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Kyle N. Brim

Philadelphia College of Osteopathic Medicine

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**Does musical therapy increase reading ability in children aged
8-10 that are diagnosed with dyslexia?**

Kyle N. Brim, PA-S

A SELECTIVE EVIDENCE BASED MEDICINE REVIEW

In Partial Fulfillment of the Requirements For

The Degree of Master of Science

In

Health Sciences – Physician Assistant

Department of Physician Assistant Studies
Philadelphia College of Osteopathic Medicine
Philadelphia, Pennsylvania

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ABSTRACT

OBJECTIVE: The objective of this selective EBM review is to determine whether or not, “Does musical therapy increase reading ability in children aged 8-10 that are diagnosed with dyslexia?”

STUDY DESIGN: Review of three English language primary studies, published between 2013 and 2016. Articles were selected based on outcomes measured and relevance to the objective.

DATA SOURCES: Two randomized controlled trials (RCTs) and one non-randomized control trial were found using PubMed. These studies analyzed how music training affected the reading ability in children with dyslexia or severe reading impairments.

OUTCOMES MEASURED: Main outcomes assessed were word accuracy measured with the Test of Phonological Awareness, DDE-2 Pseudo Word Reading Test, and MT Text Reading, as well as the speed and quality of reading measured with NEPSY II Battery: Phonemic Fusion Assessment.

RESULTS: All three studies showed statistically significant improvement in the reading abilities of children with reading impairment after a period of musical training. The Cogo-Moreira et al. study showed improvement in phonological awareness, word accuracy, and text accuracy, the study done by Habib et al. displayed an improvement in the speed and quality of reading, and the Flaughnacco et al. study showed the performance in the accuracy of pseudoword reading and the reading of words and text improved greatly.

CONCLUSION: The result of two RCTs and one non-randomized control trial compared the effects of musical therapy on reading ability pre- and post- therapy as well as compared to control groups using alternate therapies such as painting classes showed musical therapy to be an effective tool to improve reading ability in children with dyslexia.

KEY WORDS: Music, Dyslexia

INTRODUCTION

Dyslexia is a type of reading disability that occurs when an individual is identified to have tremendous difficulty decoding words with accuracy and speed.¹ This deficit is seen despite normal intelligence level and without an apparent psycho-affective or socio-educative problem.² Worldwide, it is estimated that about 5-15% of the school-aged population has difficulty with one or any combination of the following: acquired reading, writing, and calculation. The most common learning disability seen is a reading disability.³ Dyslexia affects boys and girls equally, but referral rates in schools show a heavy preference for boys to be referred for treatment or testing. Referral rates for boys historically average about 13.6%, with only 3.2% of girls being referred.¹ Early identification and intervention is the best way to ensure long-term complications do not arise. Other than reading difficulties, long term effects of improperly treated dyslexia include anxiety, poor self-esteem, aggression, as well as social and economic consequences from educational deficits.⁴

Literacy develops in parallel with language during infancy, however, literacy must be taught since it is not inborn like language which is inherent.³ During development, children learn to associate letters and patterns of letters with specific language sounds. After repeated exposure and practice, these associations become almost automatic. The framework for reading involves five domains including phonemic awareness, phonics, sight word acquisition, vocabulary, and comprehension.³

A strong predictor of whether or not a child will have difficulty with reading is if they have difficulty with phonemic awareness. A phoneme is the smallest unit of sound into which all words can be broken down. Phonemic awareness helps new readers understand the sounds

associated with written letters and when assembled together allow words to be recognized accurately.³

There is evidence that shows that both children and adults with dyslexia have cortical and subcortical activity abnormalities in several regions of the brain and cerebellum.² Additionally, these different areas of the brain also have poor connection to each other.² These neurocognitive changes may impact a child's ability to retrieve, isolate, and manipulate speech sounds as well as disrupt the learning associations between the written and spoken word.⁵ One aim to improve reading comprehension is to try to strengthen the connections within the temporal brain region and the connection between the temporal and frontal brain region.⁶

Presently, treatment techniques revolve around helping the child learn to recognize and use syllables, understand strings of letters, comprehend what is being read, increase fluency and accuracy, and build a vocabulary. This is done primarily through the use of repetitious reading exercises with private tutoring and reading techniques.⁷ Families currently spend an average of \$1,000 per year per dyslexic child on private tutoring and assistive technology, and about two hours per week per child trying to ensure their children get the help they require.⁸

Musical therapies, such as compositional or instrumental music training, are being examined as a method to help strengthen the neural connections. The brains of professional musicians show subcortical and cortical plasticity from the repeated cognitive activity utilizing the fine motor and sensory portions of the brain.² Neuroimaging studies have also shown parallels between music and reading in that they utilize similar neural pathways.⁹ By strengthening these pathways through music education and training, the idea is that the reading barriers listed above will be lessened or removed thereby allowing for easier recall and processing of information when reading.

OBJECTIVE:

The objective of this selective EBM review is to determine whether or not, “Does musical therapy increase reading ability in children aged 8-10 that are diagnosed with dyslexia?”

METHODS

Studies were evaluated and selected based on their adherence to specific criteria: population studied, intervention used, and measured outcomes. The studies selected needed to focus on school-aged children between the ages of 8-10 with dyslexia, or severe reading impairment, without another learning or visual impairment. The intervention had to be musical training of any type, either compositional or instrumental. Comparison groups were preferentially selected for non-musical alternative treatment groups such as art classes. However, pre- and post- treatment evaluation of improvement were acceptable alternatives. The outcomes measured needed to be patient-oriented evidence that matters including reading accuracy, speed, and quality of reading.

PubMed was used to find randomized controlled trials published in peer-reviewed journals in the English language. “Dyslexia” and “music” were the key words used when searching for these articles. Selection was based on the articles relevance to the objective of this systematic review. Inclusion criteria were control trials published after August 2012. Exclusion criteria consisted of articles with a population older than 13 years old or a severe learning disability other than dyslexia. The statistics of these articles were analyzed using Mann-Whitney U test, Fisher’s exact test, t-tests, intention to treat (ITT), and complier average causal effect (CACE). The data from this systematic review utilizes odds ratio (OR), t-tests, ITT and CACE with corresponding p-values using continuous data from the articles to analyze the efficacy of musical therapy at improving reading ability in children with dyslexia. Table 1 provides a

breakdown of the study demographics and characteristics for the three articles that were selected to be reviewed.

Table 1 – Demographics & Characteristics of included studies

Study	Type	#Pts	Age (yrs)	Inclusion Criteria	Exclusion Criteria	W/D	Interventions
Cogo-Moreira (9)	Pragmatic Cluster-RCT	240	8-10	Second – Fourth grade students that scored 14.5 points or lower on the Scale of Assessment of Reading Competence by the Teacher (EACOL) and were given parental consent	Children that scored below the 25th percentile of Raven's Coloured Progressive Matrices or children already participating in regular hearing or speech therapy or music classes.	5	Music education that focuses on musical improvisation, composition, and interpretation implemented 50 minutes per day, 3 times a week for five months.
Flaunacco (6)	RCT	48	8-11	Italian native speaker, reading performance failed on at least 2 of 3 standardized Italian tests, normal visual, hearing, and neurological examination, IQ>85	Confounding co-morbidity such as developmental or behavioral disorder	2	2 hours/week for 7 months of at home music classes based on the Kodaly and Orff pedagogy
Habib (2)	Clinical trial	12	7-12	Main diagnosis of severe dyslexia	N/A	0	3h/week for 6 weeks with four interventions: 2 workshops of 1h with a speech therapist, two musical workshops of 30 min

OUTCOMES MEASURED

Cogo-Moreira et al. primarily used the Test of Phonological Awareness which consists of ten subsets of four items that analyze a different skill involved in reading such as phonemic synthesis and rhyme.⁹ Scoring of this assessment is between 0-40. The lists included 88 words and 88 non-words to assess word accuracy, non-word accuracy, and in-text accuracy, all of which were evaluated based on the rate of correct items read per minute.⁹ These values were then used to assess phonological awareness.

Flaugnacco et al. measured the accuracy of pseudoword reading as the primary outcome for the study.⁶ Secondary outcomes included speed of pseudoword reading, and accuracy and speed of reading words and text. Pseudoword accuracy and speed was calculated in coherence to the pseudo-words repetition test of the Promea Battery,⁶ where as the text reading excerpts were taken from a standardized test for reading abilities MT Reading Test.⁶ When examining the data's frequency distribution, Fisher's Exact Test was used.⁶ This helped ensure that the scores from the assessments were not influenced by working memory or other variables.⁶

Habib et al. examined the accuracy and speed of reading abilities by examining reading in one minute, pseudo-word repetition and phoneme fusion.² Reading in one minute evaluates the number of correct and incorrect words read in a column within one minute from the Khomsi Test, and the difference between the two measures provides the score, which assesses the degree of automation in reading.² Pseudo-word repetition requests the participants to repeat nonsensical words presented from an audiotape. Four tasks were selected to be used from the BALE Battery which allowed for testing of reading, spelling, and meta-phonological skills.² Phonemic fusion also utilized the BALE Battery. Here, the participants are shown two words; they are then asked to take the first sound of each word and merge them together. Each participant is shown three

examples prior to starting the assessment, which has a total of ten items.² Both the number of correct responses and time taken to finish the examination are used to provide a score.² For the in-text readings, three different selections were chosen for the three different age groups.

RESULTS

Of the selected articles, two were randomized control trials, and the last was a non-randomized clinical trial. All studies excluded children with learning disabilities or severely low IQs to ensure that the capacity for reading and learning how to read is standardized.

Cogo-Moreira et al. performed a pragmatic cluster, open-blind RCT which used ten schools found in impoverished neighborhoods to perform the study. Teachers submitted eligible students aged 8-10 based on the inclusion and exclusion criteria, and a lottery system then selected 24 students per school for a total of 240 participants total.⁹ Overall, 235 participants finished the study; three students' parents retracted their consent to participate and two students moved to another school district prior to the completion of the study.⁹ Each director of the schools was randomly given a number between 1-10, which was the order in which the directors reached into a bag containing ten balls to decide which intervention to use.⁹ The intervention selected was 50 minutes of musical education classes given in school three times a week for a total of five months. Musical education classes were designed methodologically and educationally based on the National Curriculum Parameters (NCP).⁹ The control group had daily class as usual with no musical education. Mann-Whitney and T-Student tests were used to calculate the intention to treat analysis and CACE estimation, which removes the bias of non-compliance. Initially, ITT was not very promising except for accuracy of word, but after recalculating to adjust for compliance, CACE values were much more promising.

Table 2: Effects of music education considering ITT and CACE⁹

Outcomes	ITT estimates	ITT RSE	CACE estimates	CACE RSE	P-value
Accuracy of non-word	-1.39	1.67	-1.3	0.959	ITT & CACE: >0.05
Accuracy of word	2.57	1.29	13.983	0.853	ITT: 0.05 CACE: 0.001
Accuracy of text	3.00	2.519	0.41	2.412	ITT: >0.05 CACE: 0.001
Phonological awareness	0.88	0.94	19.719	1.00	ITT: >0.05 CACE: 0.001

RSE = Robust standard error

Based on the results shown in table 2, the CACE evaluation shows an improvement in accuracy of word, text, and phonological awareness with statistical significance.⁹ The only negative correlation was with accuracy of non-word which was shown to not be statistically significant for either ITT or CACE. Intraclass coefficient correlations (ICC) were also calculated in Table 3 which compared pre- and post- test values.

Table 3: Intraclass correlation coefficient for outcomes at baseline and last assessment⁹

Outcomes	Pre-test			Post-test		
	ICC	SE	95% CI	ICC	SE	95% CI
Accuracy of word	0.18	0.08	0.01 – 0.34	0.22	0.1	0.03 – 0.41
Accuracy of non-word	0.11	0.06	0 – 0.23	0.24	0.1	0.04 – 0.43
Accuracy of text	0.12	0.07	0 – 0.26	0.15	0.08	0 – 0.30
Phonological awareness	0.14	0.07	0 – 0.29	0.36	0.12	0.12 – 0.60

CI = confidence interval; SE = standard error; ICC = intraclass correlation coefficient

Despite a low ICC and wide confidence intervals, especially with phonological awareness, there still appears to be a statistically significant improvement for all assessments after the five months of musical education.²

Flagnacco et al. sampled their population from dyslexic children aged 8-11 that were referred to the Institute for Maternal and Child Health in Trieste between 2007-2011.⁶ A total of 48 children were enrolled in the study after applying the inclusion and exclusion criteria, 2 of

whom did not complete it.⁶ This study was also an open-randomized controlled trial that divided the children into painting or music classes based on the Kodaly and Orff pedagogy for two hours per week for seven months.⁶ Parents were kept blind to which class was expected to be more effective, and clinicians were kept blind to the data analysis procedures. Before the study, neither group significantly differed in any of the assessments, and despite both groups improving at the end of the trial, the music group outperformed the painting group. The results from the assessments were analyzed through the Wenchsler Intelligence Scale for Children III to create Table 4 below.

Table 4: Summary of reading and phonological awareness results before and after training⁶

Test	Outcome	Measure	Before training		After training		Effect	ES
			PG	MG	PG	MG		
DDE2 Pseudo	Accuracy	# impaired	15	17	12	5	0.016	OR=3.7
	Time	Z score (s)	4.1 (3.0)	3.6 (2.6)	2.89 (2.6)	2.42 (2.2)	0.57***	
MT text reading	Accuracy	# impaired	21	20	15	8	0.038	OR=1.9
	Speed	Z score (s)	-2.2 (0.84)	-1.83 (0.62)	-1.88 (0.61)	-1.68 (0.61)	0.51**	
DDE2 word	Accuracy	# impaired	18	15	8	7	0.76	
	Speed	Z score (s)	6.2 (5.5)	5.6 (4.4)	4.18 (4.7)	3.38 (2.9)	0.67***	

PG = painting group, n=24; MG = music group, n=22; Effect = Larger effect of music training; ES = Effect size; “DDE2 Pseudo” = DDE-2 Pseudo word reading test; # impaired = N of severely impaired children; Z score (s) = Mean of Z score of seconds; DDE2 word = DDE-2 word reading test; OR = Odds ratio. ** = p-value <0.01; *** = p-value <0.001

An odds ratio (OR) of 3.7 for accuracy of pseudoword reading is a strong indicator that music education and musical therapy has a positive effect on reading ability in dyslexic children, especially when the ratio is in comparison to a control that also showed improvement.

Habib et al. used a classroom of 12 children aged 7-12 with a main diagnosis of dyslexia to evaluate the effects of cognitive-music training (CMT) over a six week period.² Three groups were created based on reading ability. CMT was performed three hours each week in school for six weeks;² training workshops were adjusted based on the subject’s age but each exercise provided the same type of intervention. Assessments were then evaluated at different time points to check the overall efficacy of music training on reading ability and its permanence.

Assessments include piano and percussion, as well as hour long workshops with a speech therapist.² Each assessment was converted into a T-score to allow for comparison before (T2) and after (T3) CMT was given.

Table 5: Phonological and reading tasks²

Task	Type of measurement	T2/T3			T3/T4	
		T-test	P-value	Effect size	T-test	P-value
Pseudoword repetition	Pseudo-word span	2.57	0.03	0.52	1.48	0.17
Reading in 1 min (LUM)	# items read	5.59	0.001	0.29	0.20	0.85
Phoneme fusion	Fusion score	2.90	0.01	0.78	0.70	0.50
	Time	1.94	0.07	-	0.46	0.65

T2 (just before CMT), T3 (just after CMT), T4 (6 weeks after CMT ended). Student T-tests and p-values were computed and significant improvements are in bold.

Pseudo-word repetition, reading in 1 minute, and phoneme fusion all had statistically significant improvements immediately after CMT as shown in table 5. Additionally, there was no decline in any of the assessment six weeks following the end of CMT.²

DISCUSSION

The three control trials discussed in this review suggest with statistical significance that musical therapy is beneficial in the improvement of reading ability for children with dyslexia. Although all three studies did not agree that speed of reading was increased, the accuracy of both words and phonemes had improved with a statistically significant threshold set at $p = 0.05$. Each study also assessed additional outcomes other than reading ability and speed. For example, Flaughnacco et al. also determined that the self-esteem of the children improved with statistical significance after music training was given,⁶ thereby furthering the positive impact that musical therapy can have on young dyslexics.

Improvement in phonemic accuracy and awareness was also consistently high in every study. Phonemic awareness is difficult to train and most of the time remains impaired in adult

dyslexics.⁶ Since phonemes make up the basic unit of spoken word, it is a key skill required for effective reading.

One advantage to musical therapy is that it is non-pharmacologic and can be performed as part of the school day. Furthermore, the participants do not need to be limited to children with reading difficulties as the skills acquired can benefit all students. The major hurdle would be to ensure that school systems have the funds to properly run and staff an effective music program. Since 2008, it is estimated that more than 80% of US school districts had their budgets cut, and with that the first programs to lose funding are normally the disciplines such as art, music, and foreign language.¹⁰ Preserving these programs is imperative to ensure children have all the necessary resources at their disposal to overcome challenges such as dyslexia. To do so, more clinical trials will likely need to be published proving the positive effect of music on cognition and reading ability.

A limitation of the studies discussed here is the population size and sample selection. The largest study finished with 235 children, followed by the next largest study of 48, finally the last study only had 12 participants. Sample size alone can skew data and statistics if not large enough. Therefore, a larger population size would help to strengthen the statistics, which was an issue with Flaughnacco et al. when calculating the ICC and CI.² Larger sample sizes would help narrow the intervals. Additionally, the studies discussed in this review selected children that were all part of the same schools, or enrolled at the same programs. On one hand, that allows for more effective treatments since the interventions were performed during the school day, however, it lends itself to a population bias restricting the studies to specific communities.

A second limitation seen in all studies is the inability to fully blind the participants and their parents. Flaughnacco et al. was the only study to provide a sufficient control group in the

form of painting classes,⁶ and although the intervention itself cannot be blinded, the expectation for greater improvement can be blinded. Since both the treatment and control would be receiving a therapy, any parental interventions can be assumed to be minimal since it can be assumed to occur with both groups. Studies without a control group are subject to parental intervention that could influence the results such as extra attention to reading homework.

CONCLUSION

Musical therapy is an effective intervention in improving reading ability in children aged 8-10 with dyslexia. The trials showed statistically significant improvement in pseudo-word, word, and in-text accuracy, reading speed, and phonemic awareness after musical training was provided. Based on these results, musical therapy should be considered as a primary treatment option for school-aged children with reading difficulties.

In order to strengthen the effectiveness of musical therapy on dyslexia, additional studies should be performed to compare musical therapy against non-musical interventions such as private tutoring time or other creative alternatives such as art classes. These studies should be performed with as random a sample as possible and with a larger study population than the ones reviewed here. After these studies are completed, if musical interventions still prove to be effective, studies comparing specific musical interventions should be completed to better the efficiency of the therapy provided to the children. For example, compositional music education should be compared to instrumental music education to determine if one is more effective at improving reading accuracy or speed than the other.

REFERENCES

1. Siegel LS. Perspectives on dyslexia. *Paediatrics & Child Health*. 2006;11(9):581-587.
2. Habib M, Lardy C, Desiles T, Commeiras C, Chobert J, Besson M. Music and dyslexia: A new musical training method to improve reading and related disorders. *Front Psychol*. 2016;7:26. doi: 10.3389/fpsyg.2016.00026 [doi].
3. Hamilton SS. Reading difficulty in children: Normal reading development and etiology of reading difficulty. https://www.uptodate.com/contents/reading-difficulty-in-children-normal-reading-development-and-etiology-of-reading-difficulty?source=search_result&search=dyslexia&selectedTitle=3~24. Published July 3, 2017. Accessed November 25, 2017.
4. Mayo Clinic Staff. Dyslexia. Mayo Clinic. <http://www.mayoclinic.org/diseases-conditions/dyslexia/symptoms-causes/dxc-20341797>. Published July 22, 2017. Accessed October 1, 2017.
5. Henderson LM, Warmington M. A sequence learning impairment in dyslexia? It depends on the task. *Research in Developmental Disabilities*. 2017;60:198-210. doi:10.1016/j.ridd.2016.11.002.
6. Flaunacco E, Lopez L, Terribili C, Montico M, Zoia S, Schon D. Music training increases phonological awareness and reading skills in developmental dyslexia: A randomized control trial. *PLoS One*. 2015;10(9):e0138715. doi: 10.1371/journal.pone.0138715 [doi].
7. Mayo Clinic Staff. Dyslexia. Mayo Clinic. <http://www.mayoclinic.org/diseases-conditions/dyslexia/diagnosis-treatment/treatment/txc-20341822>. Published July 22, 2017. Accessed October 1, 2017.
8. Family Dyslexia Cost and Support Survey. *Family Dyslexia Cost and Support Survey*. <http://www.decodingdyslexiaor.org/wp-content/uploads/2015/06/Family-Dyslexia-Cost-and-Support-Survey-final-draft.pdf>. Accessed October 1, 2017.
9. Cogo-Moreira H, Brandao de Avila CR, Ploubidis GB, Mari Jde J. Effectiveness of music education for the improvement of reading skills and academic achievement in young poor readers: A pragmatic cluster-randomized, controlled clinical trial. *PLoS One*. 2013;8(3):e59984. doi: 10.1371/journal.pone.0059984 [doi].
10. Boyd S. Extracurriculars Are Central to Learning. U.S. News. <https://www.usnews.com/opinion/articles/2014/04/28/music-art-and-language-programs-in-schools-have-long-lasting-benefits>. Published April 28, 2014. Accessed November 25, 2017.