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Singing Competency and Language Abilities in Children

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SINGING COMPETENCY AND LANGUAGE ABILITIES IN CHILDREN

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Abstract

Past research found that there seems to be a relationship between musical and non-musical abilities. Specifically, research has identified many benefits of singing for children. Singing has been linked to certain language skills such as pronunciation, the learning of vocabulary, and sentence structure. Singing has also been used as a means of improving language abilities in children with language and mental delays. The present study aimed to identify if there was a direct correlation between singing competency and language abilities in children. In the present study, language abilities were measured using the Peabody Picture Vocabulary Test and the Expressive One Word Picture Vocabulary Test, and singing competency was defined and measured as an ability to match a model's pitch, timing, and contour. A total of sixteen children between the ages of two and five were tested. The results showed no significant correlation between singing competency and language abilities independent of age. Age did not correlate with ability to match timing or pitch, but a significant relationship was found between age and ability to match contour.

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Introduction

Singing is a common practice in early years, and children are often exposed to music from an early age; mothers sing to their children from the time they are born, and singing and music is often incorporated into classroom activities in primary years. Singing is an ability that humans possess naturally. It incorporates sensory, motor, cognitive, social, and emotional aspects that are important to recognize (Cohen, Armstrong, Lannan & Coady, 2009). Research in the field has aimed to identify the benefits and importance of singing and music exposure in the early years.

The Use and Benefits of Singing in Early Years

Many quasi-experiments have aimed to identify whether children who have had musical lessons also perform better on tests of other, non-musical competencies, such as intelligence and language (Schellenberg 2001). However, Schellenberg (2001) conducted the first and only true experiment to date in which children were randomly assigned to one of three groups to see if musical experience influences other abilities. Depending on their group, children were either assigned to have musical instruction, either vocal or keyboard, or the child was placed in the control group in which no such musical instruction was given (Schellenberg, 2005). All participants were 6 years of age, and at the beginning of the experiment, all children took standardized tests of intelligence (the WISC-III, the Kaufman Test of Educational Achievement, and the Parent Rating Scale of the Behavioral Assessment System for Children) before the onset of musical lessons. Children placed in the experimental group had a total of 36 weeks of musical training. At the end of the experiment, all participants re-took the intelligence tests that had been taken previously. While all groups showed a significant increase in IQ scores, this was

attributed to the normal increase in performance that occurs over the course of development. However, what was most interesting to the researchers was that children who had taken part in musical training lessons over the year experienced significantly larger increases in IQ than the control group. This study provided the first experimental evidence of the effect of musical abilities on non-musical abilities, but it still raises the question of which specific aspects of intelligence increased as a result of musical instruction. It may be that the influence of music on intelligence test scores is due to the relationship between music and language since language and intelligence test scores are highly related (Dunn & Dunn, 2007).

The relationship between musical abilities and language abilities can be seen through the use of song in young children. Children are often introduced to patterned text through the use of songs, chants and rhymes. Through repetition of these songs, chants and rhymes, children are able to form a more meaningful and deeper understanding of the language and text in the appropriate context (Paquette & Rieg, 2008). Specifically, through the use of songs children can experience and learn crucial language skills such as sentence structure, patterns, vocabulary, pronunciation, and rhythm (Paquette & Rieg, 2008). Thus, singing in the classroom in early years holds much potential to provide children with learning opportunities that are latent or non-explicit; students can learn and develop many important skills through the use of songs, but are not necessarily aware of what they are learning, or that they are learning at all.

More specifically, reading and singing utilize many of the same fundamental skills and abilities. For instance, reading and singing both require sensitivity to phonological and tonal distinctions (Butzlaff, 2000). In addition, through learning the

lyrics of a song, children are provided with exposure to language. This language is often repetitive, making it easier to learn for children (Butzlaff, 2000). Children may also be exposed to new vocabulary and language through the use of song. Through the process of singing and music in general, children are able to refine skills that are fundamental to reading and other language abilities. Butzlaff (2000) conducted a meta-analysis to find out if there was evidence that music may be used as a means of improving reading abilities in children. While it was found that students studying music had significantly higher reading scores on standardized reading tests, it is unclear exactly why this is the case. However, it is evident that musical learning and language share some commonalities, and that there is a positive relationship between music experience and reading abilities in children.

Some researchers have suggested that motivational factors related to singing influence learning in other domains. Singing promotes a casual and safe environment that is appealing to children, and this helps to promote an overall positive attitude towards language learning. Woodall and Ziembroski suggested that singing can be easily integrated into everyday activities in all subjects for children, and thus is an easy way for children to gain exposure to rich language in a manner that is pleasing to them (as cited by Paquette & Rieg, 2008). Both listening to songs and singing are commonly used to shape fundamental skills such as reading, writing, listening and speaking (Paquette & Rieg, 2008). Utilizing language-rich songs is a means of generating interest, fostering creativity, and developing an overall positive attitude towards learning in early years classrooms (Paquette & Rieg, 2008). The use of music and songs in primary years is vital for developing all of these important skills (Paquette & Rieg, 2008).

Differing Musical and Singing Abilities in Children

As with any human ability, variations between musical and singing abilities exist among children; some children perform better than others. Researchers have suggested that singing ability can be systematically defined as an ability to sing with accurate pitch, and many studies have used this as a basis of measuring singing ability (Mang, 2006). General trends in singing ability have been found to be related to context, age and gender.

Singing in school occurs both on an individual basis and in groups, as in the case of school choirs. A study conducted by Cooper (1995) aimed to address whether singing ability changed as a result of context (i.e., if children performed better individually than in a group setting). The study utilized a within-subjects design, and tested children from grade one through five. Children repeated a 4 beat melodic pattern. Vocal pitch accuracy scores measured singing ability, and deviations from the correct pitch (either sharp or flat) were calculated using a computerized database. The study found that there was no significant difference between a person's ability to sing individually or within a group. In addition, while the study found that the oldest children did have the highest vocal pitch accuracy scores, and thus the highest singing ability, they did not find a main effect for age. In other words, it was not found that improvement in singing ability is successive as a function of age.

A study conducted by Welch, Sergeant and White (1997) studied children's singing ability in a longitudinal fashion. The study sampled 184 boys and girls and tested their abilities at age 5, 6, and again at 7. The study analyzed pitch to measure singing ability, and tested pitch glides, pitch patterns, and vocal pitch accuracy over the course of two songs. In general, the study found a steady improvement in both boys' and girls'

Vocal Pitch Accuracy Scores over the three years of testing. While the study found that boys and girls' Vocal Pitch Accuracy remained consistently close over all three years, girls generally had greater scores for song performance. Specifically, the study found that in the third year of testing, girls achieved significantly higher Vocal Pitch Accuracy scores than boys. In addition, the researchers provided some hypotheses as to why these differences in singing ability existed between genders. Specifically, the researchers suggested that singing songs combines language abilities with vocal pitch matching and that the reasons for a poorer performance in boys could be due to a reflection of their language development, as boys' reading competency is significantly poorer than girls' at the age of 7 (Welch et al., 1997, Sammons, 1995).

Singing and Language

As hypothesized by Welch et al. (1997), the reason for gender and age differences in singing competencies may be due to an underlying confound of language ability. More specifically, others have hypothesized that singing and language abilities rely on similar cognitive resources, and thus utilize similar systems and resources (Carlson, Friberg, Frydén, Granström & Sundberg, 1989). The theory of cognitive overlap between singing and language abilities may explain the similar trends that can be found in language abilities and in singing abilities.

For instance, as language abilities improve naturally with age over the course of development, singing abilities too become more refined. Welch, Sergeant and White (1998) accounted for age differences in singing abilities with language. They theorized that during the first years of schooling, children are more likely to focus on learning correct words of a song, as they are still learning linguistic concepts and structures, and

only later focus on achieving correct pitch. The study was conducted in a longitudinal fashion and measured children's ability to sing two songs each year that were taught to them by their regular music teacher. While word accuracy improved over the first two years of schooling, it was not until the third year of schooling that a significant improvement was found in singing competency, specifically pitch accuracy. These findings illustrate the use of singing as a means to develop fundamental language abilities. Interestingly, the study also gives supporting evidence that gender differences in singing ability may actually be due, at least in part, to differences in language abilities.

Additionally, the theory that singing and language abilities rely on similar cognitive resources can help account for the gender differences observed in singing abilities. If this theory is true, the reason for gender differences in singing ability may simply be due to the fact that language abilities are different between boys and girls. Sammons (1995) conducted a 9-year longitudinal study and examined certain factors affecting student achievement. The study found that in junior schooling years, gender had a significant effect on reading competency, with boys performing more poorly than girls. If it is assumed that females do have better reading abilities than boys in general, it may be reasonable to conclude that this is also why boys tend to perform more poorly on song singing tasks. With these findings, the theory that language and singing abilities share similar cognitive resources seems to hold weight. However, these studies simply make the assumption that poorer singing performance is related to language ability. Welch et al. (1998) did not test language ability in his sample of singers nor did he investigate changes in language ability as singing improved.

Singing as a Tool in Language Recovery

The theory that singing and language utilize similar cognitive resources is supported by studies that examine the use of singing as a means of language improvement. Miller suggested that singing shares many of the specific behaviours and skills that are necessary for speech production, and thus singing may be an effective way to improve these behaviours and skills in children facing developmental or language delays (as cited by Hoskins, 1988). Hoskins (1988) sampled a population of sixteen 2- to 5-year-old children with developmental and mental delays. Before the experiment, children were given the Expressive One-Word Picture Vocabulary Test (EOWPVT) and the Peabody Picture Vocabulary Test (PPVT). The children then underwent a 10-week experimental therapy program, meeting 3 days a week for 30 minutes. The therapy incorporated the use of song into language activities, by having children participate in music activities that had a strong emphasis on improving expressive language skills. The session began with the group singing a familiar song, and children were encouraged to sing as many words as possible. The therapist also showed a picture of an object to the children and sang a three to five word phrase about that object at the end of every session, and the children were instructed to repeat it back to the therapist. At the end of the 10-week treatment, it was found that children had significantly improved their scores on the Peabody Picture Vocabulary Test. From these findings it is evident that there is a relationship between language and singing abilities, and it seems likely that the two share some cognitive resources. Specifically, if singing may be used as a means to improve language abilities in children, it is reasonable to predict that children with greater language abilities will also have greater singing abilities.

The Present Study

Although previous research has suggested that singing and language abilities may be linked, the complex relationship between them is still not fully understood. The present study aimed to find whether there was a correlation between children's singing competency (pitch accuracy, phrase contour, and correct timing) and their language abilities. In addition, the study examined whether certain trends found in language abilities between genders and age groups would directly transfer to singing abilities. This was done through testing the same children in both dimensions, and thus seeing whether individual children with poorer language abilities (both expressive and receptive) also had poorer singing abilities. It was predicted that language and singing abilities would be positively correlated. It was also predicted that girls would score better than boys in both categories. In addition, it was predicted that singing and language abilities would consistently improve with age, as is considered normal over the course of development.

Method

Participants

Participants in the study were all children who attended the Dr. Mary J. Wright University Laboratory School at Western University. The school is comprised of a morning toddler class, morning and afternoon preschool classes, and full-day Junior and Senior Kindergarten, and thus welcomes children between the ages of 2 and 6. Letters of information and consent forms were sent out to all parents of 65 children in those classes, and only children whose parents returned those forms signed with consent were eligible to participate. A total of 29 consent forms were returned with parents agreeing to have their child participate. After testing, however, it was found that thirteen sets of data were

unusable. A set of data was considered unusable if the child did not provide a clear singing sample to be analyzed. Therefore, the final sample included sixteen children. The active participants were composed of an equal number of males and females. Furthermore, the participants included one 2-year-old, nine 3-year-olds, three 4-year-olds, and three 5-year-olds. The average age of participants was 4;0.20 (years;months), with a standard deviation of 0;9.93 (years;months).

Materials

To measure singing abilities, the AIRS Test Battery for Children was administered (See Appendix I for the procedure). The battery is a modified version of the original AIRS Test Battery, which was designed for adults (Cohen et al., 2009). The children's version consists of 11 components, of which some contain smaller sub-components. To measure receptive language, the Peabody Picture Vocabulary Test – Fourth Edition (PPVT-4; Dunn & Dunn, 2007) was administered, and for expressive language the Expressive One Word Picture Vocabulary Test-Fourth Edition (EOWPVT-4; Martin & Brownell , 2011) was used.

The Child's Singing Development and Music Exposure questionnaire (see Appendix II) was completed by parents of children attending the Lab School at the beginning of the school year as part of a larger data collection endeavour. The data from this questionnaire was used in this study for children whose parents consented to the sharing of the data with researchers doing research at the Lab School. Not all parents agreed to share the data and not all parents agreed to the completion of the questionnaire. Of the 16 participants whose data is included in this study, 13 had complete questionnaire data from consenting parents.

Tasks in the AIRS test battery that involved repeating a sound or series of notes were played from a pre-recorded audio file to children via the researcher's personal computer, a MacBook Pro. A Canon Vixia HRF400 video camera was used to record children performing the singing task, both visually and auditory.

Procedure

Children who had returned signed consent forms were first familiarized with the researcher, according to the Lab School's regulations for research. The researcher spent an approximate total of 3 hours in each classroom, where children would be participating. This allowed for children to become familiar and comfortable with the researcher. After familiarization was complete, children were taken individually from their classroom during child-initiated activity. All testing was done in private rooms located behind the classrooms, and only the child and the researcher were present. If a parent was interested, he/she was able to observe his/her child's testing via a one-way mirror window, and the child was unable to see or hear the parent. After any given day involving testing, children were sent home with a short debriefing form that outlined the research that they had participated in that day.

Each child participated in at least 2 test sessions. In the first session, the AIRS Test Battery for Children was administered. The child was seated at a small round table across from the researcher. The researcher's computer was on the table in front of her so that she could play the audio clips for the child to copy in the test session. The video camera was positioned on the table in front of the child so that the child's head and shoulders were framed in the picture. The child was told that they were going to play some games involving singing, and told that they would take turns singing with a puppet

that the researcher was holding during recordings. They were also told that they could stop at any time, if they wished. After the child gave verbal agreement to participate, the researcher proceeded with the Test Battery. Children were able to skip any components that they did not wish to perform. The total time for testing was approximately 10 minutes. At the end of the testing, the child was thanked for their participation, and was walked back to class by the researcher. If necessary, the AIRS test battery was broken up into two separate days of testing. The test session was broken down into two test sessions if the child chose not to complete participation in one session by requesting to return to his or her class.

If the child had provided a clear singing sample that could be analyzed, they were taken out of class for a second day in a different week to complete the language tests. The language tests were conducted in the same small room with children seated at the same small round table. Again, children were told they could stop at anytime if they became tired. The PPVT-4 was administered first, following the EOWPVT-4. Both tests were administered according to the specified procedure for each of the standardized tests. For some children, language testing was broken up into two days if they had become tired. Each language test took approximately between 10-15 minutes, and children were never kept in the testing room for longer than 30 minutes.

Results

Data Coding

Receptive language scores were calculated according to the results of the PPVT-4 (Dunn & Dunn, 2007). Expressive language scores were calculated according to the results of the EOWPVT-4 (Martin & Brownell, 2011). Raw data scores for the PPVT-4

and EOWPVT-4 were recorded, as well as standardized scores that were age-adjusted based on the age of the child in years and months. This scoring was done according to the procedures given in each of these published test manuals.

Audio files were extracted from the digital video files for each child's AIRS test using a program called Switch Sound File Converter Plus (NCH Software Pty Ltd). Then the audio files were spliced into sections according to the sections of the AIRS battery using a program called Audacity (GNU General Public License). For this study, only one section of the AIRS battery was analyzed, the second section of the copying game (section 5B), which was composed of six syllables, all sung with the word "la" on the notes G, G, E, G, G, E. The files for this component were individually uploaded to Pitch Analyzer (2006, Elmer & MMA Tools Group), where each syllable was analyzed for stability, pitch, and timing. Singing ability was determined by three measures: pitch, timing, and contour.

Stability was a component necessary for determining the pitch for each note that would be used in the analysis. Stability was measured according to Stadler Elmer and Elmer's (2000) criteria for pitch stability. A stable pitch occurs when there is less than a 25% deviation from a particular note throughout the sung vowel. Notes that were sung with a stable portion that began or ended with an upward or downward glissando (more than 25% deviation) were coded in the second category. However, pitch scores were calculated only for the stable portion of the pitch. A third category occurred when the entire vowel was sung with an upward or downward glissando. The average frequency was used to calculate the pitch for these notes. Finally, in one instance there was too much interference in the audio recording to be confident about the sung pitch. This note

was coded with the 4th category, estimation based on disturbed signals. Pitch Analyzer (2006, Elmer & MMA Tools Group) measures pitch in frequency (Hz) and also indicates the conventional musical notation (note on the scale plus or minus a percentage deviation from absolute pitch). Pitches were assigned a numeric value according to the note on the scale (C4 = 12) plus or minus any deviation from absolute pitch, and recorded to two decimal places. Scores were then calculated for each note to see how far children's version deviated from the model they listened to. These deviation scores were then averaged out to give each child an overall score for pitch accuracy.

For every note a child sang in the copying task, the starting and ending time was recorded (in ms.). Timing was a measure of how the child followed the model's pattern in terms of note length (two short notes followed by a third, longer note), and was scored as follows: "2" if the child had the correct timing pattern for both halves of the melody (short, short, long, short, short, long), "1" if the child had the correct pattern for either the first or second half of the melody (but not both), and "0" if the child's notes were all equal length or followed some other timing pattern.

Lastly, contour was a measure of how accurately the child followed the major third contour pattern for both parts of the melody. The model that the children listen two sang "la" on the notes "G, G, E, G, G, E". The interval from G to E is a minor third interval. Therefore, the correct contour for this song pattern is two notes the same followed by a minor third down and then a repeat of that pattern. Not all children matched the pitch of the model. However, they may have sung the correct pattern of intervals (for example, E, E, C# or A, A, F#). Thus, a contour score was created to be independent of the pitch score. As long as the child sang the correct pattern, he/she would

receive a higher score on the contour measure even if the pattern did not match the "G, G, E" pitches. Scoring for contour was as follows: The child received a "5" if the child had the correct two notes the same followed by a downward minor third for both parts of the melody, "4" if the child had one correct minor third pattern in one half of the melody, "3" if the child had the pattern of two notes the same and one lower note but not a minor third, "2" if the child had a decreasing pattern that was not two notes and one lower, or if the child had not repeated the second part of the melody (only sang three notes), "1" if the child showed no pattern but did have a minor third interval between two notes (presumably by chance), and "0" if the child had no pattern.

Findings

A Pearson's correlation revealed that there was no significant relationship between children's standardized measures of language abilities and singing competency. Specifically, no relationship was found between children's Standardized PPVT-4 scores (M = 124.938, SD = 13.616) and children's ability to sing with correct timing (M = 0.938, SD = 0.854), $r(14) = -0.092$, $p > 0.05$. There was also no relationship between standardized PPVT-4 scores and ability to match pitch (M = -2.525, SD = 2.393), $r(14) = 0.183$, $p > 0.05$. In addition, standardized PPVT-4 scores did not correlate with ability to match contour (M = 3.125, SD = 1.5), $r(14) = -0.062$, $p > 0.05$. Children's standardized EOWPVT-4 scores (M = 123.75, SD = 9.747) did not correlate with ability to sing with correct timing, $r(14) = -0.290$, $p > 0.05$, match pitch, $r(14) = 0.265$, $p > 0.05$ or match contour, $r(14) = 0.135$, $p > 0.05$. The Child's Singing Development and Music Exposure questionnaire scores (M = 15.462, SD = 1.898) were not significantly correlated with any of the other measures in the study.

Furthermore, there were no significant gender differences in PPVT standardized scores, $t(14) = 0.160$ $p > 0.05$, or in EOWPVT-4 standardized scores, $t(14) = 0.706$, $p > 0.05$. There were also no significant gender differences in ability to sing with correct timing, $t(14) = 0.284$, $p > 0.05$ or match pitch $t(14) = 0.764$, $p > 0.05$. However, girls were significantly better at matching contour ($M = 3.75$, $SD = 1.165$) than boys ($M = 2.50$, $SD = 1.60$), $t(14) = 1.784$, $p < 0.049$ (one-tailed).

In addition, there were no relationships between age and PPVT standardized scores $r(14) = -0.023$, $p > 0.05$, or EOWPVT-4 standardized scores, $r(14) = 0.143$, $p > 0.05$ (this is not surprising as the purpose of the adjusted standardized scores is to account for age differences). There was, however, a significant age effect for the raw scores on the language tests, $r(14) = 0.688$, $p < 0.004$ and $r(14) = 0.817$, $p < 0.001$ (PPVT-4 & EOWPVT-4 respectively). There was also a positive relationship between age and ability to correctly match contour, $r(14) = 0.608$, $p < 0.013$ and between EOWPVT-4 raw scores and ability to match contour, $r(14) = 0.515$, $p < 0.042$. No relationship was found between age and ability to sing with correct timing, $r(14) = -0.13$, $p > 0.05$, or match pitch,
$r(14) = -0.100$, $p > 0.05$.

Lastly PPVT scores and standardized EOWPVT-4 scores were related, $r(14) = 0.713$, $p < 0.05$.

Discussion

Singing is something that is common to many children, whether they are sung to or sing themselves. It occurs both in classrooms and in homes. Theories have suggested that singing is important because it provides young children with exposure to language,

specifically through teaching them proper sentence structure, vocabulary, and pronunciation (Paquette & Rieg, 2008). The present study aimed to find if there was a direct correlation between singing competency and language abilities in children, thus giving evidence for a common cognitive factor in both tasks. However, no such relationship was found. There was a relationship between age and language skills (raw scores on the language tests) but those children with better language skills were not better able to match the pitch or timing of the songs. It is interesting, however, that older children were better able to match the contour of the sung phrase and that this was also related to their expressive language skill. The contour of a sung musical phrase is determined by the relative pitches of the sung notes. However, speech is characterized by pitch contour also. In speech, the contour or pattern of intonation can have grammatical meaning or tone. For example, in English, a rising pitch contour at the end of a sentence indicates a questioning tone. So, as children get older and have more language experience they seem to be better able to imitate the pitch contour of a sung phrase. The two language tests used, did not directly assess grammar. They were both semantic tests (vocabulary) and so it may be that a grammatical language assessment may be related to singing ability. In addition, because girls performed better on this specific component of the singing task, it may be that this is a skill that girls learn before boys do. This finding may be a precursor to the gender differences in language ability that are found in older children.

Although no gender differences were found for either language or pitch accuracy and timing, it is possible participants in the present study were too young to see such an effect. Specifically, studies that have found significant gender differences in both singing

and language abilities had children the age of 7 as participants (Welch et al., 1997; Sammons, 1995). In other words, perhaps younger children do not show these trends because gender differences emerge at an older age. This could occur through processes of socialization or simply be due to normal development. Specifically, it may be that singing is associated with more feminine qualities and thus boys engage in singing less as age increases. Or, perhaps females possess an inherently greater aptitude for singing. These theories, however, are speculation at best, and in reality could be intensely intertwined and a difficult relationship to assess.

The design of the present study could have been improved in many ways, and may have produced different results had these limitations been addressed. The sample size was relatively small, and was very specific. Most of the children tested were 3 years of age, with less 2-4-and 5-year-olds. In addition, because all children were attending a private school, the children were of upper socioeconomic status. In addition, the only children who participated were those whose parents agreed for them to partake in the study. Although unavoidable, this may have biased the sample further. For instance, a parent who felt their child was quite capable of performing the task well may have been more inclined to sign up their child. In addition, the data that was analyzed for measuring singing competency was a task that all participants had successfully completed. If a child had failed to attempt the copying task, they were simply removed from the sample. This may also contribute to a biased sample. However, there is no way to test the singing ability of a child who is unwilling to sing. Future studies may be improved by utilizing a larger, more diverse sample of children, such as testing children of varying ages, SES, and abilities.

Testing biases may have also contributed to the findings of the present study. Specifically, because children's singing abilities were tested using an entire test battery consisting of multiple components, the children may have become more tired or agitated during testing. A child's fatigue or agitation could have profound effects on the copying task. In addition, despite familiarization days with the researcher, many children remained shy when asked to sing with the researcher. It is possible that children may have been more receptive to a researcher with whom they felt more comfortable. Possible ways to ensure that these limitations are addressed in future research may be through testing the singing component in isolation, and thus reducing testing time for children. In addition, using familiar individuals to conduct the testing may increase children's receptiveness. This may be done specifically through using testers to whom children are accustomed.

Past studies have used singing as a means of improving language abilities in children with developmental and mental delays (Hoskins, 1988). However, the hypothesis that that language and singing must originate from a common denominator may have been erroneous. It is possible that singing may be a unique process altogether. Perhaps singing allows for a unique type of processing, which has been utilized to expand children's abilities and learn certain skills via an alternate route. Future research should be conducted to find new ways in which singing could be used as an alternate means of achieving certain fundamental skills in children. In addition, a future study may compare language and singing tasks through using brain imaging techniques such as fMRI to show what specific parts of the brain are activated in the two tasks and compare similarities and differences. These brain imaging techniques may also be used to show what changes in

the brain occur during music-intensive therapies which help children with language delays. This could give important insight into what is really occurring in a child's brain when they are singing. On a long-term scale, such as through the use of longitudinal studies, it could also establish the gradual changes that occur in the brain as a result of musical therapy.

While the results of the present study did not support the hypothesis, it is important to continue research on singing in children. Past research has given evidence of the many benefits to singing in younger years, and thus it is still important to continue conducting research that allows for a better understanding as to why this is. Although singing and language may not have a similar cognitive basis, singing appears to be a useful tool for children to improve upon many other important skills. Specifically, singing may offer an alternate means of learning for children with various language and mental delays. For other children, singing may allow for a more enriched type of learning, such as through providing new ways to encode information and building upon certain skills that are fundamental to language.

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Appendix I

AIRS Test Battery Procedure

(Highlighted items may be omitted if child is not able to do these items.)

Test Item	What to be tested
1. (a) Introductory conversation and (b) "Song that the child likes to sing" (rather than "a favorite song")	(a) Tester has a conversation with the child starting more generally and then asking about about music and singing: What did you do at school today? What do you like to do outside at school? What kinds of toys do you like to play with in the classroom? Do you like music? Do you like to sing? Who do you hear singing? Where do you hear singing? Tester can use a clinical interview style and add other questions dependent on the child's interests. (b) "I would like to hear you sing a song. Do you have a song that you would like to sing for me?" If yes, "Sing your song now and I will listen."
3. Range for singing voice	(a)measure the interval between the lowest and the highest pitches produced while gliding and singing. Examiner demonstrate a gliding up from C4 (middle C), and ask the child to go as high as (s)he can go by gliding. Second, the examiner demonstrates gliding down from C5 and ask the child to go as low as possible. Then the examiner shows a picture of staircase. The pre-recorded model will play notes going up while showing the puppet going up the stairs. Then, the child has a turn to show how high (s)he can go up the stairs by singing. (b) singing a major scale for 1 octave. Then, the examiner will go up the stairs by singing one or two tones more than 1 octave. Then, the measure the child's production of a major scale, The same procedure as above is used for singing a major scale down, using the same staircase picture.
4. Familiar song (1st time)	Examiner will ask "Do you know 'Are you sleeping Brother John?' If yes, let the child sing it before listening to the audio model. If no, play the audio model and ask whether the child recognizes the song. If the child does not know "Brother John" or if the child knows a different version of this song, use the song/version the child knows as "familiar song" for this child. - The child version will not do "segments."

5. Copying game (Call-response)	- The examiner will ask the child to copy what a puppet (the examiner) sings. The examiner will sing another pattern and see if the child can copy the second one as well. (Even if the child's singing is not exactly what the examiner sang, as far as the child is taking turns, the examiner can go on to the second pattern.) - 1st pattern: the original descending pattern (so-mi-mi-so-mi-) - 2nd pattern: so-so-mi-so-so-mi-) - Sing with "lala." If the child cannot do it, then try "with some words." - Then, the examiner will ask the child to begin the copying game (i.e., the examiner will copy the child this time).
6. Musical elements	The examiner will play pre-recorded musical patterns (La-la-la…) and ask the child to copy the songs: (a) the 5-tone pattern (CDEDC) (b) 6-tone pattern (DCBABC) ((c) a major triad (CEG), an augmented triad ($CEG^{\#}$) , a minor triad ($CE^{b}G$), and a diminished triad ($C\ E^{b}G^{b}$)
7. Completing a song	The examiner will play a pre-recorded musical pattern (La-la-la…) and ask the child to finish the song.
8. Composition from a picture	The examiner will show the child two pictures (a globe scene with people and a jungle scene with animals). The examiner asks the child to choose their favourite picture from the two. Then the examiner asks the child to make up a song about the picture.
9. Unfamiliar song (We are One)	The examiner plays the recorded song 3 times, and then asks the child to sings along with the model 3 times. Then the examiner asks the child to tries to sing as much as possible of the song by themself. If the child does not want to try with the words, then the child can try with lalala version.
10. Familiar song (2nd time)	The examiner asks the child if he/she remember the song "Are you sleeping Bother John?" from earlier. If yes, the child is asked to sing the song again.
11. Closing Conversation	The examiner will ask the child more open ended questions about school, weather, etc. to obtain more of a sample of the child's speaking voice if possible.

Appendix II

Child's Singing Development & Music Exposure

1. My child sings made up and/or learned songs (with words) to him/herself.

Never ____ Rarely____ Sometimes ____ Often ____ Daily ____ (scored 0 to 4)

2. My child hums made up and/or learned tunes to him/herself.

Never ____ Rarely____ Sometimes ____ Often ____ Daily ____

3. One or both parents sing songs to or with my child.

Never ____ Rarely____ Sometimes ____ Often ____ Daily ____

4. My child listens to recorded children's music.

Never ____ Rarely____ Sometimes ____ Often ____ Daily ____

5. My child listens to recorded music (not specifically for children, such as on the radio).

Never ____ Rarely____ Sometimes ____ Often ____ Daily ____

Curriculum Vitae

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