International Journal of Innovation and Research in Educational Sciences
Volume 2, Issue 4, ISSN (Online): 2349–5219

Investigating Effect of Working Memory Training on Reading Performance in Students with Reading Disorders

Keivan Kakabaraee*, Karim Afsharinia, Nabi Bostan , Mokhtar Arefi
Department of Psychology, Kermanshah Branch, Islamic Azad University, Kermanshah, Iran
Email: keivan_k76@yahoo.com*

Abstract **– Reading problem is one of basic problems in students with learning disability. So that children who couldn't read, definitely they wouldn't be successful in school setting. For being successful in schools, students need to have sufficient working memory. In this quasi experimental research, researchers investigated effect of working memory training on reading performance in 2nd and 3rd grade students who have reading disorders. This research was conducted in Iran, Kermanshah. The sample of this research consisted of 15 students with reading disorder (as experimental group) and 15 students without reading disorder (as control group). In this experimental design, statistical sample were selected by purposeful sampling. They have been promoted by working memory intervention. Working memory training software (Persian version) was used for improving working memory. Instruments included, reading and dyslexic test (Nouri, Moradi & Akbari, 2005), and Wechsler intelligence scale for children. Data were analyzed by ANCOVA and MANCOVA methods. Results show that there was significant difference between pre and post test scores. It means working memory intervention was effective on reading performance. As well as using working memory improvement leads to enhancement of chaining word, rhyming word, naming pictures, text comprehension, understanding words, deleting phoneme and evaluating letter cues. Totally this program leads to improving dyslexic student's performance.**

Keywords **– Reading Disorders, Working Memory, Reading Performance.**

I. INTRODUCTION

Working Memory is a system to save and process information temporarily through a series of complex cognitive tasks. (Ullman et al, 2014; Cowan, 2013; Baddeley, 1992, 2010; Vasile, 2012). Working memory plays an important role in thinking, calculation, understanding, implication, learning, and reading (Baddeley, 1992; Melby-Lervag & Hulme, 2013). Working memory has a key role in learning activities of students (Janacsek & Nemeth, 2013). Working memory also handles information rather than saving it, and this create complex cognitive skills (e.g. reading and learning strategies) and finally create knowledge and plays an important role in development of childhood and obtaining new skills in children (Arjmandnia et al, 2012; Gathercole, 2006; Arjmandnia & Seifnaraghi, 2009). Thus, understanding the role of working memory in learning and other cognitive activities and also proper usage of learning strategies help students to learn better and more (Schweppe & Rummer, 2013; Cowan, 2013).

Reading is a basic skill in all educational successes and helps students in receiving and understanding new information and concepts, and it is a main facto for development of children (Johnson et al, 2010; Sen, 2009). Not only reading promotes life skills and knowledge, but it plays an important role in growth of emotions, ethics, and speech intelligence (Tahar, 2010).

Dyslexia is a special disorder in reading that is not resulted from general cognitive hurts, sensuous defects, or insufficient training. In other words, dyslexia related with reading problems and spelling words (Vasic et al, 2008). In dyslexia, progress in reading is lower than the expected level significantly by Individual Balanced Test and by considering age, intelligence, and training (Kaplan & Sadock, 2009). Dyslexic students have problems in most lessons. Although they have natural intelligence, they have not desirable progress. They educate hardly or they leave education, which follows social, economic, cultural, and emotional-mental (Sen, 2009).

Dyslexic children have little chances for success (Taanila et al, 2014; Seifnaraghi & Naderi, 2010). Also, their failure to read in first years of primary school affects learning other lessons (Taannila et al, 2014; Sen, 2009). If these failures repeat, they affect their self-esteem and self-ideal and this, in turn, affect their educational progress, which creates a void succession. Therefore, identification and training these persons are very important in each education system. Nearly, reading is the main problem of 75% of persons with learning disabilities. A group of researchers believe that more than 25% of failures in primary school come from reading problems (Abedi & Aghababayi, 2010). About 8-15% of students experience reading problems (Peng, 2013). Outbreak of dyslexia in boy students is 3-4 times of that in girl students (Taanila et al, 2014). Outbreak of dyslexia among Iranian primary students is 10% (Sedaghati et al, 2009).

On the other hand, human has always noticed importance of learning. Multiple researches about learning show that most our behaviors are effects of learning. Since many our behaviors are learned, study of learning principles and methods is very important. Also, since there is a close and mutual relation between learning principles and educational method, educational method will become more effective in pace of increment of our knowledge about learning processes (Hergenahan & Olson, 2006).

Performance and ability of working memory is an important factor for efficiency of learning (Smith & Ayres, 2013; Den, 2008, Nevo & Breznitz, 2013; Gathercole et al, 2006). Weakness of working memory has close relation

with developmental language disorders such as dyslexia (Peng, 2013; Vasic et al, 2008; Brambati et al, 2006). Dyslexic children usually have problems in preserving information related with working memory, and this can affect speech training (Vasic et al, 2008).

On the other hand, audiotory perception problems relate with learning disorders. Some children cannot distinguish between sounds of different words and syllabuses and even peripheral sounds (e.g. telephone ring). These problems come for defects of audiotory separation. Persons with learning disorders have problems in audiotory blending, audiotory memory, and audiotory association. Audiotory blending is ability of a person to integrate audiotory information as they are heard. Persons with audiotory blending problems cannot integrate different parts of words that they hear. Some students have problems in audiotory memory. In other words, they cannot memorize information they hear. Defects in audiotory association because a person cannot process heard information. Obviously, defects in each above mentioned processes affect teach (Groth et al, 2009).

Generally, findings of various researches have shown that dyslexic children have weak memory performances (Peg, 2013; Vasic et al, 2008; Brambati et al, 2006; Swanson & Alexander, 2010; Berninger et al, 2008; Brooks et al, 2011; Heim et al, 2008). Regarding to the mentioned topics about memory, and learning and dyslexic problems, this research studies the effect of working memory amplification training programs on reading performance improvement of dyslexic children.

II. METHODOLOGY

Giving the reading and dyslexia tests on dyslexic children in learning disorders centers in Kermanshah, students with dyslexia were selected as sample and they were assigned into two control and experimental groups (pretest step). Then, the experimental group participated in 10 sessions (1/5 hours) of working memory program:

Session 1: Triple numbers, letters and pictures were read for the students. Then they were asked to repeat them directly.

Session 2: Triple numbers, letters and pictures were shown to the students. Then they were asked to repeat them reversely.

Session 3: Quadruple numbers were read and shown to the students. Then they were asked to repeat them directly and reversely.

Session 4: Quadruple pictures were read and shown to the students. Then they were asked to repeat them directly and reversely.

Session 5: Quadruple letters were read and shown to the students. Then they were asked to repeat them directly and reversely.

Session 6: Quintuple numbers were read and shown to the students. Then they were asked to repeat them directly and reversely.

Session 7: Quintuple pictures were read and shown to the students. Then they were asked to repeat them directly and reversely.

Session 8: Quintuple letters were read and shown to the students. Then they were asked to repeat them directly and reversely.

Session 9: Sextet numbers were read and shown to the students. Then they were asked to repeat them directly and reversely.

Session 10: Sextet letters and pictures were read and shown to the students. Then they were asked to repeat them directly and reversely.

Then post-test step was executed on two experimental and control groups.

III. INSTRUMENTS

1- Reading test and dyslexia:

This test is provided by Kormi Nouri and Moradi (2005) for students of 1st to 5th grades of mono-language primary school and bi-language students of Sanandaj -Tabriz including 10 subtests. The alpha coefficient of the test is 0/82. (Kormi Nouri & Moradi, 2005).

2-Wechsler Intelligence scale for children (WISC-R):

The intelligence scale of Wechsler includes 12 sub-tests, 6 verbal tests and 6 non-verbal (performance) sub-tests. The WISC-IV provides scores that represent intellectual functioning in four specified cognitive domains: Verbal Comprehension, Perceptual Reasoning, Processing Speed and Working Memory. The WISC-IV also provides a Full Scale IQ score measuring general intellectual ability. This scale has been standardized by Shahim in 2006 in a 1400 people sample (Shahim, 2006). The reliability of the retest- test is 0.94 (moderate 0.73) to its description 0.42 to 0.98 (0.69) were reported in this regard. Validity of the test using score correlation with non-verbal part in Wexler scale for primary school children was 0.74 obtained (Shahim, 2006).

IV. RESULTS

For investigating assumptions such as variance homogeneity in reading and auditory memory span, researchers used Levene's test for variance homogeneity. Results showed that variances were homogeny. (Auditory memory span: F=1/37, P<0/25; reading: F=0/02, P<0/78).

Table 1: Result of ANCOVA for posttest scores between experimental and control group (auditory memory span)

Source of changes	Sum of squares	df	Mean of squares	F	Sig.	Eta square
Pretest	2/84	1	2/84	11/57	0/002	0/30
Between group	12/03	1	12/03	4/03	0/002	0/64

Above table results show that with controlling pretest role on dependent variable, effect of independent variable (working memory software) on auditory memory span is significant.(F= 4/03,p>0/002).

MANCOVA was used for comparing reading subscale pretest and posttest scores in experimental and control groups. Result of hottling test is statistically significant (F= 12/60; P<0/001). This means that there is significant difference between two groups. For finding these difference needs to MANCOVA that is presented in next table.

Table 2: Result of MANCOVA for posttest scores between experimental and control group (reading)

Source of changes	Sum of squares	df	Mean of squares	F	Sig.	Eta square
Reading words	1534/61	1	1534/61	12/52	0/001	0/62
Word chaining	1146/87	1	1146/87	14/57	0/001	0/44
Rhyme	1204/22	1	1204/22	9/51	0/006	0/34
Naming picture	903/99	1	903/99	8/76	0/008	0/32
text comprehension	460/70	1	460/70	3/30	0/08	0/15
Understanding words	373/21	1	373/21	6/34	0/02	0/26
Deleting sounds	472/48	1	472/48	8/85	0/008	0/33
Reading non-words	12/89	1	12/89	0/52	0/48	0/02
letters cues	521/21	1	521/21	26/83	0/001	0/59
category cues	109/20	1	109/20	0/99	0/33	0/05

The results of covariance analysis shows that there are significant differences between posttests of experimental and control groups for variables of reading words, word chaining, Rhyme test, naming pictures, text comprehension, understanding word, deletion of sounds, and letters cues. This means that intervention for improving these sub-scales had a significant effect.

Table 3: Result of ANCOVA for posttest scores between experimental and control group (total score of reading)

Source of changes	Sum of squares	df	Mean of squares	F	Sig.	Eta square
Pretest	149274/12	1	149274/12	90/76	0/001	0/77
Group	101724/74	1	101724/74	61/85	0/001	0/69

As you see in table1, results show that with controlling pretest role on dependent variable, effect of independent variable (working memory software) on auditory memory span is significant.(F= 4/03,p>0/002).

One-way covariance analysis was used to study the effect of intervention on total reading marks of dyslexic students. After examination of pretests of this test, covariance analysis results showed that there was a significant difference between two groups (p<0.001). This means that intervention on total reading scores had a significant effect (table 3).

V. Discussion and Conclusion

The goal of this research is studying effectiveness of working memory training strategies on improvement of reading skills of dyslexic students. To achieve the goals, data was analyzed by covariance analysis method. The results showed that working memory enforcement training programs improve components of reading words, word chains, rhythm test, naming pictures, text comprehension, understanding word, deletion of sounds, and letters cues in dyslexic students. Also, the results showed that working memory enforcement programs generally improve performances of dyslexic students.

Various researches show that working memory training strategies improves reading (including comprehension, reading, phonetics recognition) of dyslexic students. The results of covariance analysis in this research showed that intervention in working memory improve reading skills of dyslexic students. The results of this research are compatible with previous ones (Sachzi & Swanson, 2001; Heland et al, 2001; Mirmahdi et al, 2009).

To interpret these findings, we can say that since working memory is necessary for learning, obviously its malfunction can brings learning disorders. Memory and reading have close interactions. Lack of capacity of working memory or weak organization of long memory may create reading problems. Working memory is a noticeable area of memory to learn reading. Working memory provides encoding, processing and registration of information. Learning to read and perception of reading both rely on working memory. Working memory affects ability of preserving data in mind for a certain moment and activates long memory during reading. Disorders of working memory prevent construction and perception of long sentences. This problem may come from limited or slow working memory while reading. When reading skills become stronger, phonemic working memory would become automatic. If phonemic working memory is automatic, there will be more space for working memory to understand words.

Norman (1990) emphasized on relationship between learning, memory, and performance. He equals learning enhancement with memory, because interpreted experiences act according to existing schemes (Hergenhan & Olson, 2006). Regarding to the cognitive theories and findings of this research, learning will be successful if one is familiar with mind functions and memory mechanisms and learn correct learning and studying methods.

Findings of different researches have shown that dyslexic children have weak performances of working memory. Working memory is an important cognitive

process that is infrastructure of thinking and learning. Successful learning is a function of capacity of working memory. This memory plays roles in learning disorders and dyslexia. Researches show that capacity of this memory can be increased by training. Brain activity related to working memory will be increased after training. Interventions include training related strategies for this memory (Abedi & Aghababayi, 2010).

According to the previous researches, it is concluded that dyslexic children have problems in their working memory; and training can enforce this memory, and this, in turn, can improve educational performance. Regarding to the effect of training on improvement of reading skills of dyslexic students, it is concluded that working memory training is an infrastructure skill to learn reading.

One of the limitations of this research is not selection of subjects randomly. Limited number of learning disorders clinics limits selection of subjects, and this caused comparison of subjects by their sex and base was not possible. Subjects of this research were student with reading disability. However, extending the results to learning disabilities such as mathematics and writing must be cautious. It is proposed that structure of working memory, its components, its role in learning, and its improvement methods will be trained in in-service training courses of teachers.

At the end we appreciate the support of Department of Science and Technology of Islamic Azad University of Kermanshah which provided us facilities to complete this research.

RESOURCES

[1] Abedi, A. & Aghababaee, S. (2010).efficacy of instructing working memory on improving academic performance in children with LD. *Journal of Clinical Psychology, 4*, 8, 73-81.

[2] Arjmandnia, A. A. , rKakabaraee, K Afrooz G A (2012). The effect of rehearsal strategy on the performance of dyslexic students working memory. *Procedia - Social and Behavioral Sciences 46*. 2620 – 2624

[3] Arjmandnia, A. A. & Seif Naraghi, M. (2009).effect of rehearsal on working memory performance in dyslexic students. *Journal of Behavioral Science*, *3*, 3, 173-178.

[4] Baddeley, A. (1992). Working memory. *Science*, 255, 556–559.

[5] Baddeley,A. (2010).Working memory. *Current Biology*,*20*, 136–140.

[6] Berninger, V.W.,Raskind,w.,Richards,T., Abbott, R.,& Stock, P. (2008).A multidisciplinary approach to understanding developmental dyslexia within working memory architecture: Genotyoes, phenotypes, brain, and instruction. *Developmental Neuropsychology, 33*(6), 707-744.

[7] Brambati, S. M., Termine, C., Ruffino, M., Danna, M., Lanzi, G., Stella, G (2006). Neuropsychological deficits and neural dysfunction in familial dyslexia. *Brain Research, 11*, 13(1), 174–185.

[8] Brooks, A. D., Berninger, V.W.,& Abbott, R. D. (2011). Letter naming and letter writing reversals in children with dyslexia:Momentary inefficiency in the phonological and orthographic loops of working memory. *Developmental Neuropsychology, 36* (7), 847-868.

[9] Chostelidou,D. (2012). Reading skills development among Greek tertiary education students: principles and practice of an experimental intervention. *Procedia - Social and Behavioral Sciences 46.* 1395 – 1400

[10] CowanN(2013).Working Memory Underpins Cognitive Development, Learning, and Education. *Educational Psychology Review, 13*, 92 – 99

[11] Gathercole, S. E., Alloway, T. P., Willis, C., & Adams, A.-M. (2006). Working memory in children with reading disabilities. *Journal of Experimental Child Psychology, 93*, 265–281.

[12] Groth, K., Lachmann, T., Riecker, A., Muthmann, I., Stei nbrink, C. (2009). Developmental dyslexics show deficits in the processing of temporal auditory information in German vowel length discrimination.

[13] Heim, S., Tschierse, J. Amunts, K., Vossel, S., Wilms, M., Willmes, K.,Grabowska, A., Huber, W.(2008) Cognitive subtypes of dyslexia. *ActaNeurobiol. Exp. 68*, 73 –82.

[14] Hergenhan, B. R. & Olson, M. H. (2007).*Introduction to learning theories*. Translate to persian by Seif, A. A. 1385).Tehran: Douran

[15] Johnson T. E.; Archibald T N; Tenenbaum G (2010). Individual and team annotation effects on students' reading comprehension, critical thinking, and meta-cognitive skills. *Computers in Human Behavior 26*, 1496–1507

[16] Kaplan & Sadock (2009).*Summery of Psychiatric*.(translate to persian by Rezaee,F.1388).Tehran: Arjmand.

[17] Kormi Nouri R. & Moradi A. R. (2005). *Test of reading and dyslexia*. Tehran: Jihad Ddaneshgahi University, Tarbiat Moallem Branch.

[18] Melby-Lervåg M, Hulme C (2013). Is Working Memory Training Effective? A Meta-Analytic Review. *Developmental Psychology*, *49*, (2), 270–291.

[19] Mirmahdi, R.; alizadeh, H. & Seif Naraghi, M.(2009).effect of Executive function instruction on math and reading performance in children with SLD. *Research in Exceptional Children, 9*, 1, 1-21.

[20] Nevo E, Breznitz Z. (2013).The development of working memory from kindergarten to first grade in children with different decoding skills. *Journal of Experimental Child Psychology*, *114*. 217-228

[21] Peng, P. Sha, T., Beilei L (2013). The deficit profile of working memory, inhibition, and updating in Chinese children with reading difficulties. *Learning and individual Differences ,25*, 11-117

[22] Sarmad, Z.; Bazargan, A. & Hejazi, E. (2011). *Methodology in behavioral science*. Tehran: Agah

[23] SchweppeJ ,Rummer R (2013).Attention, Working Memory, and Long-Term Memory in Multimedia Learning: An Integrated Perspective Based on Process Models of Working Memory. *Educational Psychology Review*, *52*, 35 - 42

[24] Sedaghati, L.; Foroughi, R.; Shafiee,B. & Marath, M.(2010).study on epidemiology of reading disorders in students that studying in Isfahan. *Audiology*, *1*, 1-8.

[25] Seif Naraghi, M & Naderi, E. (2010).*Learning Disabilities*. Tehran: Amir Kabir press.

[26] Sen, H. S. (2009). The relationship between the uses of met cognitive strategies and reading comprehension. *Procedia Social and Behavioral Sciences*, *1*, 2301–2305.

[27] Shahim S. (2006). *Scale of the intelligence of Wechsler, manual and norms*. Shiraz: Shiraz University Press.

[28] Shahim, S.& Harounorrashidi,H.(2007).comparing performance of children with verbal and non-verbal learning disabilities in WISC-4.*Journal of Science and Research, 2*, 3, 61-90.

[29] Shokouhi-Yekta, M. & Parand, A. (2012). *Learning disabilities*. Tehran: Teimourzadeh.

[30] Smith A& AyresP().The Impact of Persistent Pain on Working Memory and Learning. *Research into Practice, 15*. 97- 104

[31] Swanson, H. L., & Alexander, J. E. (2010). Cognitive processes as predictors of word recognition & reading comprehension in learning-disabled & skilled readers: Revisiting the specificity hypothesis. *Journal of Educational Psychology*, *89*,128-158.

[32] Taanila A; Ebeling H; Tiihala M; Kaakinen1 M; Moilanen I; Hurtig T; Yliherva A (2014). Association between Childhood Specific Learning Difficulties and School Performance in Adolescents With and Without ADHD Symptoms: A 16-Year Follow-Up. *Journal of Attention Disorders. 18*(1) 61– 72

[33] Tahar M. M ; , Toran H, HanafiMohd M, Barid S (2010).Reading skills among year one students in Malaysia. *Procedia Social and Behavioral Sciences*, *9*, 378–383

[34] Ullman H, Almeida R, Klingberg, T. (2014). Structural Maturation and Brain Activity Predict Future Working Memory Capacity during Childhood Development. *Journal of Neuroscience*,34(In press)

[35] Vasile, C. (2012).Working Memory and the feeling of success in students. *Procedia - Social and Behavioral Sciences, 33.* 781 – 785

[36] Vasic, N; Lohr, C ; Steinbrink C, Martin, C; Wolf R C (2008).Neural correlates of working memory performance in adolescents and young adults with dyslexia. *Neuropsychology, 46.* 640–648

AUTHOR'S PROFILE

Keivan Kakabaraee
is an assistant professor in Kermanshah branch Islamic Azad University, psychology department.
His research interest is special education and curriculum, child psychology, and psychomotor and psychological treatments and rehabilitation.
Dr. Kakabaraee has authored/edited one book and authored, co-authored, or presented several articles, and conference presentations.
Correspondence Address: Ferdosi Ave. kasra St.
Department of Psychology, Kermanshah branch Islamic Azad University, Kermanshah, IRAN
Tel: 0098- 912 225 7860
Email: keivan_k76@yahoo.com, keivan@iauksh.ac.ir