Critical Review:
Is rhythmic music therapy effective in improving phonological awareness skills in children with dyslexia?

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The present study critically evaluates research regarding the effect of rhythmic musical therapy on the phonological awareness skills in children with dyslexia. Included is a critical review of six articles pertaining to various music interventions, with articles including nonrandomized clinical trials and mixed method designs. Overall, the results of this review suggest that rhythmic music therapy could be a beneficial supplement to traditional language therapy to improve phonological awareness skills in children with dyslexia.

Introduction

Dyslexia is a neurodevelopmental disorder, involving a cluster of symptoms that may affect the accuracy of word recognition, spelling, and decoding. According to the International Dyslexia Association (IDA), dyslexia, a specific language impairment, is the most common cause of difficulties with reading, writing, and spelling, affecting 5-20% of the general population (2012). One of the main underlying deficits in those with dyslexia is phonological awareness, which affects the individual's ability to recognize and manipulate sounds in syllables, words, and phrases (Bishop-Liebler, Welch, Huss, Thomson, & Goswami, 2014). Impairments present in dyslexia can further extend to non-linguistic deficits, such as the inability to perceive rhythm in both speech and music (Bishop-Liebler et al., 2014).

The IDA recommends structured literacy as the most effective approach to intervention for dyslexia (2018). Structured literacy is a systematic, explicit method of instruction that addresses all methods of reading comprehension, including how phonology, orthography, syntax, morphology, and semantics work together (IDA, 2018). Students begin learning phonemes, which are smallest units of language, and build up to put together large words and sentences, allowing them to develop decoding skills (IDA, 2018). Other research has shown the importance of using multisensory techniques to develop reading skills, such as focusing on building connections between visual, auditory, and kinesthetic/tactile domains to improve deficits (Al Otaiba, Rouse, & Baker, 2018). This approach supports the role of music therapy in intervention for dyslexia.

As music and language have been found to share similar structural characteristics, music therapy has been suggested as an effective treatment for the improvement of various communication disorders (Hobson, 2006). These disorders include but are not limited to aphasia, apraxia, dysarthria, Autism Spectrum Disorder, and specific language impairments (Hobson, 2006). As dyslexia is considered a specific language impairment, research suggests that music therapy may be beneficial in improving the deficits associated with dyslexia (Rolka and Silverman, 2015). One linguistic and non-linguistic skill evident in the music-language relationship is auditory processing (Kraus & Banai, 2007). Deficits in auditory processing have been found in children with dyslexia, with further evidence indicating the potential impact of auditory processing deficits on phonological awareness skills in children with dyslexia (Flaugnacco, Lopez, Terribili, Zoia, Buda, Tilli, Monasta, Montico, Silia, Ronfani, & Schön, 2014). Accordingly, music therapy targeting auditory processing skills has been theorized to improve phonological awareness deficits in children with dyslexia. This review aims to critically examine the literature to determine what effects rhythmic musical interventions have on the phonological awareness skills of children with dyslexia.

Objectives

The primary objective of this review is to critically evaluate current literature regarding the effectiveness of rhythmic music therapy on the phonological awareness skills in children with dyslexia.

Methods

Search Strategy
An online search through the computerized databases of PubMed, PsycINFO, and JSTOR was completed. The following key words were used in the search: (music) AND (dyslexia) AND (phonological) AND (intervention). Reference lists of previously selected articles were reviewed to obtain further relevant

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articles. The search was limited to articles written in English or French from the years 2000-2019.

<u>Selection Criteria</u>
In order to be included in the review, articles must have met the following inclusion criteria: the use of music therapy or rhythmic intervention training, participants being children with dyslexia or at a strong risk for dyslexia, and phonological awareness or skills included as outcome measures.

<u>Data Collection</u>
The literature search generated six articles which met the aforementioned selection criteria. The articles included (4) nonrandomized clinical trials and (2) mixed methods designs which included a combination of single subject design and nonrandomized clinical trials.

Results

<u>Nonrandomized clinical trials</u>
A nonrandomized clinical trial uses a non-randomized control group or condition to determine the effectiveness of an intervention. Implementation of this format is effective when factors are unable to be randomized. The lack of a blinding procedure in this design may lead to observational biases. Regardless, this design provides a high level of evidence.

Flaugnacco, Lopez, Terribili, Montico, Zoia, and Schön (2015) conducted a study with 48 children with a diagnosis of dyslexia. Participants underwent seven months of intervention in a group setting (twice per week for an hour) and individually at home with parental supervision (20 minutes per day). The children were assigned to a music group or a painting group (control). The study was done in a test, rehabilitation, re-test format, with various assessment tests and batteries testing cognition, phonological awareness (blending and segmentation), reading abilities, self-esteem, rise time, temporal anisochrony, tapping, rhythm reproduction, and perception of musical meter.

The methods employed in this paper were appropriate for their hypotheses. Participants were selected based on strict inclusion and exclusion criteria. Pseudo-randomization was employed following a baseline assessment to ensure that there were no significant differences in the dependent variables between the groups. Results of the study indicated that the music group had improved certain reading skills and phonological skills in comparison to the painting group. Music training was able to improve severely impaired phonological and reading abilities in children with dyslexia.

The researchers performed appropriate nonparametric statistical analyses to determine that results were not due to motivational effects or self-esteem effects following intervention. No extraneous variables were identified as being potentially influential in the results. This study used a single blind method, with the addition of clinicians being blinded during data analysis to reduce bias. The assessments were performed by neuropsychologists and neurologists; however, the number of clinicians was not specified. In addition, it is unclear whether the assessments were randomized or not, both between each participant and following the test-retest format.

Flaugnacco et al. (2015) provided compelling evidence that music therapy, specifically targeting temporal processing and rhythm, is influential in improving reading skills and phonological awareness in children with dyslexia.

Habib, Lardy, Desiles, Commeiras, Chobert, and Besson (2016) developed a music intervention program that targeted the temporal and rhythmic aspects of music to determine if certain linguistic and non-linguistic deficits in children with dyslexia, including temporal, perceptual, and rhythmic challenges, could be remediated.

In their research, two experimental studies were completed. The first study involved implementing their intervention, Cognitivo-Musical Training (CMT), over a three-day period (for 18 hours in total). The second study involved implementing CMT over a six-week period (for 18 hours in total) with the intent of addressing unanswered questions arising from their first study. Children with dyslexia (N=12) were reading age matched to 22 children with normal reading ability. An assessment targeting various aspects of music was completed before and after the intervention. In the second study, 12 different children with dyslexia were categorized, based on school criteria determined by a teaching team, into three groups according to their reading abilities: 1) just stepped into reading; 2) did not reach automation in reading; 3) reached automation in reading). The children in each group were of various ages. Accordingly, similar but easier tasks for the intervention were given to the younger children compared to the more challenging tasks given to the older children. The children were also assessed using language, reading, and cognitive psychometric tests at four time points—before, twice during, and after the intervention.

Results of the study indicated that CMT positively influenced temporal components of speech, as well as other speech aspects, including phonological awareness. Treatment protocol was reported adequately and in detail. Appropriate data analyses were completed to compare the results of the two studies. In the second study, testing at four different time points was beneficial in removing the potential of a motivational bias.

A limitation of the study is the small sample size, as is common in studies regarding developmental dyslexia. In the second experiment, an additional caveat affecting generalizability arose from the lack of criteria reported in determining the categorization of reading abilities. Overall, this paper did not report reliability measures. No analyses were run comparing the differences between groups.

Accordingly, this study provides mildly compelling evidence that music training is beneficial to improving the phonological deficit present in children with dyslexia.

Overy (2000) completed a nonrandomized clinical trial to examine the nature of timing deficits in musical abilities in children with dyslexia, and if music training focused on timing skills helps improve language and literacy skills. Children with a strong risk for dyslexia (N=6) (based on the Dyslexia Screening Test) were matched with 16 controls, children with "no risk" for dyslexia. All children were pre-tested on WORD reading and spelling tests, along with particular music tests that had been developed to test specific music skills, including rhythm perception, production, and processing, metre skills, and rapid temporal processing. After receiving training for one whole school year, the children were post-tested.

Inclusion criteria was relatively strict as participants were drawn from one class receiving a specific music program, with the requirement that none of the children had received formal music lessons outside of school. Information pertaining to the teacher's qualifications were provided, but apart from that, minimal details were given regarding the specifics of the implementation of the music training. This study had a lack of diagnostic criteria employed as children were identified as dyslexic based solely on their score on the Dyslexia Screening Test. However, authors argued that due to the young age of the participants (M = 6;8), an official diagnosis was not possible. This lack of diagnosis challenges the validity of the study. An additional caveat to this research was the

small sample size: a common issue for studies investigating this heterogenous population.

Results of the study indicated that significant improvements were seen in phonological skills following musical intervention, and in addition, spelling skills improved. However, these two areas of improvement did not generalize to reading skills. Overall, this study provides somewhat compelling evidence to support the use of musical intervention to improve phonological awareness in children with dyslexia.

Thomson, Leong, & Goswami (2012) assigned 33 children with dyslexia to one of three groups to determine the most effective treatment for developmental dyslexia: 1) a novel rhythmic processing intervention; 2) a commercially available phoneme discrimination intervention; 3) a control group. Intervention was implemented one-on-one for 30 minutes per week for six weeks. Baseline measures were completed by a variety of assessment tests and batteries, with assessments examining a variety of linguistic and musical skill areas.

Appropriate inclusion and exclusion criteria were reported. Randomization of participants was limited due to a qualification outlined in a longitudinal study performed by the same researchers, from which 10 of the participants were drawn, specifying that those participants were to receive intervention of some form. This randomization affects the level of evidence of this study, meaning that this study is not a true nonrandomized clinical trial nor a randomized clinical trial, despite the fact that the remaining participants were randomly assigned to groups. Analyses were run to indicate no significant differences between the groups pre-intervention. As the variables within each group deviated from a normal distribution, nonparametric tests were used to determine the results. A further limitation of this study is the lack of blinding, as neither of the participants nor the investigators were blinded, posing a threat to this study's validity. Further, the study included no details outlining of the order of testing suggesting the potential influence of order effects.

Results indicated that both intervention groups demonstrated improvements compared to the control group in terms of auditory, phonological, and literacy performance. Significant gains were made for both interventions in phonological awareness at both rhyme and phoneme levels, with large effect sizes shown at the phoneme level. Thomson, Leong, & Goswami (2012) provided highly suggestive

evidence for the use of 1:1 rhythmic auditory training to improve phonological skills in children with dyslexia.

Mixed methods design
A mixed methods design incorporates one or more different experimental designs into the study. The following studies were comprised of nonrandomized clinical trials, as described earlier, or single-subject designs. A single subject design (SSD) is used in smaller sample sizes where the manipulation of variables occurs to compare treatment effects, with participants typically acting as their own control. Resulting from this smaller sample size, these studies can be at risk for sample selection bias or low statistical power. A further limitation of the sample size is the generalizability of the study, as SSDs typically need multiple studies to demonstrate the effectiveness of an intervention.

Forgeard, Schlaug, Norton, Rosam, Iyengar, and Winner (2008) completed four experimental studies to determine if music and language skills were related. Three studies were nonrandomized clinical trials, with the remaining study being a single subject design. The first study sought to measure if children with musical training demonstrated a stronger relationship between musical discrimination and phonological skills than those without training. The sample was comprised of 44 children, divided into a music group (N=32) and a control group (N=12). Results indicated that children receiving musical intervention demonstrated a stronger relationship between phonological skills and pitch-processing than children not receiving intervention. The second study measured reading ability in 10 children with and without music training. Reading ability was determined by a battery of language and intelligence tests. Results indicated that musical skills are strongly related to reading abilities. The third study sought to determine if there were deficits in certain musical abilities (when compared to the norms in Gordon's Intermediate Measures of Music Audiation) for children with dyslexia. Results indicated that the 31 children with dyslexia demonstrated deficits in melodic and rhythmic discrimination in comparison to the norms. The final study compared five children with dyslexia, five children with normal-reading ability who were receiving music training, and five children with normal reading ability who were not receiving music training. Results indicated that children with dyslexia had significantly lower melodic and rhythmic discrimination abilities than those children with normal reading ability. Normal-reading children with music training surpassed both other groups on melodic discrimination tasks.

Participants were drawn from dyslexia-specialized schools or from a longitudinal study conducted by the same researchers at the time, where the skills of normal-reading children were compared to those of children with dyslexia. Appropriate analyses were run for each study and included in the article, along with appropriate outcome measures and use of statistical analyses. Limitations of this series of studies included small sample sizes, a lack of reported results comparing the four studies overall, and a lack of reliability and validity measures.

Overall, the results of all four studies indicated a strong relationship between musical discrimination abilities and language-related skills in children. In children with normal reading ability, melodic discrimination ability was observed to predict phonological and reading skills. These results are taken in combination with the findings revealing deficits in pitch and rhythm processing in children with dyslexia, and the results indicating a more significant than expected global impairment in music skills. Overall, these findings suggest that if music training improves skills in normal reading children without impairments, it may generalize to a population of dyslexia. As this was not directly tested, results of all four studies provide somewhat suggestive evidence, that by targeting pitch and rhythm processing in children with dyslexia, musical intervention may help improve phonological and reading skills.

Overy (2003) sought to determine if children with dyslexia have difficulty with musical timing skills, and if classroom-based music lessons can have a positive effect on the phonological, spelling, and reading skills of these children. In the first of three exploratory experiments, 28 children were organized into three groups based on their Dyslexia Screening Test Score – those with strong risk, mild risk, and no risk for dyslexia. Singing-based music lessons were completed for one hour per week and were led by the classroom teacher. Children were tested pre- and post-intervention on language, literacy, and music skills. The second study further investigated if classroom-based music lessons improved various language and literacy skills. In this study, nine boys with a diagnosis of dyslexia received 15 weeks of music therapy, totalling one hour per week, with testing completed throughout to monitor development. The third study further examined the specific musical timing deficits in children with dyslexia. The study, comprised of 15 boys with dyslexia and a control group of 11 typically reading children, completed a variety of music, literacy, and language tests. Results of the test were compared to

determine deficits in children with dyslexia. The two former experiments were relevant for the purpose of this appraisal.

This research study lacked accurate reporting of the methods and results. Participants in the first study were classified into three groups based on their risk of dyslexia. The lack of a true dyslexia diagnosis challenges the validity of the results; however, the lack of a diagnosis was likely due to participants being too young to have an official diagnosis (M = 6.7 years). The following study included children with a diagnosis of dyslexia (M = 8.8 years), however it was not specified how or by whom they were diagnosed. There was limited detail provided, in all studies, indicating how the assessment or intervention was conducted. Assessments were listed generally for the first two studies, however no details on the specific tasks assessed were provided. The studies stated that appropriate outcome measures were conducted, however limited statistical reporting was provided. No reliability or validity scores were reported.

Results of the first two studies demonstrated improvement in phonological skills and spelling skills, but no improvement in reading skills. These results, with consideration for the design of the study, lead to minimally suggestive findings that music therapy is a suitable intervention to improve phonological awareness skills in children with dyslexia.

Discussion

This paper sought to evaluate the existing literature regarding the effect of rhythmic musical intervention on phonological awareness skills in children with dyslexia. Six articles were identified for inclusion in this review. Of these articles reviewed, three articles provided compelling evidence that music therapy is influential in improving phonological awareness skills in children with dyslexia (Flaugnacco et al., 2015; Habib et al., 2016; and Overy, 2000), whereas the remaining three articles provide suggestive evidence (Forgeard et al., 2008; Overy, 2003; and Thomson, Leong, & Goswami, 2012).

All of the included studies targeted rhythmic aspects of music in their music therapy programs (Flaugnacco et al., 2015; Forgeard et al., 2008; Habib et al., 2016; Overy, 2000; Overy 2003; and Thomson, Leong, & Goswami, 2012). Four studies targeted both rhythmic and temporal skills (Flaugnacco et al., 2015; Habib et al., 2016; Overy, 2000; and Overy, 2003). Three of the four studies targeting temporal

and rhythmic aspects of music, with Overy's (2003) study being the exception, provided compelling evidence for the implementation of music therapy as a means of improving phonological skills in children with dyslexia. This evidence suggests that in addition to rhythm, temporal aspects of music could be targeted as well. This supports the idea that temporal processing deficits, a component of auditory deficits present in children with dyslexia (Flaugnacco et al, 2014), could be remediated following intervention. Forgeard et al. (2008) focused on pitch in addition to rhythmic skills, and although other studies did not target pitch skills in their intervention, two studies (Flaugnacco et al., 2015; Habib et al., 2016) acknowledged the impact that pitch may have on certain linguistic skills.

All studies provided evidence for the improvement of phonological skills following rhythmic musical intervention (Flaugnacco et al., 2015; Forgeard et al., 2008; Habib et al., 2016; Overy, 2000; Overy, 2003; and Thomson, Leong, & Goswami, 2012). Accordingly, the consistency in the results of all studies following intervention provides compelling evidence in support of implementing rhythmic music therapy as a supplement to improve phonological awareness skills. Despite the overall improvements in phonological abilities, studies were divided regarding the impact of rhythmic musical intervention on reading skills. Four studies found that reading or literacy skills improved following rhythmic music intervention (Flaugnacco et al., 2015; Forgeard et al., 2008; Habib et al., 2016; and Thomson, Leong, & Goswami, 2012), however Overy's two studies (2000; 2003) indicated no improvement in reading skills. It is important to note that in Overy's studies, participants were classified according to their risk of having dyslexia, rather than having an official diagnosis. This unofficial method of classification, along with Overy's research being preliminary in this field, could indicate that future, more current research may provide evidence of a link between improvement in reading skills and rhythmic music intervention. Further studies should be completed to determine the impact of overall reading skills following rhythmic music intervention.

Although no other skills were consistently targeted throughout all of the studies, Overy (2003) reported an improvement in spelling skills and Habib et al. (2016) indicated an improvement in auditory attention. These results indicate a need for research that targets a variety of outcome measures, including but not limited to spelling skills and auditory attention skills.

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The generalizability of the results is limited by the small sample sizes present in each of the studies. Due to the heterogenous nature of this population, obtaining large sample sizes is challenging, which in turn, compromises the overall validity of the study. Further limitations include the inconsistency of diagnostic criteria across all studies, as each study had different inclusion criteria and had different professionals "diagnosing" dyslexia in participants. The reliability of the data is also impacted by the variety of music therapy programs included in these studies, as each music therapy program incorporated different components to target rhythm. For example, Habib et al. (2016) created their own music therapy program, CMT, which used exercises, instruments (e.g., piano), and dancing, whereas Thomson, Leong, & Goswami (2013) created their own version of a rhythmic intervention incorporating drumming and games to be compared with a commercially available phoneme discrimination program. The lack of uniformity in the novel interventions created or used by each researcher impacts the generalizability of the results. In addition, each intervention varied in its length of implementation and qualification of instructors, further limiting the validity of the findings.

Conclusion

Although the evidence from all studies varied, taken together, the overall improvements of deficits of phonological skills across all studies provide compelling evidence for the implementation of music therapy. Results suggest that rhythmic music intervention may also improve reading skills, however additional research is needed to further investigate this topic. It may be beneficial for future studies to target additional outcome measures, including spelling and auditory attention. Future research should continue to investigate and clarify the role of rhythmic music intervention independent of a traditional language approach.

Clinical Implications

Based on the results of this review, clinicians working with children with dyslexia should consider implementing music therapy to complement traditional language therapy. Music therapy, in combination with a more typical language therapy approach, may work to improve the phonological awareness deficits present in children with dyslexia. While the validity of the studies reviewed is varied, overall evidence indicated the benefits of implementing music therapy to remediate a variety of linguistic and non-linguistic deficits present in those

with dyslexia. However, until further research takes place, music therapy should not be used in place of traditional language therapy in children with dyslexia, but rather used to supplement traditional intervention.

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