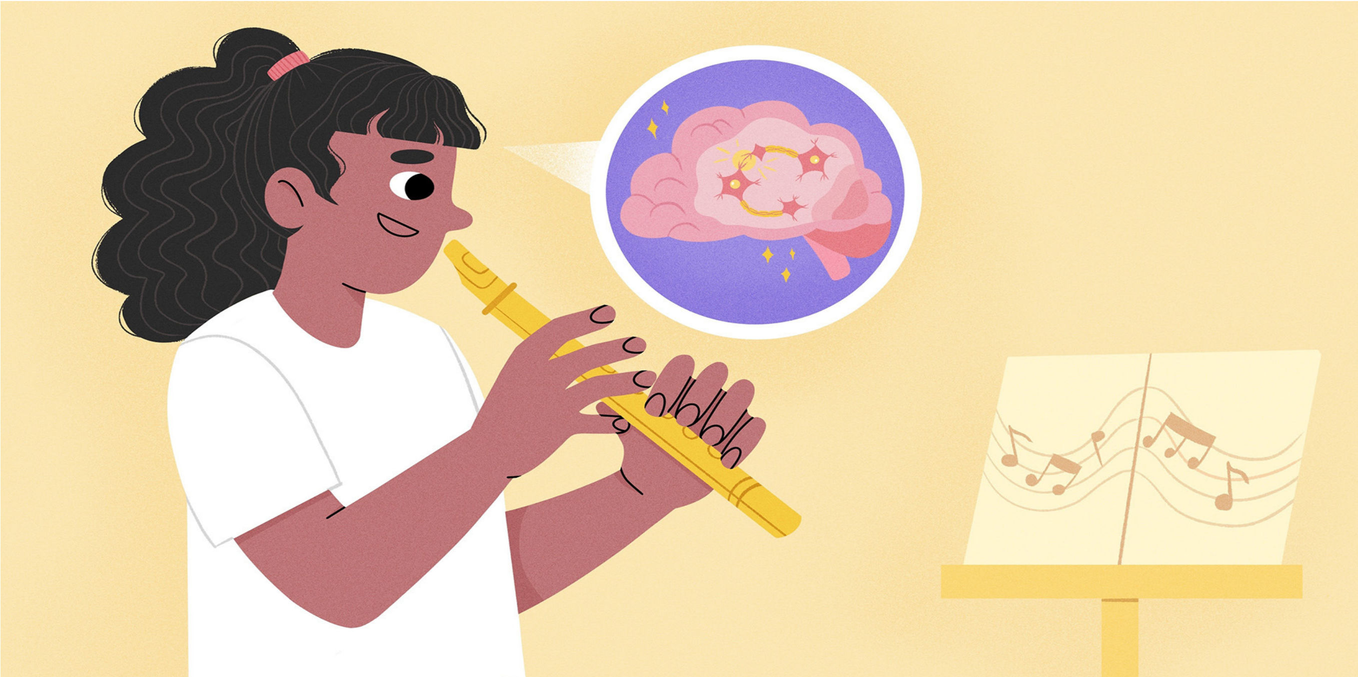
NEUROSCIENCE AND PSYCHOLOGY
Published: 04 January 2024
doi: 10.3389/frym.2023.1151914



HOW MUSIC AND ART TUNE AND SCULPT YOUR BRAIN'S ARCHITECTURE

Alexandria N. Weaver**, Mariya Vodyanyk and Susanne M. Jaeggi

School of Education and Center for the Neurobiology of Learning and Memory, University of California, Irvine, Irvine, CA, United States

YOUNG REVIEWERS:
UNIVERSITY OF CALIFORNIA IRVINE BRAIN EXPLORER ACADEMY
AGES: 8–12

Your brain is constantly changing as you grow up and get older. Throughout your life you have all kinds of experiences, and your brain has the amazing ability to respond to those experiences in various ways. For example, when you learn something new, such as how to play a new game or speak a new language, your brain makes new connections, and these connections get stronger the more you practice or use what you learned. The experiences you had when you were younger can have lasting effects on your brain as an adult. In this article, we will talk about how playing musical instruments and creating visual art can change your brain, how these changes affect your future adult brain, and examples of a few technologies that have been used to help scientists visualize brain changes.

THE CHANGING BRAIN

Have you ever noticed that learning something new, like how to ride a bike, feels difficult at first, but the more you practice the better you get and the easier it feels? That is because when you learn something new, your brain is creating new cells called **neurons** and making new connections between neurons. With repeated practice, these connections get stronger, making it easier for neurons to communicate with one another which, in turn, makes you do better.

NEURON

A brain cell that sends messages back and forth between the brain and body.

Your brain's ability to make new neurons and strengthen connections is called **neural plasticity**. Neural plasticity is an important part of development, but your brain can continue to change all throughout your life, allowing you to learn new things even when you are older. Engaging with music and art are examples of experiences that can change your brain (Figure 1).

NEURAL PLASTICITY

The brain's ability to make new neurons and strengthen connections between neurons in response to experiences.

Figure 1

Figure 1

Playing music or making art can help the brain create new neurons and strengthen the connections between neurons (Image created using Canva.com).

PLAYING MUSIC

When you play a musical instrument, many processes must come together to make it sound good. Your hands might be doing two different things, you might be reading sheet music, all while you are listening and keeping track of how fast or loud you are playing, coordinating your playing with that of others, and ignoring distractions that might cause you to make a mistake. Thus, playing an instrument requires many brain skills including **executive functions**. Executive functions help us to set goals, learn, pay attention, and control our behaviors.

EXECUTIVE FUNCTIONS

A set of mental skills that allow a person to effectively set goals, learn, pay attention, control their behaviors, and manage their daily life.

Repeated musical practice is believed to put a high demand on the brain areas that control executive functions, leading to changes in these brain areas. This is important because these brain areas and the skills they control help you navigate your daily life—and the more you use and exercise them, the stronger and more efficient these neural connections become. Playing music does not just create *functional* changes in your brain, it can also change the brain's *physical* structure. Researchers have found that musicians who have practiced and played for many years show structural differences in brain areas involved in hearing, movement, and visual skills as compared with non-musicians. These structural differences may be related to better skills—for example, musicians may have better hearing skills than non-musicians [1].

MAKING ART

Visual art, specifically drawing from observation, is another creative skill that requires executive functions. Drawing from observation means to draw what you are looking at, like your favorite cartoon character or pet. During this process, you are using your **working memory**, a particular type of executive function, by keeping track of what you are drawing. Another important executive function is the ability to switch attention between the bigger picture and the details. When sketching, you first map the larger shapes and then gradually add details, while making sure these details fit the larger image. Studies that compare visual artists to non-artists show that artists are better at storing visual information in working memory [2]. Furthermore, college art students can process things they see more quickly and accurately than non-art students can [3]. The reason for these findings might be because drawing uses many of the same brain regions responsible for skills that might help people pay attention in class, for example.

WORKING MEMORY

The information that you actively keep or manipulate in your mind, such as solving a math problem in your head.

MUSIC, ART, AND THE AGING BRAIN

Did you ever notice that you adapt quickly to changes in your environment or to new technologies, without putting in much thought? While adapting to new technologies is easy for young people, it often requires more work for older adults. This is because our brains change as we get older. The brain reaches maturity, or stops growing, when people are in their mid to late 20s, which is when executive functions and memory are at their best. In older adults, executive functions and memory start to show age-related changes and gradually become less optimal. This can make some things more challenging, such as reacting quickly or remembering to get a cake for someone's birthday [4]. However, some individuals experience these changes earlier or later than other people do. Both our genes and what we experience in our day-to-day lives could cause these differences in brain changes. Specifically, life-long engagement in

AGE-RELATED COGNITIVE DECLINE

A decrease in some brain processes that happens because of getting older.

certain activities may protect the brain against **age-related cognitive decline** [5]. Playing a musical instrument and making art are examples of activities that can contribute to a healthy brain.

Researchers have found that older adults who have been musicians for more than 10 years have better executive functions compared with non-musicians [6, 7]. Older adult musicians also have better hearing skills than non-musicians. For example, they may have an easier time hearing conversations in noisy environments [8]. Such results suggest that musical training and practice when you are younger can have long-lasting impacts on your adult brain, and might even slow down the negative effects of brain aging. How? Scientists believe that practicing music over time may lead to permanent physical changes in brain structures that affect brain performance as adults, even if adults do not practice music as much anymore.

Visual art and drawing from observation are also gaining attention as tools to improve memory and executive functions which contribute to healthy aging. For example, older adults taking art classes in their 60s show increased connections between brain regions responsible for working memory [9]. Additionally, using drawing as a memory strategy can improve memory in older adults [10]. Although this field is still developing, current research suggests that taking time to create visual art can cause lasting brain changes. Artistic training may be particularly impactful during in early education, as the brains of young children are more ready to change.

MAGNETIC RESONANCE IMAGING (MRI)

A technique used to make images of the inside of objects, like the brain, using a magnetic resonance scanner.

FUNCTIONAL MAGNETIC RESONANCE IMAGING (FMRI)

A technique used to measure changes in blood flow using a magnetic resonance scanner, a machine that works using magnetic fields and radio waves.

HOW DO WE KNOW WHAT THE BRAIN IS DOING?

Scientists use various technologies to see what our brains look like and how they function while doing specific tasks. Commonly used technologies include **magnetic resonance imaging (MRI)** and **functional magnetic resonance imaging** (fMRI).

An MRI scanner allows scientists to collect images of soft tissues within our bodies, like our brains (Figure 2A). The MRI scanner uses powerful magnets and radio waves to create detailed 3D images, allowing scientists to capture the brain's exact shape and structure. For example, scientists can use MRI to test whether there are structural differences in brain areas when people play music or do art for many years.

What if we want to know what parts of the brain are especially active while we are doing something like moving our hands or using working memory? The same kind of MRI scanner can produce an fMRI scan, which allows researchers to see differences in oxygenated and non-oxygenated blood in the brain. Whenever your brain is engaged with a certain task, oxygen-containing blood flows to those areas to help the neurons to work. In comparison, brain areas that are less

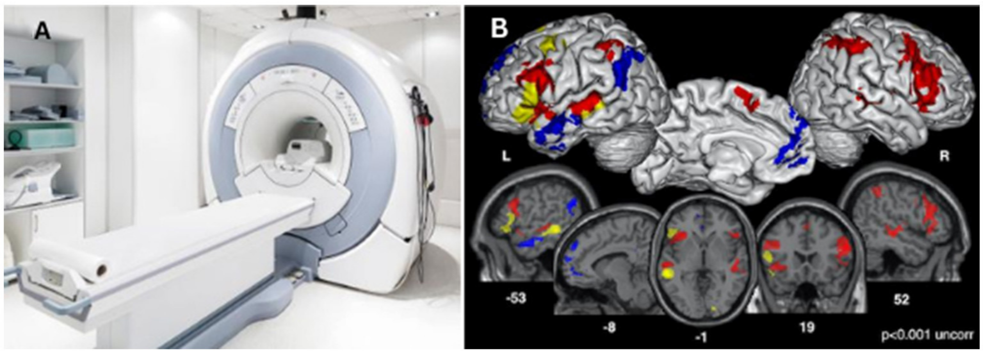


Figure 2

Figure 2

(A) An MRI scanner. **(B)** fMRI images of the brain surface (top) and "slices" through the brain (bottom) while the person is completing two memory-related tasks. In one task, the person was asked to listen to two melodies and decide whether they were the same. The verbal task was similar but used words. Colors represent brain areas activated while completing these tasks. Red shows activation of the brain while doing the music task. Blue shows activation while completing the verbal task. Yellow shows brain areas that were used for both the music and verbal tasks (Figure credits: A Getty Images; B [11]).

involved in the task need less oxygenated blood because they are not working as hard. For an fMRI scan, a person lies down in an MRI scanner and is given a task to do, such as looking at pictures or doing mental math. The scanner's computer creates a color-coded map of brain activity, which can identify brain regions that are active during certain tasks or whether there are differences between individuals performing the same task (Figure 2B). For example, fMRI can be used to see differences in brain activation between musicians and non-musicians when they are listening to pleasant and unpleasant sounds [12]. fMRI can also show which brain regions are active following art production. This technique has been used to study the connectivity between brain regions in older adults who create art compared to those who examine art in a gallery [9]. To learn more about fMRI, check out this Frontiers for Young Minds article.

Scientists can also use a special technology to detect the brain's electrical activity. The brain is an electrical system that works by constantly sending signals through a network of neurons. **Electroencephalography** (EEG) measures the electrical activity that occurs when large groups of neurons are active while you are doing a task, using an electrode-containing cap worn on the head (Figure 3).

ELECTRO ENCEPHALOGRAPHY

A method that measures the brain's electrical activity using electrodes that are put on a person's head.

EEG records the brain's electrical activity as a series of waves. The sizes and shapes of the waves indicate different brain states. EEG is very good at capturing tiny signals and giving precise information right when something is happening in the brain—within a fraction of a second. But compared to fMRI, EEG is not as good at telling scientists specifically *where* something is happening in the brain. Nonetheless, in art research, EEG has shown differences between artists and non-artists when they are performing tasks that require executive functions. This research has shown that when drawing from memory, artists have an easier time staying focused on the task as compared to non-artists. As a result, artists work faster and can capture more details [13]. If you want to learn more about EEG, check out this Frontiers for Young Minds article.

Figure 3

Figure 3

For EEG, a person wears a cap with electrodes that can record the brain's electrical signals. The waves on the screen in the background show what an EEG recording may look like. Each line shows the activity from a different electrode (Image from Getting Images via Canva.com).

SUMMARY

Overall, music and art can influence how your brain functions, and being engaged in music and art leads to changes in your brain that can last into adulthood. The more you practice playing music or making art, the more you shape your brain and exercise important mental skills like your executive functions. Exercising your executive functions through music and art can help you learn and navigate your daily life and can help ensure that your brain stays healthy as you get older. Finding an activity that you enjoy, whether it is music, drawing, knitting, or dancing, can enrich your life in many ways. The next time you play music or draw, not only will you be having fun, but you will know that those activities can change your brain, too!

ACKNOWLEDGMENTS

We would like to thank our reviewers for their insightful comments and suggestions.

REFERENCES

1. Bermudez, P., Lerch, J. P., Evans, A. C., and Zatorre, R. J. 2009. Neuroanatomical correlates of musicianship as revealed by cortical thickness and voxel-based morphometry. *Cerebral Cortex* 19:1583–1596. doi: 10.1093/cercor/bhn196
2. Perdreau, F., and Cavanagh, P. 2015. Drawing experts have better visual memory while drawing. *J. Vision* 15:5. doi: 10.1167/15.5.5
3. Chamberlain, R., and Wagemans, J. 2015. Visual arts training is linked to flexible attention to local and global levels of visual stimuli. *Acta Psychol.* 161:185–197. doi: 10.1016/j.actpsy.2015.08.012

4. Henry, J. D., MacLeod, M. S., Phillips, L. H., and Crawford, J. R. 2004. A meta-analytic review of prospective memory and aging. *Psychol. Aging* 19:27–39. doi: 10.1037/0882-7974.19.1.27
5. Harada, C. N., Natelson Love, M. C., and Triebel, K. L. 2013. Normal cognitive aging. *Clin. Geriatr. Med.* 29:737–752. doi: 10.1016/j.cger.2013.07.002
6. Strong, J. V., and Mast, B. T. 2019. The cognitive functioning of older adult instrumental musicians and non-musicians. *Aging, Neuropsychol. Cogn.* 26:367–386, doi: 10.1080/13825585.2018.1448356
7. Zuk, J., Benjamin, C., Kenyon, A., and Gaab, N. 2014. Behavioral and neural correlates of executive functioning in musicians and non-musicians. *PLoS ONE* 9:e99868. doi: 10.1371/journal.pone.0099868
8. Parbery-Clark, A., Strait, D. L., Anderson, S., Hittner, E., and Kraus, N. 2011. Musical experience and the aging auditory system: implications for cognitive abilities and hearing speech in noise. *PLoS ONE* 6:e18082. doi: 10.1371/journal.pone.0018082
9. Bolwerk, A., Mack-Andrick, J., Lang, F. R., Dörfler, A., and Maihöfner, C. 2014. How art changes your brain: differential effects of visual art production and cognitive art evaluation on functional brain connectivity. *PLoS ONE* 9:e101035. doi: 10.1371/journal.pone.0101035
10. Wammes, J. D., Meade, M. E., and Fernandes, M. A. 2016. The drawing effect: evidence for reliable and robust memory benefits in free recall. *Quart. J. Exper. Psychol.* 69:1752–1776. doi: 10.1080/17470218.2015.1094494
11. Groussard, M., Rauchs, G., Landeau, B., Viader, F., Desgranges, B., Eustache, F., and Platel, H. 2010. The neural substrates of musical memory revealed by fMRI and two semantic tasks. *NeuroImage* 53:1301–1309. doi: 10.1016/j.neuroimage.2010.07.013
12. Sachs, M., Kaplan, J., Der Sarkissian, A., and Habibi, A. 2017. Increased engagement of the cognitive control network associated with music training in children during an fMRI stroop task. *PLoS ONE* 12:e0187254. doi: 10.1371/journal.pone.0187254
13. Kottlow, M., Praeg, E., Luethy, C., and Jancke, L. 2011. Artists' advance: decreased upper alpha power while drawing in artists compared with non-artists. *Brain Topogr.* 23:392–402. doi: 10.1007/s10548-010-0163-9

SUBMITTED: 26 January 2023; **ACCEPTED:** 08 December 2023; **PUBLISHED ONLINE:** 04 January 2024.

EDITOR: Michael A Yassa, University of California, Irvine, United States

SCIENCE MENTORS: Manuella Oliveira Yassa

CITATION: Weaver AN, Vodyanyk M and Jaeggi SM (2024) How Music and Art Tune and Sculpt Your Brain's Architecture. Front. Young Minds 11:1151914. doi: 10.3389/frym.2023.1151914

CONFLICT OF INTEREST: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

YOUNG REVIEWERS

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We are the Brain Explorer Academy at the University of California, Irvine's Center for the Neurobiology of Learning and Memory. We love learning about the brain and nervous system in a fun, interactive and hands-on way and we love contributing to the Frontiers for Young Minds articles as reviewers.

AUTHORS

ALEXANDRIA N. WEAVER
I recently earned my Ph.D. from the University of California, Irvine. My research explored how experiences and lifestyle factors, such as playing music, support brain health as we age. I grew up playing the piano and guitar and have always been fascinated by the relationship between music, learning, and memory. My latest project worked to create a training game using music to improve the ability to hear speech amongst competing sounds for older adults. When I am not working, I love to be outside playing with my dog or roller skating with friends. *anweaver@uci.edu

MARIYA VODYANYK
I am a Ph.D. student working with Dr. Susanne Jaeggi. Overall, I am interested in how engagement in certain activities over the lifespan can promote successful aging of the brain and body. Currently, I research the effects of training in observational drawing on reasoning, attention, and memory. I believe learning to draw from observation is a skill that can be acquired by anyone given the proper training, as with learning to write. In my free time, I enjoy plein air painting and learning about the intersections of Eastern and Western medicine.

SUSANNE M. JAEGGI
I am a professor who recently moved from the University of California, Irvine to Northeastern University's Center for Cognitive and Brain Health. In my Working Memory and Plasticity Lab, we study how people learn. We are particularly interested in understanding why people learn differently, and to do so, we look at the role of the environment and the types of activities that people engage in, and how they shape brain development across the lifespan. Importantly, we focus on what we can do to help individuals become better learners by creating games and other engaging activities. I enjoy mentoring the next generation of scientists and helping them find their unique voice and calling.