



MUSIC AND COGNITIVE BENEFITS

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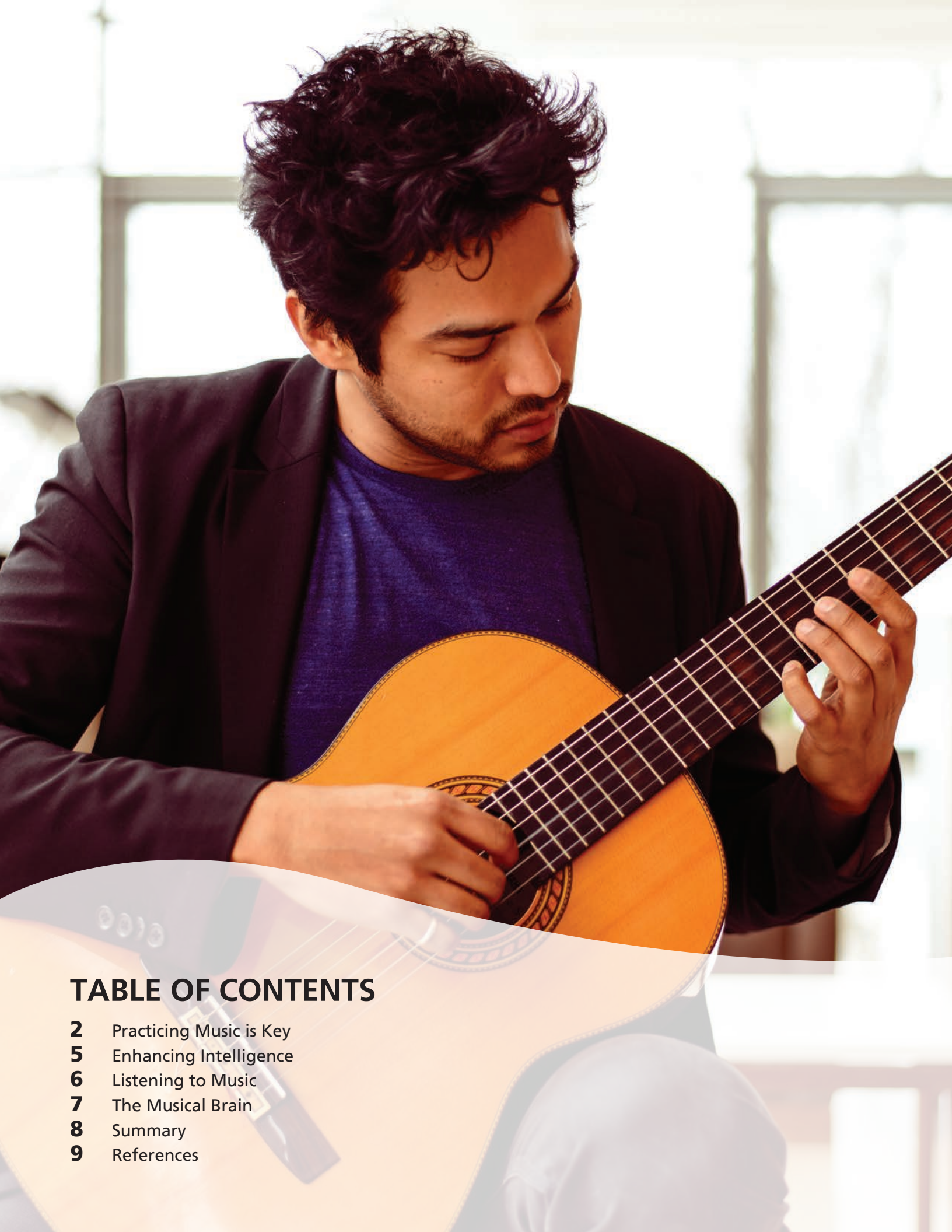


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COGNITIVE SKILLS

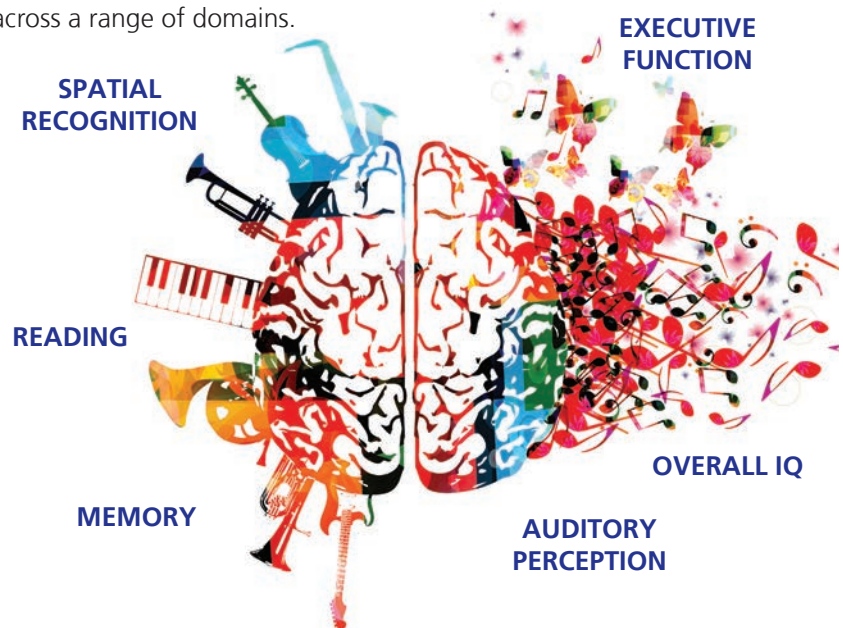
Music makes you smarter. We've all heard that before. But is it true? Is there any evidence for this claim? What parts of intelligence might music affect? How *does it* make you smarter?

Scientists have also been interested in these questions. Over the past twenty years, there have been numerous psychological and neuroscientific studies investigating the link between music and the mind. The upshot? Musicians have better cognitive skills than their non-musician counterparts across multiple domains of intelligence. Studies have demonstrated that in areas as diverse as reading, spatial ability, memory, perception, and executive function, musical training is associated with higher performance. These changes can be seen in the brain, with musicians showing bigger brain size, more connectivity, and higher neural efficiency.

What's more, studies show that being a musician isn't just correlated with improved cognitive abilities; training in music can cause improvements in many cognitive domains. Though the results are not unambiguous, there is solid evidence that participating in musical training can lead to increases in several aspects of intelligence — results that are bolstered by the correlational findings of superior abilities in trained musicians.

The musical mind

How does music make you smarter? By boosting key cognitive abilities across a range of domains.



Musicians show larger vocabularies, better reading ability, and enhanced recognition of emotions in speech.

PRACTICING MUSIC IS KEY

Music *does* make you smarter, but that doesn't apply to any kind of interaction with music. Rather, the evidence is clear that these benefits are associated with *practicing* music. Simply listening to music will not have any long-term impact. The popular notion that listening to Mozart will make your child a genius is a media myth. But studying music and learning an instrument are associated with improved cognitive abilities over the course of a life.

Music and Language

One of the most robust cases where musical training transfers to other cognitive domains is that of language. Musicians outperform non-musicians in many aspects of language ability, including perception and production.

At a basic level, musicians do better at tasks involving low-level speech perception. Studies show that if you ask people to recognize spoken sentences when heard against other conversation in the background (like you might encounter at a party), musicians can pick up more words than non-musicians as the background speakers get louder and louder. This life-skill becomes especially important as we age, as we tend to lose this ability as we get older. The research shows that musical training can stave off this deterioration — one estimate showed that musicians' perceptive abilities are similar to that of non-musicians' who are more than a decade younger.

Enhanced Spatial Abilities

Musicians outperform on tasks like visual search, judging the orientation of lines, remembering complex drawings, and arranging blocks to fit a pattern.



Perceiving Sound

Musicians' increased perception abilities appear to be due to a higher fidelity of the neural signals associated with hearing sounds. It seems that the high degree of auditory precision required by musical training transfers over to other sounds as well. This also affects other aspects of speech perception, such as the ability to recognize and manipulate the sounds within words

(for example, try saying the word 'pixel' without the 's' sound).

This increase in low-level ability carries over to more complex speech tasks as well. One well-documented advantage is that musicians find it easier to use complex grammar in their speech. Musicians also show larger vocabularies, better reading ability, enhanced recognition of emotions in speech, and even better ability to use a second language. Many of these



abilities have been seen in children as well as adults, showing that these benefits aren't limited to highly trained professionals, but also extend to those who are developing their musical skills.

Visuospatial Abilities

One less closely related domain where we also see evidence for the cognitive benefits of music training is in visuospatial abilities. These skills, which relate to the ability to work with spatial relations and visual form, are critical to many everyday activities such as navigation, athletics, fixing household items, and keeping

track of objects. Just like language skills, spatial abilities are relevant to many academic domains, including mathematics, geography, science, and engineering.

Visuospatial abilities can be measured in many different ways. For example, in a mental rotation test, participants are asked whether pictures of two complex objects can be rotated to be identical to each other. Orchestral musicians could do this task faster and more accurately than non-musicians especially for bigger mental rotations. In brain scans during this task,

these same musicians showed more activation of Broca's area – a brain region that is also associated with sequencing actions and processing grammatical structure.

Other tests of spatial abilities show similar results. Musicians outperform non-musicians on tasks like visual search, judging the orientation of lines, remembering complex drawings, and arranging blocks to fit a pattern. This is likely to reflect a superior underlying spatial ability, which may help with many other types of non-musical activities.

The Memory Advantage

There is also evidence that music training can benefit more general cognitive functions. One such area that scientists have investigated is memory. Memory can apply to any domain – auditory, spatial, visual – and studies of musicians' abilities show evidence for a general cognitive benefit to memory.

This benefit is clearest in the auditory domain. When it comes to remembering lists of words or numbers, musicians have a distinct advantage. Being able to process sounds faster and more accurately seems to lead to a clearer memory for things that can be encoded as sounds. For example, a musician can remember a colour more accurately when it presented as a word rather than when presented visually. Musicians can make use of this auditory memory benefit even for visual tasks like reading, either through reading out loud or imagining the sounds of words in their heads. This can help in tasks like remembering stories or lyrics, and might be behind some of the advantages we see for musicians in reading and language abilities.

Scientists have even found some advantages of music training for purely visual items. Although the benefits of music training aren't as

clear-cut as they are for remembering sounds, several studies show musicians outperforming non-musicians in memory for line drawings or positions of images. This may be related to improvements in spatial abilities.

Executive Functions

When cognitive abilities like memory and attention are used in controlled, intentional ways, this is referred to as executive functions. This includes behaviours like resisting impulses, updating memory, and switching tasks. These executive functions can underlie many complex musical activities, such as improvisation, composition, and interpretation, and so it is thought that music training may help to train these skills. In fact, in many tests of executive function, musicians outperform non-musicians.

For example, in tests of attentional abilities, musicians show better abilities to inhibit their responses than non-musicians, and are able to selectively attend to their task at hand while ignoring other types of distractions. Other tests of working memory (the ability to manipulate and control what is stored in memory) show advantages for musicians, as do measurements of long-term planning. Although some studies have shown mixed results, on the whole, there is evidence that musical training is associated with stronger executive functioning.



Boosting Creativity

One interesting corollary of musicians' increased cognitive skills may be increased creativity. Creativity generally involves the generation of novel and useful ideas, and music itself offers plenty of avenues for expression. But at least one recent study has shown that musicians show greater creative originality even outside of music. Having the cognitive flexibility to entertain parallel lines of thought and new perspectives seems to help musicians both inside and outside of their field.

ENHANCING INTELLIGENCE

Of course, after seeing all of these enhanced cognitive abilities in musicians, you may now be asking yourself, “Well, what about IQ?” There have been numerous studies comparing the IQs of musicians and non-musicians, and the majority of these show higher IQ among the musicians. This is true for children and adult musicians. What’s more, the longer someone has taken music lessons, the greater the IQ.

It is true that people who take music lessons often come from households with greater incomes and educational backgrounds. However, when these factors are controlled for, the boost that practicing music provides to IQ remain. In fact, among university-aged students, studies show that those who took music lessons in their childhood still demonstrate higher IQs, even if they no longer take lessons.

What’s more, controlled trials of children music lessons show that if you give a random sample of children lessons and others not, those who receive music training show increases in IQ compared to the others. *Music lessons cause increases in IQ.* The effects are not easy to see on a case-by-case basis, but they are quite robust.

Given the association between practicing music and other cognitive abilities, the effect on IQ shouldn’t be surprising. In fact, IQ tests include measures of cognitive abilities such as language, spatial recognition, memory, and executive functions.

Add these benefits up, and what we get is an increase in IQ. And this is what it means to say “Music makes you smarter.” It’s not a matter of knowing more facts about the world; it’s a matter of processing and using the information you get efficiently and capably.

Less of a Link Between Music and Math

Interestingly, there is one domain of knowledge where we do not see a reliable connection with musical skill, and that is mathematics. People have long thought that there might be a special relationship between music and math, and it’s easy to see why. Music itself is built upon a framework of numbers. From counting time to harmonic series to complex acoustics, the mathematical nature of music has led to speculation that

musical training might help with mathematical abilities.

However, studies have shown no reliable link between these two abilities. While some studies have shown a small benefit for the mathematical abilities of musicians compared to non-musicians, others have found no effect. And among the studies that do show an association, the benefit can often be ascribed to other factors. Studies looking at the converse association show that mathematicians aren’t more musical than average, either. So while we do sometimes see a small benefit to musicians’ numerical abilities, it looks like this may stem more from the overall benefits to their IQ, rather than a specific link between music and math.

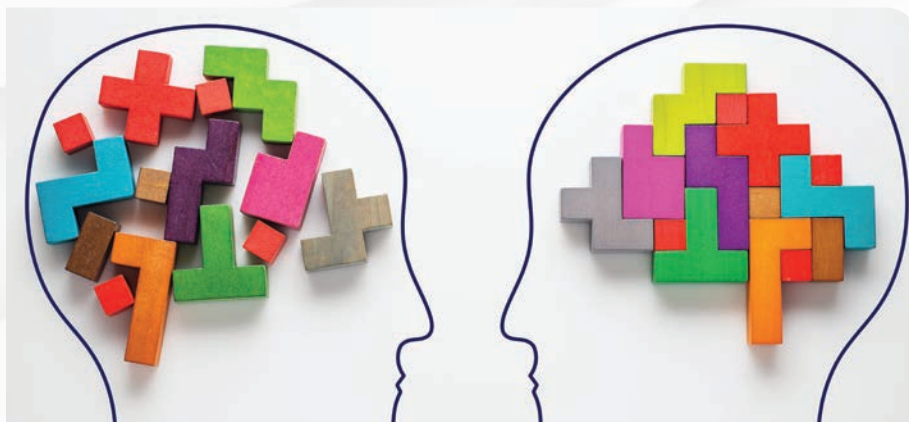
When it comes to remembering lists of words or numbers, musicians have a distinct advantage.

LISTENING TO MUSIC

The evidence is pretty strong that taking music lessons can have an impact on cognitive skills and intelligence. But what about listening to music? Can that play a role in enhancing cognitive abilities?

A few decades ago, there was some speculation that listening to certain types of music might also be able to temporarily raise intelligence. This phenomenon, termed the “Mozart Effect,” was based off a study showing better spatial skills after listening to the music of Mozart. While it kicked off a media sensation, and ultimately led to a lot of wholly unsubstantiated claims, subsequent research in the field showed that the effect was not as noteworthy as originally thought.

When re-examined more carefully, the small benefits seen from listening to Mozart actually stemmed from the energy and vibrancy of the music, rather than anything specific to Mozart or classical music. The people who had listened to Mozart were more alert, helping their performance on the tests. Now, that’s not nothing, but it’s not different than what you’d get from drinking a cup of coffee. When it comes to lasting change, listening along won’t cut it; it’s music training that makes the real difference.



What the studies can tell us

One difficulty that arises in many studies comparing musicians and non-musicians is that it’s difficult to tease apart which effects are caused by music training and which are just associated with it. Scientific best practices often involve taking two otherwise identical groups and giving only one group a treatment. However, when the “treatment” is a lifetime of musical practice, this design becomes impractical. But there are ways of trying to determine what the causal effects of music training actually are. Many studies use a longitudinal design, looking at the change in abilities in the same group over time. Scientists have also examined the role of duration of training. If more training leads to better results, this is an argument in favour of causation. Finally, many correlational studies try to measure other important causes of cognitive differences, such as home environment, socio-economic status, and educational background, in order to statistically control for these factors. And of course, there are several studies that do compare people given music lessons to a control group after a short- to medium-term timeframe. In all, the majority of these studies do provide good evidence that music training is actually responsible for cognitive benefits.

THE MUSICAL BRAIN

The effects of music training are not only seen in cognitive tests; we can also see changes in the brain itself. Music training can shape many different aspects of the brain, including its size, connectivity, and function.

Using an MRI scanner, scientists have compared the brain sizes of musicians and non-musicians in order to better understand how musical experience might affect the physical shape of the brain. Although brains can vary widely between individuals, as a group you can see differences between musicians and non-musicians in grey matter volume (that is, the cell bodies of neurons in the brain). Musicians tend to have more grey matter in the auditory cortex, which supports their ability to perceive and process sounds; in the parietal cortex, which supports the integration of information from different senses and plays a role in spatial ability; and in the frontal cortex, which supports executive functions and working memory, as well as being involved in motor planning and coordination. What's more, these differences are also affected by amount of practice — professional musicians show larger volumes in these areas than amateur musicians.



Neural pathways

Other scanning methods have been used to look at the connectivity within the brain — how different brain regions communicate with each other. Once again, musicians show several key advantages in these measures. The corpus callosum, which connects the left and right hemispheres of the brain, is larger in musicians than in non-musicians. Another important neural pathway, the arcuate fasciculus, shows a similar group difference. This pathway connects the temporal (auditory), parietal, and frontal cortices, and plays a key role in translating sounds into actions. This is important not only for music, but for speech as well.

Brain differences between musicians and non-musicians can also be seen in neural function. For example, about ten milliseconds after sound hits the ears, the signal is sent to the brainstem before being passed along to higher areas of the brain. The neural signal encoding this sound in the brainstem is more faithful to the original in musicians than in non-musicians, resulting in a higher-quality representation of the sound being passed along. This is another example of how skills enhanced through music can transfer to other domains, such as speech processing.

SUMMARY

Overall, there is a rich body of evidence that music training can lead to enhanced cognitive benefits. Musicians outperform non-musicians in domains such as language, spatial ability, memory, executive function, and more. These benefits are reflected in higher IQ scores and even in the size and function of the brain itself. But the studies also show that there is nothing “magical” about music — these effects do not come from simply putting Mozart on in the background, but from long-term training and practice in music. The cognitive benefits of music training can be seen in all age groups, and are enhanced both when study begins and by the amount and intensity of the training. These benefits show up whether or not music ends up being a primary career. In sum, the scientific research shows that cognitive abilities gained through music training can transfer to other domains and practices, making music a valuable addition to any path in life.

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