchers have reported the presence of a negative relationship between the processing and the level of anxiety. Meanwhile, many findings are evidence of the basic role of the central executive system and the working memory in the processing of complicated cognitive data. PET predicts that those with high levels of anxiety tend to make more efforts and demonstrate lower levels of processing efficiency in comparison with the people who display low levels of anxiety. This is shown through lengthier response time. Relaxation reduces anxiety and improve processing.

Significant increase of academic achievements as a result of relaxation training has been proved by many studies. It is certain that anxiety decreases the performance of the individuals particularly in those tasks that require high abilities. This is because anxiety disrupts the learning process by exhausting the required energy. PET assumes that stressful situations add to the worry of those individuals who face high levels of anxiety.

Eysenck and Calvo studied those researches that showed high levels of anxiety would help individuals keep a watchful eye on the actual or potential threats (Daneman & Tradif, 1987). This in turn shifts selective attention from the task in hand to the threats and increase preparedness for interference and confusion. Consequently, information retaining and processing as well as educational performance are adversely affected. Relaxation reduces tension, relieves anxiety, switches attention from threatening environmental stimuli to the current task, widens the scope of attention and increases concentration on the task. Relaxation also improves educational performance by investing the energy released from anxiety in the task and studying. To extend the obtained results, it is suggested that this investigation carry out for both of the girls and boys in the different school levels.

In conclusion, this research revealed that relaxation training is a useful technique that not only reduces anxiety but also improves working memory capacity and academic performance in students. Therefore, relaxation training programs are offered to schools.

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