

An Overview of Current
Neuroscience Research



The Benefits of Music Education



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Your Child's Development: Music Study may be the Best Tool

A WEALTH OF SCIENTIFIC RESEARCH over the last decade is proving that music education is a powerful tool for attaining children's full intellectual, social, and creative potential.

- It speeds the development of speech and reading skills
- It trains children to focus their attention for sustained periods
- It helps children gain a sense of empathy for others

Music study requires a high degree of precision in auditory processing: being almost in tune is not good enough. This means that musically trained children are better able to distinguish subtle details of speech, leading to improved reading, better comprehension, and also a greater ability to interpret what other people – children and adults – are really saying.

Musically-trained children develop to their full potential because participation in music is inherently rewarding, making children more likely to devote the time and practice necessary to develop strong cognitive and social abilities.

Most importantly, music gives children a means to express themselves, to unleash their creativity, and to be inspired by their own boundless capacity for personal growth.

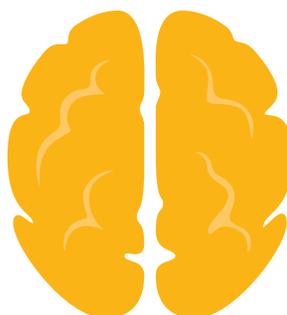
For more than 127 years, The Royal Conservatory of Music has contributed to the musical education of millions of Canadians, as well as to their academic success and social well-being. The research we highlight in this document offers compelling insights into the powerful, long-term value children gain through music study.

“Musical activity involves nearly every region of the brain that we know about, and nearly every neural subsystem.” **Daniel Levitin**, *This is Your Brain on Music*, p.299

Brains of Musically Trained Individuals



MUSIC
EDUCATION →



- **STRONGER NEURAL CONNECTIONS**
- **MORE GREY MATTER**
- **BETTER INFORMATION PROCESSING**
- **HIGHER IQ**
- **BETTER MEMORY AND ATTENTION**
- **BETTER MOTOR COORDINATION**

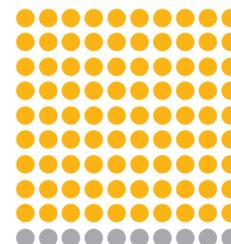
The Backstory

Over the past 20 years, several large-scale studies of school achievement have found a strong correlation between learning to play an instrument and academic success.

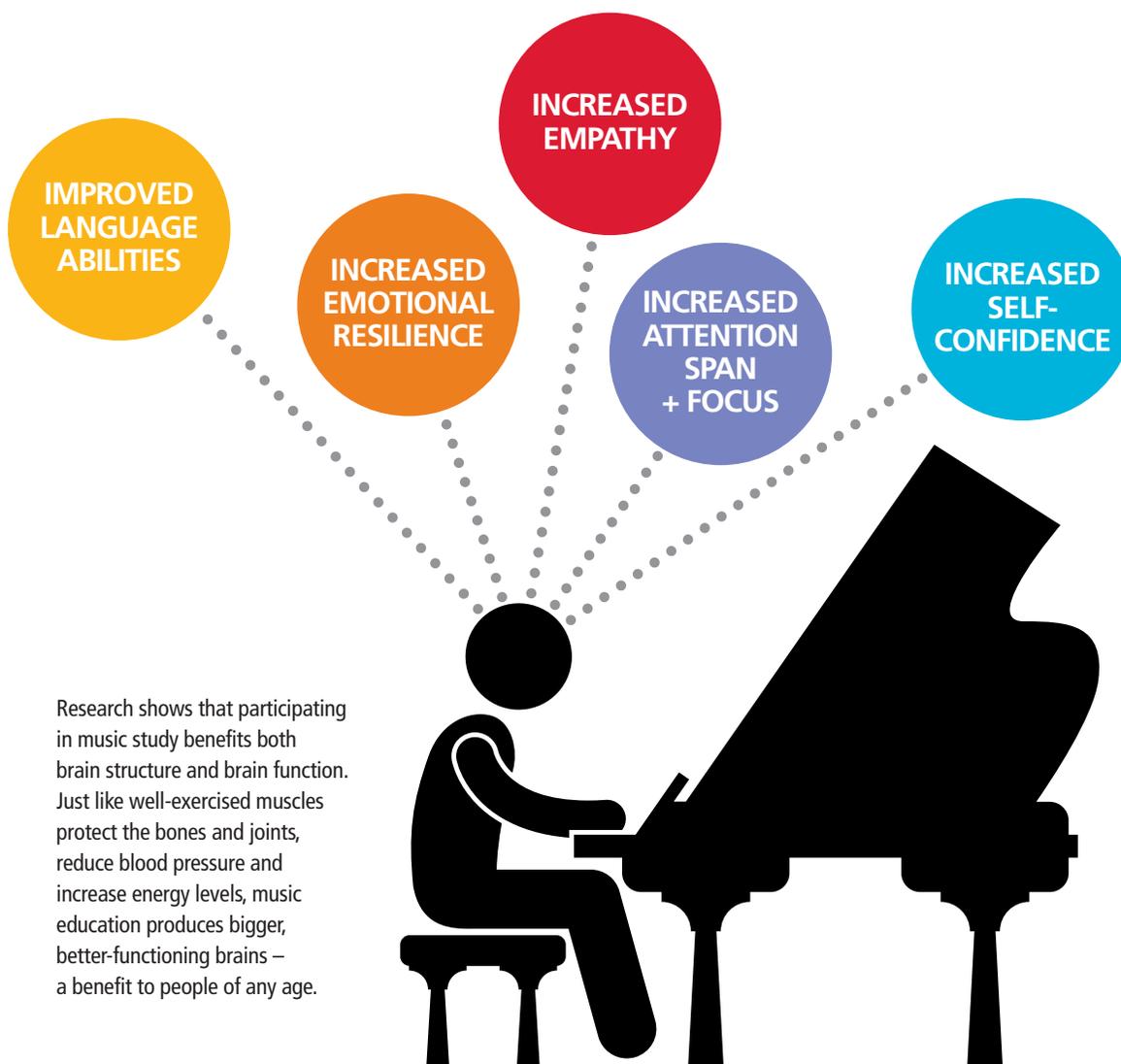
One decade-long U.S. study found that students who participated in at least nine hours of arts education a week (including music study) were **four times more likely** than their peers to have won recognition for their academic achievement, and three times more likely to have won an award for school attendance.¹

1. S.B. Heath, 1999, cited in National Endowment for the Arts 2011 White Paper *The Arts and Human Development*, p.22

A research report by Dr. Sylvain Moreno et al showed that 90% of the children who participated in their study showed a remarkable gain in intelligence after only 20 days of musical training.



The Benefits of Music Education — Quick Facts



“Our data have confirmed a rapid transfer of cognitive benefits in young children after only 20 days of music training. The strength of this effect in almost all of the children was remarkable.”

Dr. Sylvain Moreno, Rotman Research Institute

2. E. Glenn Schellenberg,
Music Lessons Enhance IQ
(Psychological Science, 15)

Scientific Proof

Now, in a research breakthrough, neuroscientists are demonstrating that there is a causal connection between music study and cognitive growth.

The use of technologies such as functional Magnetic Resonance Imaging (fMRI) and electroencephalography (EEG) has given researchers a better understanding of exactly what happens inside the brain when it processes music and how this activity contributes to better learning and functioning.

The research is showing that learning to play an instrument leads to changes in a child's brain that make it more likely **they will reach their full cognitive and academic potential.**

Participating in musical activities – whether playing an instrument, singing or listening – stimulates a whole network of brain areas, each interacting with the others to contribute to enjoyment and understanding of the music. This brain workout leads to improved structure and function through a process called neuroplasticity – the brain's ability to reorganize itself by forming new neural connections. The improvements are responsible for many of the benefits of active participation in music.

Overview of Music Study's Benefits

You may have noticed that stories about music and the brain appear frequently in the media. More than two hundred neuroscientists around the world are involved in researching the effect of music on brain function and structure, and their work is garnering regular media attention.

Musical experience draws on nearly every region of the brain, making music an ideal experimental tool to explore brain function. Following is a summary of recent findings.

IQ, Memory and Focus

Many researchers have linked music lessons with improved IQ and academic performance. In a formal study conducted through the University of Toronto and published in 2004, researchers compared the IQ performance of children in music lessons with those in drama lessons or no extra lessons at all. IQ was measured before and after the lessons.

The students in the music group showed greater increases in full-scale IQ scores than those in either of the other groups.² IQ scores are widely accepted as standardized predictors of academic achievement.

Recent studies have also indicated that **individuals who are musically trained show better working memory** abilities than those who are not. Working memory is the type of memory that allows us to remember things even while our minds are busy with other matters – crucial for such essential tasks as mental arithmetic and reading comprehension.

Much has been written about the importance of developing focus or self-discipline in children as preparation for success in life. Current research shows this is one of the key outcomes of music instruction.

Learning to play an instrument or sing requires significant levels of attention and concentration. There is evidence that children who take music lessons have greater abilities to focus their attention. Music training seems to be a very active form of mental training that increases children's cognitive capacities, enabling them to perform better in many other aspects of their life.

A CONVERSATION WITH DR. SYLVAIN MORENO

Lead Scientist,
Centre for Brain Fitness,
Rotman Research Institute

“MUSIC IS AN INCREDIBLY POWERFUL TOOL, WE’RE LEARNING.” Dr. Sylvain Moreno

DR. MORENO IS STUDYING HOW TRAINING AND REHABILITATION CAN AFFECT HIGHER ORDER PROCESSES, SUCH AS LANGUAGE AND INTELLIGENCE.

THE RCM: TELL US ABOUT YOUR WORK.

DR. MORENO: My area of expertise is in human development, and how we can impact the brains of children through musical training.

THE RCM: WHAT HAVE YOU LEARNED?

DR. MORENO: Musical training impacts a set of processes in the brain that are related to a whole host of other activities, from intelligence and reading to the ability to focus and do well in school. When we understood that musical training is beneficial, we set out to learn the exact benefits and limits.

We started this way because there is a link between music and language. They’re both auditory activities and they share the same acoustic parameters. They even share the same goal of communicating to a human being.

So we studied reading and we have shown that musical training improves reading. We looked at verbal intelligence and there was an absolute trend of improvement. These were some of the positive intellectual benefits that we measured.

THE RCM: ANY SURPRISES IN YOUR RESEARCH?

DR. MORENO: It was really astonishing to see how quickly the brain changed in response to musical training. We provided musical training to young children, and within 20 days we would see a shift in a number of cognitive areas.

We started with one simple question: “Is musical training beneficial?” and the answer that we got was a resounding “YES.” Musical training has a positive impact on a set of core neural processes that are related to focus, intelligence, reading, academics and more.

Music is an incredibly powerful tool, we’re learning.

THE RCM: HOW CONCLUSIVE WERE YOUR FINDINGS?

DR. MORENO: The standard for a typical scientific study is 60 to 70%. That is, we would have to show that musical training impacts this percentage of the participants. Our research showed that musical training impacted over 90% of the children we studied. We asked three different people to reanalyze our data to confirm our findings.

THE RCM: THIS CERTAINLY VALIDATES WHAT SO MANY CANADIAN PARENTS HAVE ALWAYS BELIEVED ABOUT THE VALUE OF MUSIC LESSONS.

A FEW WORDS ABOUT HOW DR. MORENO CONDUCTED HIS RESEARCH

DR. MORENO AND COLLEAGUES conducted a pair of studies designed to examine the effect of musical training on the developing brain. In the first of these studies, 32 eight-year-old children were given free music or painting lessons over a six month period.

None of the children had any prior music or painting training. They were randomly assigned to either the music or the painting group (so the researchers could ensure that any outcomes did not come from a biased selection).

The children were tested before and after training. These tests included measurements of reading skills, cognitive abilities, and listening abilities.

Following the training, the music group (but not the painting group) showed improvement in reading skills. They were better able to connect written words with their spoken sounds – a critical component of literacy.

The children taking music lessons were also better at hearing changes in intonation – not only in music, but also in speech – which is critical for understanding emotion and nuance in conversation.

The researchers also monitored the children’s brain waves using neuroimaging techniques. This research showed increased activity in regions associated with careful listening to speech and music.

In the second study, 48 preschool children between the ages of four and six were tested in a similar program. These children engaged in a computerized training program, led by an instructor, over the course of one month. Again children were randomly assigned to either a music or visual art group.

At the end of the training, the children who had been given music (but not visual art) lessons, improved in measures of verbal intelligence and attention. Over 90% of the children taking music lessons showed this improvement. These children also showed significant changes in their brains’ processing of items requiring a controlled response, or attention.

SOURCES

Short-Term Music Training Enhances Verbal Intelligence and Executive Function; Sylvain Moreno, Ellen Bialystok, Raluca Barac, E. Glenn Schellenberg, Nicholas J. Cepeda and Tom Chau; *Psychological Science*, 2011

Musical Training Influences Linguistic Abilities in Eight-year-old Children: More Evidence for Brain Plasticity; Sylvain Moreno, Carlos Marques, Andreia Santos, Manuela Santos, São Luís Castro and Mireille Besson; *Cerebral Cortex* (Volume 19, Issue 3), 2009

Speech and Reading Ability

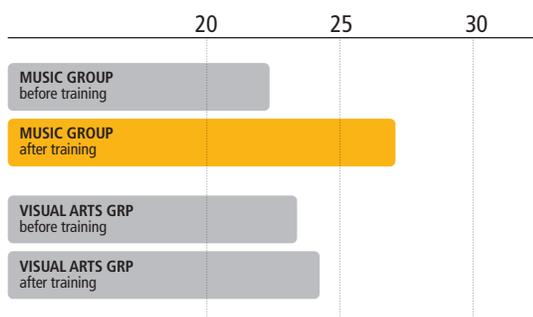
Reading, understanding and speaking a language requires the ability to identify where syllables and words begin and end. This skill is called phonological ability and uses the same areas of the brain used to identify and break up sounds. These are important skills that we gain through experience, and they help us understand our native language and new ones.

Studies have shown that musically-trained children have better phonological skills, which can help them to learn words faster, develop a richer vocabulary, and learn to read sooner.

In a 2009 Canadian study, young children taking music lessons showed dramatic improvement in their verbal intelligence scores **after only four weeks of training**. The gains from studying music were much greater than for other types of arts training.³

Improvements in speech and reading are critical to success in school, where strong literacy is a pre-requisite for nearly every subject area, including mathematics.

RAW VOCABULARY SCORE³



Creativity

Another study found a marked difference in inter-hemispheric communication (communication between the right and left sides of the brain) in individuals with musical training versus those without musical training. Scientists involved in this area of study believe the greater connectivity between brain regions may help foster increased creativity.⁴

“The theory of relativity occurred to me by intuition, and music is the driving force behind this intuition. My parents had me study the violin from the time I was six. My new discovery is the result of musical perception.” **Albert Einstein⁵**

3. Sylvain Moreno et al, *Musical Training Influences Linguistic Abilities in Eight-year-old Children: More Evidence for Brain Plasticity, Cerebral Cortex*, (Volume 19, Issue 3, 2009)

4. Gottfried Schlaug, *The Brain of Musicians – A Model for Functional and Structural Adaptation*

5. Shinichi Suzuki, 1969, *Nurtured by Love. A New Approach to Education*, p90



ANNABEL LYON
Author and 2009 Rogers
Writers' Trust Fiction
Prize Winner

Music study made me disciplined, and it's helped me to understand that you don't need to feel brilliant or inspired all the time to know that you're moving forward. Practicing scales isn't particularly exciting, and sometimes neither is writing a first draft. But I've learned to push through the harder days, knowing my persistence will pay off down the road.



JEREMIAH BROWN
Olympic Silver Medal-
winning Rower

Music has shaped my life from an early age. I think of my life as a series of increases in personal discipline. It started with piano lessons. My parents did a great job keeping me from quitting for those first two years of study, but then I began to love the music more and more and continued studying because of that love. As a youth and teenager I did not practice very much – 30 minutes a day or so. But piano lessons were my first experience sticking with something over a long period of time. This set me up for being able to pursue goals that did not come with quick rewards. Funny thing is now I am using those same experiences cultivated through sport to continue studying music more effectively.

6. Kirschner and Tomasello, *Evolution and Human Behavior*, 2010

7. Johnson, CM and Memmott JE, *Examination of Relationships between Participants in School Music Programs of Differing Quality and Standardized Test Results*, *Journal of Research in Music Education* (Winter 2006), Volume 54, Number 4

Empathy and Social Awareness

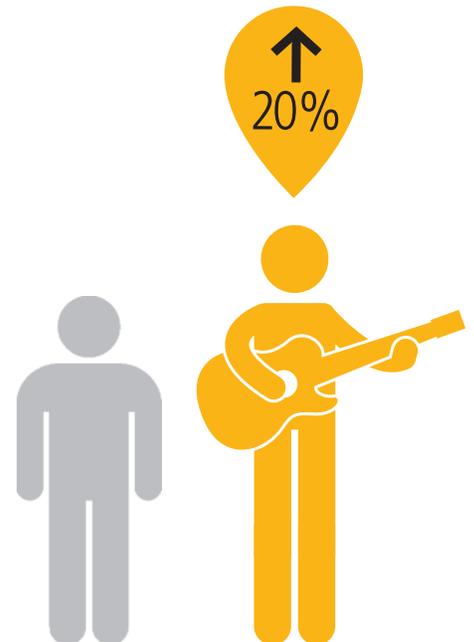
Recent studies have shown that collaborative music making can increase empathy in toddlers. Empathy, in part, comes from being sensitive to subtle changes in the human voice that indicate mood and emotion. Children need to develop empathy if they are to thrive in family life, at school, and later, at work.

This connection between music and empathy may be due to improved verbal intelligence. Playing music improves a child's ability to listen and pick up nuances of speech – the way something is said and the emotions underneath the words, not just the words themselves, which in turn is a key element of empathy and emotional intelligence.

Music is inherently emotional, and musical memories are among the most visceral and vivid. Consequently, musicians must learn how to connect with people on an emotional level. Whether harmonizing in a choir or performing in a string quartet or simply jamming with friends, music students of any age, even the very young, learn how to share attention, co-operate and collaborate. These are extremely valuable skills in both personal relationships and in the workplace. Studies have even shown that collaborative musical activities can increase toddlers' pro-social behaviours, making them more likely to help someone in need.⁶

High-quality Music Education Makes a Difference

The quality of a child's music education is linked to their academic achievement. Elementary school students in high quality music education programs outperformed those in lower-quality programs in standardized tests of English and mathematics.⁷ While music education by itself may not be responsible for the entirety of the 20% improvement in test scores, scientists now believe that the changes in the brain caused by music training can lead to improvements in general cognitive skills like memory, attention, and reading ability, all of which are predictive of educational outcomes.



Health and Resilience

Parents will be heartened to know that studying music also brings children life-long health benefits. Scientific research is starting to emerge showing that life-long music training can offer improved cognitive function as we age.⁸ We already know that music therapy has helped people recover from strokes, and can be useful in treating a variety of neurological disorders, such as stuttering, autism and Parkinson's disease.⁹ Music training has even been shown to delay the onset of dementia.¹⁰ Consequently, the strong parallels between music and speech, as well as the inherent enjoyment of music, make it a useful and flexible rehabilitative technique at many ages.

And music study can compensate for hearing loss in adults. Studies show that seniors with musical training are able to pick out sounds in noisy environments – such as restaurants – and can carry on conversations better than those without this training, even though they've suffered hearing loss.¹¹

Increases in the Capacity of Key Brain Regions

Important regions of the brain, such as the frontal lobes that perform higher-level cognitive functions, are larger in musically trained individuals than in those without this training.¹²

In the illustration below, the coloured areas are the regions of the brain that are significantly larger in musically trained people – the brighter the colour, the bigger the difference. The brains of musically trained individuals are typically larger in the temporal cortex – an area on the side of the brain that controls hearing, among other things – and in the frontal cortex – an area in the front of the brain in charge of abstract thought, planning, and complex behaviours, as well as controlling our intended movements.

8. Brenda Hanna-Pladdy and Byron Gajewski, *Frontiers of Human Neuroscience, Recent and past musical activity predicts cognitive aging variability: direct comparison with general lifestyle activities*, 2012

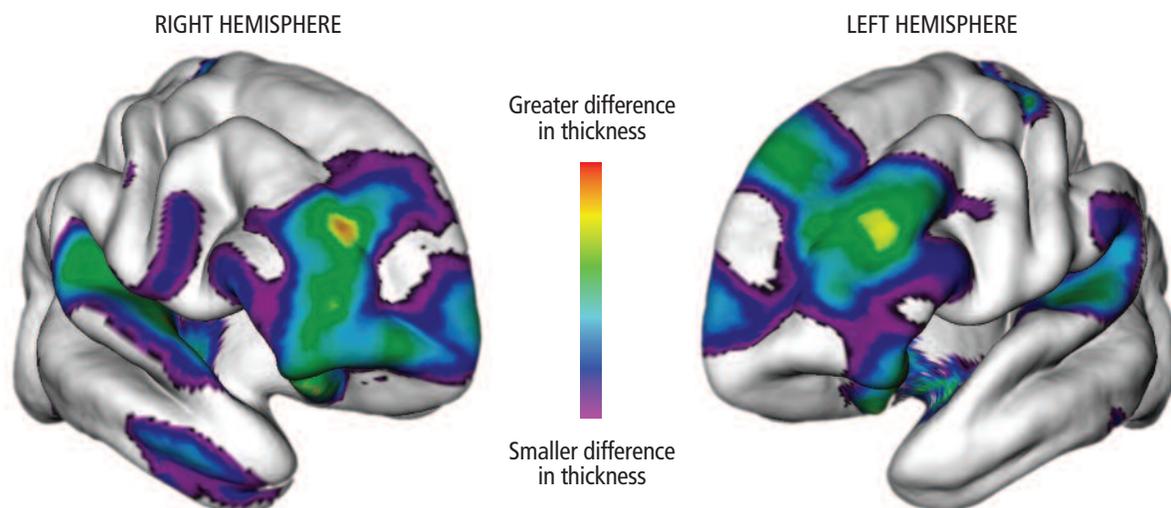
9. Wan, Ruber, Hohmann and Schlaug, *Music Perception*, 2010

10. J. Verghese et al, *Leisure activities and the risk of dementia in the elderly*, *New England Journal of Medicine* 2003; 348:2508-16

11. Perri Klass, M.D., *The New York Times*, *Early Music Lessons Have Longtime Benefits*, 2012

12. Patrick Bermudez et al, *Neuroanatomical Correlates of Musicianship as Revealed by Cortical Thickness and Voxel-Based Morphometry*, *Cerebral Cortex* July 2009; 19:1583–1596

Areas of Greater Cortical Thickness in Musicians





PIYA CHATTOPADHYAY
Journalist and Broadcaster

People sometimes ask me what it is that makes me sound confident as a broadcaster. I always harken back to my days growing up, learning Royal Conservatory vocal, and standing in front of the examiner to pass each grade. No instrument is more personal than your own voice. To be able to stand in front of someone and sing takes some guts, but it sure does help build your confidence... and of course, there's no better way to improve your diction than singing.



DAVID FOSTER
Academy Award-winning
Producer

The Royal Conservatory of Music was crucial to my development as a musician and in my preparation for my career that has unfolded over the last forty years. I always sweated the exams because there was no "hometown boy" attitude. I had to compete with the best of the best in a national competition with extremely high standards. I have been fortunate to infuse my classical learning into every phase of my musical career. Simply put, I would not be where I am today had I not gone through The Royal Conservatory program.



Conclusion

We know that from early childhood through to retirement years, whether involved in recreational music making or training for a professional career, people who are engaged in music study are sharpening their cognitive skills and developing social connections.

Over the past two decades, several large-scale studies have found that music students outperform academically compared to other students, often by large margins. Music students tend to be more engaged and motivated in their studies, and more likely to win academic awards.

Thanks to the groundbreaking research of neuroscientists, we now have a clear scientific explanation for this phenomenon. Music study leads to lasting changes in children's brains, increasing their capacity to perform tasks that require sustained attention and careful listening and reading.

Parents can be more confident than ever that an investment in music lessons will deliver lifelong benefits for their child.

To Learn More

Music instruction is beneficial for individuals of all ages, however the research suggests the benefits are greatest when a child begins at a young age. To learn about the many music education options available, visit rcmusic.ca/learning or call **1.800.461.6058**. We are here to help parents find the right music instruction for their children.

RELATED READING

THE ROYAL CONSERVATORY is committed to advancing the study of the benefits of music education and sharing those results with Canadian parents. To this end, we are pleased to provide a comprehensive list of sources for further reading. We will continue to report new research findings on our website at rcmusic.ca/research.



- *Music, The Brain, And Ecstasy: How Music Captures Our Imagination*, Robert Jourdain
- *This Is Your Brain on Music: The Science of a Human Obsession*, Daniel Levitin
- *The Tao of Music: Sound Psychology*, John Ortiz
- *Music, Language, and the Brain*, Aniruddh Patel
- *Listen to This*, Alex Ross
- *Musicophilia: Tales of Music and the Brain*, Oliver Sacks
- *Music and the Mind*, Anthony Storr
- *Emotional Intelligence: Why It Can Matter More Than IQ*, Daniel Goleman, 2005, Bantam Books
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- TORONTO STAR: *Everything I Need to Know, I Learned in School Music Class* at http://www.thestar.com/news/insight/2013/06/15/everything_i_need_to_know_i_learned_in_school_music_class.html
- ABC NEWS: *Music Lessons Linked to Lasting Brain Benefits* at <http://abcnews.go.com/blogs/health/2012/08/21/music-lessons-linked-to-lasting-brain-benefits/>
- ABC NEWS: *How Music Could Make You a Rocket Scientist* at <http://abcnews.go.com/Technology/music-make-rocket-scientist/story?id=20692544>
- THE NEW YORK TIMES: *Why Music Makes our Brains Sing* at http://www.nytimes.com/2013/06/09/opinion/sunday/why-music-makes-our-brain-sing.html?_r=1&
- THE NEW YORK TIMES: *Long-Term Benefits of Music Lessons* at http://www.nytimes.com/2013/11/12/science/long-term-benefits-of-music-lessons.html?smid=tw-nytimesmusic&seid=auto&_r=1&
- THE NEW YORK TIMES: *Is Music the Key to Success* at <http://www.nytimes.com/2013/10/13/opinion/sunday/is-music-the-key-to-success.html?emc=eta1>
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- THE DAILY TELEGRAPH (UK): *Music – a gift for language learners* at <http://www.telegraph.co.uk/education/educationadvice/10435498/Music-a-gift-for-language-learners.html>
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ABOUT THE ROYAL CONSERVATORY OF MUSIC

The Royal Conservatory is one of the largest and most respected institutions in the world dedicated to music and arts-based education. Providing the definitive standard of excellence in music education through its curriculum, assessment, performances, and teacher education programs, The Conservatory has had a substantial impact on the lives of millions of people globally. In addition, the organization has helped to train a number of internationally celebrated artists including Glenn Gould, Oscar Peterson, David Foster, Sarah McLachlan, Angela Hewitt, and Diana Krall.

Motivated by its powerful mission to develop human potential through leadership in music and arts education, The Royal Conservatory is committed to the advancement of research and science in the field. Consequently, The Conservatory has emerged over the last two decades as a leader in the development of arts-based programs that address a wide range of social issues.



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