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Effectiveness of Music Therapy on Sensitivity, Memory, and Auditory Sequence of 7 to 9-Year-Old Girls with Reading Disorder

Majid Akhshabi* and Fariborz Dortaj

Majid Akhshabi and Fariborz Dortaj*
Department of Educational Psychology, Allameh Tabatabai University, Tehran, Iran

Abstract

Background: This study aimed to evaluate the effectiveness of music therapy on the components of sensitivity, memory, and auditory sequence of 7 to 9-year-old girls with reading disorders.

Methods: The selected method for the present study was quasi-experimental with a pretest-posttest design and a control group. The statistical population of the present study comprised 30 volunteer girls aged 7 to 9 (Persian speaking) with reading disorders who were randomly placed in experimental and control groups (15 people each). The experimental group participated in music therapy sessions for 30 minutes twice a week for four months. First, to increase their proportion of focusing on music little by little; second, to increase the speed of the music gradually during the sessions; and third, to replace the active method slowly with the passive approach and move the tendency of the selected melodies from monophonic and vocal-less texture to polyphonic and vocal orchestral texture.

Results: The data were analyzed using paired t-test. The results showed that the experimental group's sensitivity, memory, and auditory sequence were significantly higher than those in the control group post-test ($p<0.001$).

Conclusion: Music as an applied method can effectively improve the auditory symptoms of children with reading disorders.

Keywords: Auditory memory, Auditory sensitivity, Auditory sequence, Music therapy, Reading disorder

*** Corresponding author**

Majid Akhshabi, Ph.D
Department of Educational Psychology, Allameh Tabatabai University, Tehran, Iran
Tel: +98 21 8820 5001
Fax: +98 21 8820 5002
Email: majidakhshabi@pnu.ac.ir

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Introduction

Reading difficulties are one of the students' most common problems, while dyslexia is the most important. Dyslexic people have difficulty reading most subjects due to reading disorders (1). Although they usually have great normal intelligence, this group cannot make good academic progress, thus they continue their studies with great difficulty or have a higher tendency to drop out of education. This problem brings social, economic, cultural, and psycho-emotional damage (2). Reading disorders are observed in approximately 75% of children and adolescents with learning disabilities (3). The prevalence of this disorder in Iran is reported to be at least 200,000 students (4). Even a lower prevalence than this can affect a large population. Many studies indicate that timely diagnosis and proper treatment planning can improve the reading level in many people with dyslexia (5).

The characteristic of most compensatory strategies available for children with reading disorders is the direct teaching of different reading components focusing on the child's attention and the combination of verbal and spelling sounds (6). In recent years, research has been conducted on other treatments for this disorder, including direct education and phonological and combined phonological awareness (7,8). Dyslexics are deficient in processing auditory information and the evoked potentials of the auditory brainstem (7,9).

Music and sound are used today to help improve children's auditory processing, language, and cognitive functions. Sound waves can be a powerful force in helping the human body's treatment (5,10,11). The Tomatis Sound Therapy method's effect on children and adults with learning and communication disorders and children with auditory processing disorders, autism, attention deficit disorder, and hyperactivity disorders has been analyzed in various studies (5,12-17). Similarly, a meta-analysis has been conducted on the effects of music application on learning and communication disorders, and the results signify a positive effect on the treatment of learning disorders (18). According to the literature, no studies were found on auditory processing skills among Iranian students with reading disabilities. Music therapy is relatively efficient in terms of cost and length of treatment compared with other treatments. Families prefer music therapy since it is a non-invasive treatment. Therefore, this study tries to evaluate the effectiveness of music therapy in improving reading disorders.

Materials and Methods

The present study was a quasi-experimental study and the research design is pre-test-post-test with a control group. The statistical population of the present study included 7 to 9-year-old girls with reading disorders in Tehran who were introduced to Hamraz music training center and music school in the first half of 2022 through psychotherapy centers related to the diagnosis of reading disorder for music therapy courses.

The inclusion criteria for participants in this study included: 1. Reading disability diagnosis by a psychologist, 2. Healthy vision and hearing, 3. Average or above average intelligence based on psychologist`s judgment, and 4. Parental satisfaction. The exclusion criteria for the study were: 1. Intelligence below average (based on psychologist or psychiatrist judgment), 2. Using psychotropic medication or other cognitive therapies, 3. Reluctance to cooperate, 4. Having diagnosed another psychiatric disorder (Based on psychologist or psychiatrist judgment). In this study, selecting a sample, using available and targeted sampling methods among 68 children referred to the center and volunteered to participate in the study, as well as Wechsler IQ test, optometry, and audiometry tests, worm reading disorder test, and Moradi and Karami's dyslexia test (2005), were performed. Through the above screening, people diagnosed with reading disorders were introduced to the researcher for cooperation. Of these, 34 demonstrated a willingness to work with the researcher, but two were excluded from the study due to receiving other treatments during the study. Two other participants were also excluded from the control group due to personal reasons. Finally, the study continued with 30 people, of which 15 people were in the experimental group and 15 people were in the control group using the random replacement method.

Research tools

In this research, with Kormi-Nouri and Moradi's

reading disorder tests (2004), the participants` sensitivity, memory, and auditory sequence factors were evaluated before and after the music therapy sessions. Saif Naraghi and Naderi confirmed the validity of this test, and the alpha coefficient of this test was equal to 0.78 (19).

In the auditory sensitivity test, auditory memory and auditory sequence of children older than two years, a list of unrelated words and numbers, which gradually increases during the repetition of the test, is read from the word table by the experimenter, and the child is asked to repeat them immediately (20). The child's sensitivity, sequence, and auditory memory level are measured through the number of correctly pronounced words, the strict observance of the sequence of words in the repetition of words, and finally, the number of words remaining in his memory. The method of performing the test was such that the researcher expressed each category of words at the appropriate time (one second for one word) for each student individually. The student had to recite these words immediately. The first step comprised double words (such as water-swing), and if the student passed this step successfully, the researcher added to the number of words in the next step. This process continued until the child could not answer correctly three times in a row. In this case, the test would be stopped. The criteria for scoring and recording it in the information file for each student included:

• The number of correctly pronounced words for auditory sensitivity.

• The number of two or three, or more words the child repeated precisely in the same order for the auditory sequence.

• The number of words that the child could remember from the series of main words for auditory memory.

For example, if the student could say the double series of words accurately, regularly, and consecutively (and not more), number 2 is in the column of their auditory memory. If they could recite the series of words up to three correct words in order (and he could not handle more than that), number 3 would be entered in the column of the sequence. If they could remember four words from the series of multiple words, number 4 would be entered in the column of their auditory memory.

Execution stages of the study

Before the music therapy intervention, a pre-test was performed for both groups. For each person, a file containing information related to three separate factors of sensitivity, memory, and the auditory sequence was allocated based on the test information they gave. According to the regulatory protocol, 30-minute sessions were held for the experimental group. First, to increase their proportion of focusing on music little by little; second, to increase the speed of the music gradually during the sessions; and third, to replace the active method slowly with the passive approach and move the tendency of the selected melodies from monophonic and vocal-less texture to polyphonic and vocal orchestral texture. Details are described in the following.

After the strict implementation of the above protocol in four months (Table 1), both groups were tested again (post-test), and the new information obtained from the post-test of the subjects was added to the desired files. The data obtained from the pre-test and post-test in two experimental and control groups were statistically analysed using SPSS 26 software and the covariance method and paired t-test.

It is worth mentioning that the informed consent of parents, the confidentiality of subjects' information, and implementing treatment for the control group after completing the work are among the ethical principles observed in the mentioned steps.

Results

In this study, sensitivity, sequence, and auditory memory were assessed in two stages (pre-test and post-test) in the control and experimental groups. The information obtained from the related tests is presented separately in table 2.

The results of table 3 shows that the distribution of variable scores for auditory memory, auditory sensitivity, and auditory sequence in the pre-test-post-test is normal, and the data has a normal distribution ($p>0.05$). Due to the non-significance of the Loon test for the pre-test and post-test, it can be concluded that the assumption of homogeneity of variances is established.

Regression homogeneity test

Investigate the lack of interaction between groups and

Table 1. Implementation protocol of music therapy in sessions

Mon hly schedule	Session scheduling	Music used	Speed (tempo)	Session condition
First month	Part One: 15 minutes --- Part Two: 15 minutes	A selection of non-verbal soundtracks and captions for children's films, as well as the use of guitar and piano solos --- A selection of music with calm and heavy childish words	40 - 60	Encouraging and inviting to listen to music in case of fatigue, drawing, or playing a favorite game
Second month	Part One: 15 minutes --- Part Two: 15 minutes	Includes a selection of orchestral music from Mozart, Tchaikovsky, Beethoven and guitar and piano solos. --- Playing music with the words heard in the previous month and inviting the child to participate in maintaining the rhythm by touching and harmonising its lyrics	60 - 80	More encouraging children to listen to music carefully (passive method and start active method) Let them only play (eliminate painting)
Third month	Part One: 10 minutes --- Part Two: 20 minutes	A selection of fast guitar and piano solos and fast and dynamic classical music --- Use the verbal music of the past months plus a selection of pop music of the day at a relatively fast pace and invite the child to listen carefully to the song and the rhythmic accompaniment by touching and performing rhythmic movements in agreement with the rhythm of the music.	80 - 100	More encouraging children to listen to music carefully and participate (active method) Eliminate playing and painting
Fourth month	Part One: 10 minutes --- Part Two: 20 minutes	Encourage and guide the child to sing the lyrics of songs they have heard sufficient times in the past months along with playing the original music as a subwoofer --- Encourage and guide children to sing previous songs and tunes this time without music with a touch of solo or group singing	100 - 120	Drawing children's attention to participate in music (active method)

pre-test scores, the same assumption of regression slope was examined, which are shown in table 4.

This study demonstrated that F calculated at the level ($p< 0.05$) is not significant. Therefore, the regression gradient in the variables of auditory memory, auditory sensitivity, and auditory sequence is the same and there is no interaction between groups and pre-test. Given the confirmation of statistical assumptions (normal distribution of equality scores of variances, regression homogeneity) and the research method (experimental with a control group), the analysis of covariance can test the hypotheses. The results are summarized for different hypotheses.

Table 5 indicates the value of F (51.435) calculated with degrees of freedom (25 and 1). Since the calculated F (51.435 with degrees of freedom 25 and 1) is larger than the F of the table with the same degree of freedom, and we also know that if the observed significance level of the test is smaller than the desired error level, a significant difference between the data is concluded.

There is a significant difference between the mean score of pre-test and post-test of auditory memory in the experimental and control groups, which is in

Table 2. Descriptive statistics of memory, sensitivity, and auditory sequence

Research variables	Level	Pre-test (n=15)		Post-test (n=15)	
	Groups	Mean	SD	Mean	SD
Auditory memory	Experiment	2	0.751	3.92	1.07
	Control	2.2	0.791	2.1	0.784
Auditory sensitivity	Experiment	2.78	1.25	4.357	1.00
	Control	2.71	1.06	3.00	1.35
Auditory sequence	Experiment	2	0.784	3.857	0.864
	Control	2	0.784	2.07	0.828

Table 3. Results of Kolmogorov-Smirnov test and Loon test for auditory memory, auditory sensitivity, and auditory sequence (n=15)

Kolmogorov-Smirnov test						Loon test	
The level	Variables	Mean	SD	Z	Sig	Leven test	Sig
Pre-exam	Auditory memory	1.92	0.766	0.224	0.056	0.051	0.822
Post-test		2.96	1.34	0.214	0.081	1.083	0.308
Pre-exam	Auditory sensitivity	2.75	1.14	1.02	0.244	0.150	0.701
Post-test		3.67	1.36	0.880	0.421	0.362	0.553
Pre-exam	Auditory sequence	2.00	0.769	1.134	0.153	1.001	1.00
Post-test		2.96	1.231	1.073	0.200	0.188	0.668

Table 4. Interaction between independent variables and covariate (same regression slope assumption)

Source of change	F	Sig
Auditory memory	0.479	0.496
Auditory sensitivity	2.036	0.167
Auditory sequence	0.136	0.715

Table 5. Analysis of covariance for auditory memory, auditory sensitivity, and auditory sequence of experimental and control groups (n=28)

Variables	Source of changes	Total squares	df	Average squares	Ratio F	Sig
Auditory memory	Pre-exam	8.947	1	8.947	15.997	0.001
	Interaction of groups with pre-test	28.766	1	28.766	51.435	0.001
	Error variance	13.982	25	0.559		
	Total	295.000	28			
Auditory sensitivity	Pre-exam	22.377	1	22.377	37.706	0.001
	Interaction of groups with pre-test	11.822	1	11.822	19.919	0.001
	Error variance	14.837	25	0.593		
	Total	429.00	28			

Cont table 5

Auditory sequence	Pre-exam	7.563	1	7.563	17.063	0.001
	Interaction of groups with pre-test	22.321	1	22.321	50.363	0.001
	Error variance	11.080	25	0.443		
	Total	287.00	28			

favor of the experimental group assuming the study of other demographic variables, controlling the effect of pre-test scores on post-test, and being significant the mean difference, music therapy intervention can be introduced as an effective method to significantly increase the experimental group's auditory memory compared to the control group. There were no significant differences in the baseline parameters between groups (t=-1.825, p=0.075). Also, the results of the Independent t-test showed that there was a significant difference between experimental and control groups in overall score (auditory memory, auditory sensitivity, and auditory sequence) (t=8.797, p<0.001). In addition, the results of paired t-test represented that after 4 months of music therapy, the overall score increased significantly in the experimental group (t=-43.737, p<0.001).

Discussion

The present study was conducted to evaluate the effectiveness of music therapy on sensitivity, memory, and auditory sequence of 7 to 9-year-old girls with reading disorder in a quasi-experimental with a pre-test-post-test design and a control group. The findings of the current trial show that music-therapy as an applied method can effectively improve the auditory symptoms of children with reading disorders.

While it is a novel method among patients with psychiatric disorders, particularly childrens, several previous studies have demonstrated the efficacy of music-therapy in this group of patients (21).

A huge number of studies investigated this method on patients with Autistic Spectrum Disorder (ASD). Mayer-Benarous *et al* published a systematic review in 2021 concerning efficacy of music-therapy in patients with ASD and/or other neurodevelopmental disorders and concluded based on 39 studies that improvisational music therapy in this group of patients appears relevant for children with both ASD and Intellectual Disability (ID) (22).

In agrrement with current findings, Flaugnacco *et al* performed an open-label trial among 24 children with dyslexia and showed that music training can modify reading and phonological abilities in comparison with 22 patients in control group (23).

Furthermore, Leloup *et al* examined a 5-week newly developed intervention known as repeated reading with vocal music masking (RVM) among children with dyslexia. In agreement with our findings, they reported that this music-therapieutic method is effective. Therefore, they concluded that RVM may be useful to treat reading fluency disorders, more especifically when standard programs do not provide results (24).

Interestingly, another study amid the COVID-19 pandemic examined the efficacy of a rhythm-based intervention, called Rhythmic Reading Training (RRT), using 10 biweekly sessions of 45 min. telerehabilittion or in-person in order to improve reading skills of patients with dyslexia (25). They reported that both methods were effective and emphasize well-known fact that numerous psychiatric inteventions can be used remotely amid pandemic situations like COVID-19 (26-28)

It is worth mentioning that, to the best of our knowledge, no research was found in the literature that has studied precisely these cases in Iranian population.

Limitations

The population of this study was 7 to 9-year-old girls with reading disorders referred to the skill training center and Hamraz Music School in Tehran. Therefore, due to some cultural, financial, environmental, and social differences, it is necessary to generalize the results to the communities and be careful about the gender of boys. The sampling of the

statistical population of this research is non-random and available, which can affect the generalization of the research results. Generally, the internal feelings and momentary conditions prevailing while taking tests in children, such as fatigue, stress, discomfort, and such things, are not ineffective in responding. However, in this research, the conditions were relatively and outwardly the same for both groups. The small sample size and conducting the study among the students of a city are other limitations of this research.

Suggestions and Implications

Suggestions that can be made in improving reading disorder can include:

Screening children's hearing and reading disorders before or they enter school.

Starting music therapy courses for children before entering school.

Creating facilities and conditions for everyone to use music therapy during school hours.

Sampling in future research should be done randomly with a wider statistical population because of cultural, environmental, and social differences, such as the present study in different samples and societies with different socio-economic cultures and classes. Finally, it is emphasized that music has mysterious and hidden capacities that need to be revealed with the efforts of researchers in line with the highest human goals.

Conclusion

Music-therapy can improve auditory symptoms and ultimately be effective in enhancing female children with reading disorders. More trial with larger sample size is suggested.

Ethical Considerations

This research has the ethics ID IR.ATU.REC.1401.016 from the Ethics Committee of Allameh Tabatabai University.

Conflict of Interest

The author declares no conflict of interest.

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