Research Paper: Comparing the Effectiveness of Software-based vs. Non-soft Packages of Working Memory and Selective Attention

Nafiseh Tabatabaei[1], Mohammad Ali Nadi[2*], Ilnaz Sajjadian[3]

1. Department of Educational Sciences, Faculty of Educational Sciences & Psychology, Isfahan (Khorasgan) Branch, Islamic Azad University, Isfahan, Iran.

Use your device to scan and read the article online

Citation: Tabatabaei, N., Nadi M. A., & Sajjadian, I. (2020). Comparing the Effectiveness of Software-based vs. Non-soft Packages of Working Memory and Selective Attention. *Journal of Practice in Clinical Psychology, 8*(4), 277-286. https://doi.org/10.32598/jpcp.8.4.609.1

https://doi.org/10.32598/jpcp.8.4.609.1

Article info:
Received: 10 Oct 2019
Accepted: 24 Aug 2020
Available Online: 01 Oct 2020

Keywords:
Training package, Working memory, Selective attention, Temporal lobe epilepsy

ABSTRACT

Objective: The present study aimed to compare the effects of the non-computerized training package of Working Memory (WM) and selective attention with Captain's Log software on the components of WM.

Methods: This was a quasi-experimental study with a non-random targeted sampling method, and pre-test, post-test, follow-up, and a control group design. A sample of 150 cases aged 13 to15 years diagnosed with Temporal Lobe Epilepsy (TLE) referring to neurology clinics was selected and randomly divided into two case groups (n=15/group) and a control group (n=15). The non-computerized package was performed in 15 one-hour sessions for 4 weeks in the first case group. Besides, the computerized package was provided in 15 sessions (45 minutes each) for 4 weeks in the second case group; however, the control group received no training. All WM components were examined in the pre-test, post-test, and follow-up (3 months after post-test) steps in all study groups.

Results: The repeated-measures Analysis of Variance (ANOVA) data indicated a significant difference in the mean scores of the components of WM in the first case group, compared to the second case group and the controls (P<0.05).

Conclusion: The non-computerized package of WM and selective attention were significantly more effective on the WM components, compared to the Captain's Log computerized package.

*** Corresponding Author:**
Mohammad Ali Nadi, PhD.
Address: *Department of Educational Sciences, Faculty of Educational Sciences & Psychology, Isfahan (Khorasgan) Branch, Islamic Azad University, Isfahan, Iran.*
Tel: *+98 (913) 3268857*
E-mail: *mnadi@khuisf.ac.ir*

Highlights

- Applying cognitive training significantly enhances working memory.
- Software-based cognitive training was less effective than classic training.
- Selective attention was more enhanced by classic than software-based training.

Plain Language Summary

Epilepsy is a brain disorder with different manifestations. The prevalence is one to two out of 200 individuals. The disease manifests in various types, including Temporal Lobe Epilepsy (TLE). Memory and attention particularly working memory and selective attention are the functions that could be affected by TLE. Numerous children with seizure disorders experience learning difficulties due to memory and attention complications. It is noteworthy that patients with focal seizures present more failures in selective attention assessments, compared to generalized seizures. Few studies have addressed the psychological interventions regarding this issue. Hence, we aimed to compare the effects of the non-computerized training package and Captain's Log software package on enhancing working memory and selective attention in patients with TLE. In this study, 45 cases diagnosed with TLE were selected and categorized into two case groups (non-computerized training package, Captain's Log software package) and one control group. Data analysis indicated a significant difference in the scores of the components of working memory in the first case group, compared to the second case group and the controls. Therefore, the non-computerized package of working memory and selective attention were significantly more effective compared to the Captain's Log computerized package. Although training (either software-based or non-software packages) enhances cognitive and executive functions, the quality of these interventions remains pivotal; thus, it should be recognized besides the medical treatments.

1. Introduction

Epilepsy has long been recognized as a brain disorder with somatic manifestations (Bradley, Droff, Fenichel & Jancivic, 2008). The prevalence of epilepsy is one to two out of 200 individuals and its clinical manifestations include seizure attacks. This noncontagious disorder is equally prevalent in both genders and usually starts either in childhood (2 to 14 years) or old age (after 65 years) (Rowland & Pedley, 2010). The disease generates in various types, including Temporal Lobe Epilepsy (TLE), i.e. common in all ages (Ropper & Victor, 2001).

Attention is among the vulnerable cognitive functions affected by epilepsy. This distortion varies based on the epilepsy type. In other words, it is primarily more affected by idiopathic generalized epilepsy than focal epilepsy, which might be due to further underlying structures in charge of maintaining attention being involved. Additionally, patients with focal seizures present more failures in selective attention assessments, compared to generalized seizures (Reynolds & Jancen, 2012).

Research has suggested that Working Memory (WM) can be affected by cortical damages. WM is primarily in charge of three domains; central executive factor, the phonological loop, and visuospatial sketchpad (Sternbergg, 2016). Accordingly, numerous children with seizure disorders experience learning difficulties due to memory and attention complications (Reillis & Neville, 2011; Colenso, 2013; Friedman et al., 2007; Bear, Conners & Paradiso, 2016). Audio-Verbal WM and visuospatial WM are essential predictors in reading and mathematics achievements. Therefore, WM defects endanger academic achievements (Engle & Smith, 2010; Rowland & Pedley, 2010).

Despite the rich literature regarding WM, few studies have addressed the psychological interventions regarding this issue (Salehzadeh, Najafi & Ebrahimi, 2010); amongst which, one study revealed enhanced WM in TLE cases after using online training packages. However, they believed that further research was required to thoroughly identify the influential factors (Thompson et al., 2016).

Pumaccahua, Wong, and Wiest (2017) have also studied the effects of Captain's Log software training on the WM of children with different types of cerebral damages. They concluded that the effect on visual WM is greater than that of verbal WM. Visuospatial abilities were also positively influenced by this software package in another study (Lampit, Ebster & Valenzuela, 2014).The effects of the used program are important alongside the number and duration of the training sessions. This is because using digital software and increased screen time might affect patients with epilepsy (Zarghami & Sheikholeslami, 1999).

Eventually, our study aimed to compare the effects of WM and selective attention non-computerized training package and Captain's Log software package on enhancing WM components in patients with TLE.

2. Methods

This was a quasi-experimental study with a pre-test, post-test, follow-up as well as a control group design (as per the non-random target sampling method).

Cases consisted of 150 female students aged from 13 to 15 years who were diagnosed with TLE referring to the neurology clinics of district 3 in Tehran City, Iran, in summer and autumn 2017. Those with any prior diagnosis of psychiatric disorders were excluded from the study. The time of the disease onset, the severity of the disease, symptoms, medication, and dosing data were obtained from the study participants. After the preliminary screening of WM and selective attention, 45 cases were selected and categorized into two case groups and one control group (n=15/ subjects per WM & selective attention non-computerized training package, Captain's Log software package, & the control groups). Moreover, the controls were enrolled in the study without any prior training, due to executive difficulties. Considering the ethical considerations, the controls freely received the WM and selective attention assignments of non-computerized training package after the study. The sample size was calculated based on formerly established studies and methods (Sarmad, Bazargan & Hejazi, 2007).

The further exclusion criteria were as follows: the lack of continuous presence of one of the parents in the experimental sessions (given that WM & selective attention non-computerized training packages contain home assignments for learners and require parental supervision, and the last 10 minutes of every session is dedicated to training the parent to qualify her/him for supervising the learner's work), obtaining medium or low score in WM and selective attention screening by Wechsler WM test and complex Stroop test for the controls, missing more than two sessions, any past medical history other than TLE, and the lack of cooperation and participation of the learner's parent, i.e. related to non-computerized training package (>2 sessions). These items were clarified in the obtained written consent forms acquired initially from all research participants.

The training and evaluating tools that were used in this study were as follows:

The WM and selective attention non-software training package were used in the first case group. This package is designed for female students aged 13 to 15 years with a TLE diagnosis edited by the qualitative research method according to the qualitative technique of thematic analysis and identifying related themes to WM and its internal reliability by computing experts group agreement coefficient or independent values according to bi-serial correlation coefficient about the quality of the assignment content and the number of training sessions.

This package contains 15 ninety-minute sessions; the first 10 minutes of each session is dedicated to reviewing the assignments of the last session, 40 minutes belongs to training the assignments of the current session, and the last 10 minutes contains parent training. A summary of the training sessions is listed below:

The first session of this package consists of the introduction and its purpose is to connect the educator, learner, and the parents and presenting the package (and running the required pre-tests, if necessary). The second session comprises executive WM and its reinforcement according to organizing meta-cognitive strategies and imaging. Besides, it addresses training these strategies to the learner and reinforcing problem-solving strategies and the ability to change cognitive strategies related to the attentional-supervisory controller component, i.e. related to executive WM. The third session includes visuo-spatial WM and its reinforcement according to detecting the spatial position and altering the viewing angle, diagnosing and plotting of spatial relationships, creativity, and imagination or image creativity, visuospatial intelligence, images analysis, geometric perception, and mental rebuilding with repeat and exercise strategies and identifying the learner's limitations for visual memories. The fourth session addresses audio-verbal WM and its reinforcement according to the reinforcement of simultaneous audio sequences by review and repeat strategy and integrating the mental review strategy with metacognitive skills and interpretation strategy and identifying the limitations of the learner for the audio memorial. The fifth session belongs to emotional WM and its reinforcement by understanding feelings and how to expressing them, as well as reinforcing the image memory and the ability to recognize faces and objects. The sixth session consists of reinforcing the ability of selective attention (especially for those with local epilepsies) and the power of inhabitation and response control by selecting the required information. The seventh session comprises declarative WM and procedural WM and their reinforcement according to the learner's knowledge activation and information about automatic skills and subjects. The eighth session includes accuracy and speed according to visual-audio accuracy with speed. The ninth session is related to abilities, such as reading, writing, mathematics, and their reinforcement by empowering visual-audio sequences, visual-audio discrimination, visual-audio sensitivity, shape stability, and space stability. The tenth session addresses reinforcing the recognition of information by reinforcing the function of simultaneous temporary active processing. The assignments of sessions 2, 3, 4, 5, and 6 can be completed in two sessions, the total number of the WM training package and selective attention sessions of the non-software training package is considered to be 15.

Captain's Log software package was used in the second case group. This package is the most useful software program for the rehabilitation and upgrading of cognitive functions; its English version is employed in Iran, with different exercises for 20 cognitive skills. This tool is designed for reinforcing the performance of individuals with Attention-Deficit Hyperactivity Disorder (ADHD), dementia, intellectual disability, Alzheimer's disease, learning disability, the delaying stages of development, other cerebral damages, and some psychiatric disorders. Furthermore, some utility is presented for healthy individuals seeking performance upgrades. This software is designed for individuals aged from 5 to 95 years and is presented in three difficulty levels and for three age groups, as follows: silver (6-11 years), gold (12-16 years), and diamond (≥17 years). Each exercise has 15 steps per level, and the difficulty level increases by passing every step. Cognitive skills upgradable with this software include centralized attention, selective attention, decomposed attention, distributive attention, continuous attention, general attention, attention movement, audio processing speed, central processing speed, cognitive reasoning, movement motor control, movement motor speed, instant memory, response inhabitation, visuospatial classification, visuospatial sequence, visual perception, visual processing, visual imaging, visual tracking, and WM.

The gold level of the software was applied in this study for two cognitive skills of WM and selective attention, and the assignments of the WM contain 5 tasks [the related pairs of numbers-letters (code-cracker), tricky tracks, puzzle power, remembering, & match play] and the assignments of selective attention contain 4 tasks (target practice, smart detective, happy trials, & matchmaker). Since the 9 mentioned assignments have different sub-assignments 19 assignments of the exercises of WM and selective attention were used in this study. The content validity of this package was approved in prior study in Farsi conducted by Alzahra University. The selected assignments of this software were presented to the second case group in 4 weeks for 15 45-minute sessions, except for the first session that contained an introduction (this software has no special training for parents and is provided by No Andishan Institute in Tehran).

The software version of the Wechsler WM test-fourth edition contains two visual and audio WM subscales employed for assessing the WM. Visual WM is similar to the visuospatial sketchpad component in Baddeley's model and verbal WM is alike the phonological loop component. The scoring in the part of repeat forward of digits and reverse digits in visual and audio WM ranges from 0 to 28. The average reliability coefficient of visual WM fluctuates between 0.93 and 0.96 (for the sample containing clinical disorders, this value ranges from 0.93 to 0.98); also, the average retest coefficient was reported as 0.74 (Drozdick, Holdnack & Hilsabeck, 2016). This software was implemented for the initial screening of the study subjects as well as measuring two components of the visuospatial sketchpad and phonological loop according to Baddeley's WM components.

The software version of n-back WM was used for assessing the third component of WM, the central executive factor. Accordingly, a sequence of usually visual stimuli is gradually presented to the cases. Moreover, the subject should decide whether the currently presented stimulus is consistent with the previous step or not. In these assignment tests, the ability to simultaneously maintaining and manipulating the information is considered a suitable indicator for assessing the central executive factor. The frequency of correct answers, the average answering duration, and the standard deviation of the answering time are determined when evaluating the results. The reliability cutoff point of this test is reported to be 0.78 (Zolfi & Rezaei, 2016) and the validity range is from 0.54 to 0.84 (Kamradt, Ullsperger, & Nikolas, 2014).

The software version of complex Stroop was used for evaluating selective attention in the initial screening for selecting the study sample, i.e. later divided into two groups; each having 240 consonant and inconsistent words and each receiving a separate score for each group of the words. Afterward, this score is compared with the mean and standard deviation scores of the control group and the interference score and interference time determined for each age category, then compared with each other. Researches approved the appropriate validity of this version in evaluating old age and children, selective

Table 1. Descriptive indexes of the 3 components of WM scores divided into 3 groups

Variables		Mean±SD		
		Pre-test	Post-test	Follow-up
Visuospatial sketchpad	Control group	9.2±1.78	9.13±1.76	9.2±1.79
	WM-selective attention training package group	11.87±4.47	16.8±4.21	13.87±3.77
	Captain's log group	11.47±4.2	13.6±4.25	11.8±4.02
Phonological loop	Control group	10.53±2.64	9.8±2.007	9.33±1.98
	WM-selective attention training package group	8.73±3.13	14.13±3.02	11.87±2.79
	Captain's log group	9.53±2.94	11.47±2.35	10.07±2.73
Central executive factor	Control group	70.47±19.002	67.27±21.4	68.53±19.4
	WM-selective attention training package group	71.2±18.89	94.87±13.56	8.47±10.92
	Captain's log group	64.2±17.39	83.07±12.62	68.87±14.95

PRACTICE in CLINICAL PSYCHOLOGY

attention, and the reliability of the retest coefficient was reported from 0.80 to 0.91 (Kamradt et al., 2014). Before conducting the test, all the related pre-tests were concurrently performed in all study groups. Next, the non-software package of WM and selective attention in the first experimental group and Captain's Log software package in the second case group were executed. Then, the post-tests were concurrently performed from all study groups and the process was repeated three months later in a follow-up session. All the tests were conducted for 1 hour and 45 minutes at each level of the pre-test, post-test, and follow-up (the abovementioned software tools were provided by Sina cognitive and behavioral sciences institute in Tehran).

3. Results

The descriptive findings of the current research concerning WM components (visuospatial sketchpad, phonological loop, & central executive factor) were presented separately in two cases and one control groups. Then, the related presumptions of the applied parametric tests are discussed, and lastly, repeated-measures ANOVA was applied to examine the alterations between pre-test, post-test, and follow-up values.

The Mean±SD scores of visuospatial sketchpad, the phonological loop, and central executive factor in the intervention groups of WM and selective attention training package and captain's Log software in post-test and follow-up levels were higher than those of the control group (Table 1). The related presumptions of the repeated-measures ANOVA for assessing the normal condition of the WM components' scores in all study groups and all study stages were investigated. Levene's test was applied to study the variance equality of WM components' scores in all research groups and Box's M test was used to study the covariance consistency of WM components. The P-value cutoff was set at 0.05. The relevant results are listed in the following table:

The results of the repeated-measures ANOVA, related to three components of WM are listed in Table 2.

Table 3 illustrates the significant effect of the pre-test, post-test, and follow-up WM and selective attention training on the component of visuospatial sketchpad ($P<0.01$); however, the Captain's Log group only presented significant changes in the post-test stage ($P<0.01$). Besides, the mean difference of the scores of visuospatial sketchpad in post-test and follow-up stages was significant between the WM and selective attention training package and the Captain's Log groups ($P<0.01$).

Table 4 presents the significant alterations of the phonological loop in post-test and follow-up ($P<0.01$) for the WM and selective attention training package and Captain's Log groups ($P<0.01$). Furthermore, the mean difference of the scores of phonological loops component in post-test and follow-up stages was significant between the WM and selective attention training package and the Captain's Log groups ($P<0.01$). Table 5 indicates the significant effect of WM and selective attention training package and Captain's Log on the component of a central ex-

Table 2. Results of the pre-assumptions for repeated-measures ANOVA in the study groups and all examination phases

Tests The Components of Working Memory	Normal Distribution (Kolmogorov-Smirnov)	Quality of Variance (Levene's Test)	Consistency of Covariance (Box's M test)
Visuospatial sketchpad	Except for the control group in the pre-test, it has been confirmed in all 3 stages and all 3 groups.	In all 3 groups and just in the post-test and follow-up, has been confirmed.	Rejected in all 3 stages and all 3 groups.
Phonological loop	Except for the control group in the pre-test and 3 groups in the post-test, which has been confirmed.	Has been confirmed in all 3 groups and just in the pre-test and has been rejected in all 3 groups in the post-test and follow-up.	Approved in all 3 stages and all 3 groups.
Central executive factor	Except for the experimental group of working memory selective attention training package in the pre-test has been confirmed.	Rejected in all 3 stages and all 3 groups.	Rejected in all 3 stages and all 3 groups.

PRACTICE in CLINICAL PSYCHOLOGY

ecutive factor in post-test and follow-up stages (P<0.01). The mean difference of the scores of the central executive factor component in post-test and follow-up stages was significant between the WM and selective attention training package and the Captain's Log groups (P<0.01).

4. Discussion

The current study compared the effects of WM and selective attention non-computerized training package and Captain's Log software package on enhancing WM components in patients with TLE. In general, our study suggested higher effectiveness when using WM and selective attention training packages in all pre-test, post-test, and follow-up stages.

Our results were consistent with those of Abbaraki, Yazdanbakhsh, and Momeni (2017) on the effectiveness of the Captain's Log software training on reducing the cognitive failures of the students with learning problems. Their results, however, reflected that the cognitive rehabilitation by Captain's Log failed to reduce the memory problems regarding remembering the names. Although the Captain's Log package's effectiveness was less than that of the WM selective attention training package, it presented a significant difference, compared to the control group (Abbariki et al, 2017).

Zare and Sharifi (2017) analyzed the effects of computer cognitive rehabilitation on the performance improvement of WM and futuristic memory in patients with multiple sclerosis. They concluded that computer cognitive rehabilitation significantly improved performance in the studied subjects. Our results were congruent with their study regarding the effectiveness of the computerized method.

Rosas, Parrón, Serrano, and Cimadevilla (2013) evaluated the effect of software assignment on enhancing the spatial

Table 3. Estimated parameters of WM components, including mean scores per WM components, mean scores of visuospatial sketchpad

Dependent Variable	Parameter	B	SD Error	t	Significantly (α)	Effect Size	Observed Power (1-β)
Post-test	Pre-test	0.743	0.099	4.506	0.001	0.759	1.000
	Comparing the training package group with the control group	5.685	0.904	6.288	0.001	0.491	1.000
	Comparing the Captain's Log group with the control group	2.782	0.893	`3.114	0.003	0.191	0.86
	Comparing the training package	-2.903	0.866	-3.354	0.002	0.215	0.906
Follow-up	Pre-test	0.795	0.068	11.643	0.001	0.768	1.000
	Comparing the training package with the control group	23.547	0.623	4.087	0.001	0.289	0.979
	Comparing the Captain's Log group with the control group	1.798	0.616	1.206	0.202	0.039	0.245
	Comparing the training package group with the Captain's Log group	-1.749	0.597	-2.931	0.006	0.173	0.816

PRACTICE in CLINICAL PSYCHOLOGY

Table 4. Estimated parameters of WM components, including the mean scores of the phonological loop

Dependent variable	Parameter	B	SD Error	t	Significance Level (α)	Effect Size	Observed Power (1-β)
Post-test	Pre-test	0.731	0.07	10.437	0.001	0.727	1.000
Follow-up	Comparing the training package group with the controls	5.648	0.499	11.325	0.001	0.758	1.000
	Comparing the Captain's Log group with the control group	2.397	0.488	4.976	0.001	0.371	1.000
	Comparing the training package group scores	-3.251	0.486	-6.692	0.001	0.522	1.000
	Pre-test	0.775	0.062	12.538	0.001	0.793	1.000
	Comparing the training package group with the controls	3.929	0.44	8.919	0.001	0.66	1.000
	Comparing the Captain's Log group with the controls	1.508	0.431	3.503	0.001	0.23	0.928
	Comparing the training package group with the Captain's Log group	-2.420	0.429	-5.641	0.001	0.437	1.000

PRACTICE in CLINICAL PSYCHOLOGY

memory defects of individuals with refractory TLE. Accordingly, they reported positive consistent data with our results on the computer training method.

Chen, Mitra, and Schlaghecken (2008) also reported the positive effects of computerized cognitive rehabilitation in individuals with different cerebral damages on cognitive performances, such as memory, attention, and executive performances.

Rabiner, Murray, Skinner, and Malone (2010) investigated the Captain's Log software's effectiveness on the WM performance of individuals with ADHD. They concluded that more than two-thirds of cases remained asymptomatic months after executing Captain's Log assignments; these data support our results on Captain's Log program's effectiveness in the cases and controls (Klingberg, Forssberg & Westerberg, 2002).

However, Dou, Man, Ou, Zheng, and Tam (2006) reported no significant difference between Captain's Log and non-software WM training groups in post-test and follow-up stages. Therefore, they recommended using both methods combined to improve the WM of individu-

Table 5. Estimated parameters of WM components, including the mean scores of the executive factor

Dependent Variables	Parameters	B	SD Error	t	Significance Level (α)	Effect Size	Observed Power (1-β)
Post-test	Pre-test	0.562	0.086	6.545	0.001	0.511	1.000
Follow-up	Comparing the training package group with the control group	27.187	3.757	7.257	0.001	0.562	1.000
	Comparing the Captain's Log group with the control group	19.32	3.784	5.105	0.001	0.389	0.999
	Comparing the training package group scores	-7.868	3.794	-2.704	0.044	0.095	0.626
	Pre-test	0.8	0.04	20.122	0.001	0.908	1.000
	Comparing the training package group with the control group	11.347	1.736	6.537	0.001	0.51	1.000
	Comparing the Captain's Log group with the control group	5.347	1.753	3.05	0.004	0.185	0.846
	Comparing the training package group with the Captain's Log group	5.99	1.758	-3.413	0.001	0.221	0.915

PRACTICE in CLINICAL PSYCHOLOGY

als with WM disorders. Remarkably, the non-software method used in this study was completely different from that of the WM and selective attention non-computerized training package.

Melby-Lervåg and Hulme (2013) in a systematic review on the effectiveness of the related training on WM, argued that the reported effectiveness in various reports is merely for short-term and verbal and visuospatial WM presented no reliable results in the follow-up step. Eventually, the effectiveness of the computerized program on WM in the post-test stage was obtained the same as the effectiveness of Captain's Log software on WM components in the post-test stage of the current study; however, the stability and durability of the scores of WM components by WM and selective attention non-computerized training package in the follow-up stage (3 months after post-test) were of significance.

An important remark regarding the abovementioned studies is the lack of specific inclusion criteria of cases and subsequently a specified result for each disorder. Our study however merely focused on TLE cases; despite that, the non-software training methods were not centralized on WM training in the related researches. However, its effects on epilepsy cases were rarely investigated.

Eventually, it should be mentioned that in WM selective attention training package, 15 assignments were developed for executive WM and 12 assignments were created for selective attention; some of them are presented in a training session by researchers to the learner and the remaining parts are homework assignments with parents' supervision. These 27 assignments are an indicator for improving the performance of central executive factor in WM selective attention training package while Captain's Log software only presents 9 assignments (4 assignments for selective attention & 5 assignments for WM) in three levels (easy, medium, & hard). Therefore, the quantity, quality, and type of the assignments in the WM selective attention training package justify the priority of its higher effectiveness, compared to the Captain's Log package.

5. Conclusion

Although training (either software-based or non-software packages) enhances cognitive and executive functions, the quality of these interventions remains pivotal; thus, it should be recognized besides the medical treatments, provided that the transparency of the interventions be certain. The assignment's quality, frequency, and consistency should be considered when examining their effects on WM and selective attention enhancement.

One difficulty in generalizing our results is regarding mere female case selection. This selection was conducted due to higher social stigma regarding epilepsy in females in numerous societies, including Iran. Besides, because of the uniformity of clinical manifestations in both genders, further attempts are required to increase their chances of receiving appropriate care. Furthermore, since more females are missed when diagnosing epilepsy, our results in this manner would be more generalizable. Moreover, since no gender differences in TLE-induced WM and selective attention alterations are detected, our data are generalizable to both genders. WM is recognized to constantly be increasing up to 15 years of age. Besides, the appearance of abstract thinking ability from the age of 12 years, according to Piaget cognitive evolution model, and the effective role of learning abilities in this sensitive period (high school) in future academic success, the age range inclusion criteria was selected to range from 13 to 15. However, further studies are required to support our presumptions regarding age and gender influences. Additionally, other epilepsy types and other psychiatric disorders with cognitive decline manifestations might as well be promoted by these interventions that remain to be investigated in future studies. Long-term follow-up analysis might as well present novel results. Eventually, due to the limitation of using computers in individuals with epilepsy, we recommended non-software training for the study participants.

Ethical Considerations

Compliance with ethical guidelines

All ethical principles are considered in this article. The participants were informed of the purpose of the research and its implementation stages. They were also assured about the confidentiality of their information and were free to leave the study whenever they wished, and if desired, the research results would be available to them.

Funding

This research did not receive any grant from funding agencies in the public, commercial, or non-profit sectors.

Authors' contributions

Investigation, methodology, data collection, data analysis, and writing – original draft: Nafiseh Tabatabaei and Mohammad Ali Nadi; Conceptualization: Mohammad

Ali Nadi; Writing – original draft, and writing – review & editing: Ilnaz Sajjadian; Final approving: All authors.

Conflict of interest

The authors declared no conflict of interest.

References

Abbariki, A., Yazdanbakhsh, K., & Momeni, K. (2017). [The effectiveness of computer-based cognitive rehabilitation on reducing cognitive failure in Students with Learning Disability (Persian)]. *Psychology of Exceptional Individuals, 7*(26), 127-57. [DOI:10.22054/JPE.2017.22223.1571]

Bear, M. F., Conners, B. W., & Paradiso, M. A. (2016). Neuro Science exploring the brain. Baltimore: Wolters Kluwer. https://books.google.com/books?id=vVz4oAEACAAJ&dq

Chen, Y. N., Mitra, S., & Schlaghecken, F. (2008). Sub-processes of working memory in the N-back task: An investigation using ERPs. *Clinical Neurophysiology, 119*(7), 1546-59.[DOI:10.1016/j.clinph.2008.03.003] [PMID]

Colenso, J. M. (2013). Working memory in children and its relationship to academic achievement and behavior [MSc. thesis]. Palmerston North, New Zealand: Massey University. https://mro.massey.ac.nz/handle/10179/4914

Dou, Z. L., Man, D. W. K., Ou, H. N., Zheng, J. L., & Tam, S. F. (2006). Computerized errorless learning-based memory rehabilitation for Chinese patients with brain injury: A preliminary quasi-experimental clinical design study. *Brain Injury, 20*(3), 219-25. [DOI:10.1080/02699050500488215] [PMID]

Engle, J. A., & Smith, M. L. (2010). Attention and material-specific memory in children with lateralized epilepsy. *Neuropsychologia, 48*(1), 38-42. [DOI:10.1016/j.neuropsychologia.2009.08.005] [PMID]

Friedman, N. P., Haberstick, B. C., Willcutt, E. G., Miyake, A., Young, S. E., & Corley, R. P., et al. (2007). Greater attention problems during childhood predict poorer executive functioning in late adolescence. *Psychological Science, 18*(10), 893-900. [DOI:10.1111/j.1467-9280.2007.01997.x] [PMID]

Kamradt, J. M., Ullsperger, J. M., & Nikolas, M. A. (2014). Executive function assessment and adult attention-deficit/hyperactivity disorder: Tasks versus ratings on the Barkley deficits in executive functioning scale. *Psychological assessment, 26*(4), 1095-105. [DOI:10.1037/pas0000006] [PMID]

Klingberg, T., Forssberg, H., & Westerberg, H. (2002). Training of working memory in children with ADHD. *Journal of clinical and Experimental Neuropsychology, 24*(6), 781-91. [DOI:10.1076/jcen.24.6.781.8395] [PMID]

Lampit, A., Ebster, C., & Valenzuela, M. (2014). Multi-domain computerized cognitive training program improves performance of bookkeeping tasks: A matched-sampling active-controlled trial. *Frontiers in Psychology, 5*, 794. [DOI:10.3389/fpsyg.2014.00794] [PMID] [PMCID]

Melby-Lervåg, M., & Hulme, C. (2013). Is working memory training effective? A meta-analytic review. *Developmental Psychology, 49*(2), 270-91. [DOI:10.1037/a0028228] [PMID]

Pumaccahua, T. T., Wong, E. H., & Wiest, D. J. (2017). Effects of computerized cognitive training on working memory in a school setting. *International Journal of Learning, Teaching, and Educational Research, 16*(3), 88-104. https://d1wqtxts1xzle7.cloudfront.net/55203239/Vol_16_No_3_-_March_2017.pdf?

Rabiner, D. L., Murray, D. W., Skinner, A. T., & Malone, P. S. (2010). A randomized trial of two promising computer-based interventions for students with attention difficulties. *Journal of Abnormal Child Psychology, 38*(1), 131-42. [DOI:10.1007/s10802-009-9353-x] [PMID]

Ropper, A. H., & Victor, M. (2001). Adams & vicror's principles of neurology. 7th ed. New York: MCGraw Hill.

Rosas, K., Parrón, I., Serrano, P., & Cimadevilla, J. M. (2013). Spatial recognition memory in a virtual reality task is altered in refractory temporal lobe epilepsy. *Epilepsy & Behavior, 28*(2), 227-31. [DOI:10.1016/j.yebeh.2013.05.010] [PMID]

Rowland, L. P., & Pedley, T. A. (2010). Merritt's neurology. 12th ed, Philadephia: Lippincott Williams & Wilkins a Wolters Kluwer Business.

Salehzadeh M, Najafi M, Ebrahimi A. (2011). [Effectiveness of cognitive behavioral therapy on inefficient behaviors in patients with epilepsy (Persian)]. *Medical Science University of Yazd, 19*(3), 377-87. https://www.sid.ir/fa/journal/ViewPaper.aspx?id=146402

Sarmad, Z., Bazargan, A., & Hejazi, A. (2007). [Research methodology in behavioral sciences (Persian)]. Tehran: Agah. https://www.adinehbook.com/gp/product/9643290514

Sternbergg R. (2016). Cognitive psychology [S. K. Kharazi, E. Hejazi, Persian Trans). Tehran: Samt. https://www.gisoom.com/book/11253085

Thompson, P. J., Conn, H., Baxendale, S. A., Donnachie, E., McGrath, K., &Geraldi, C., et al. (2016). Optimizing memory function in temporal lobe epilepsy. *Seizure, 38*, 68-74. [DOI:10.1016/j.seizure.2016.04.008] [PMID]

Zare, H., & Sharifi, A. (2017). [The effect of computerized cognitive rehabilitation on working and prospective memory function in multiple scleroses patients (Persian)]. *Journal of Cognitive Psychology, 5*(1), 1-10. http://jcp.khu.ac.ir/article-1-2647-fa.html

Zolfi, V., & Rezaei, A. (2015). [Effectiveness of computerized intervention of working memory on Math anxiety, working memory and math performance of students with math learning problems. (Persian)]. *Educations and Evaluation, 30*(8), 75-86. https://www.sid.ir/fa/Journal/ViewPaper.aspx?id=253973

This Page Intentionally Left Blank