4. Music Education and Child Development[1]

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Over the past two decades there has been an increase of research on the role of music in child development (Herholz & Zatorre, 2012; Swaminathan & Schellenberg, 2016). There are reports suggesting that learning to play music may further strengthen the intellectual and social development of children. In spite of this, many students in the current USA educational system have limited access to theatre, dance, visual arts, or music classes, and students from ethnic and racial minorities and from low-income communities bear a disproportionate share of this decline in art education (National Endowment for the Arts, 2011). In California, for example, during a period when the total public-school student population increased by 5.8%, the percentage of all public-school students involved in music education courses declined by 50%—the largest decline in any academic subject area (Music for All Foundation, 2004). Several factors, including overemphasis on standardized testing in the areas of reading, math, and science and an ongoing crisis of diminishing budgets for public education, contribute to this decline in enrolment and access to music over the last two decades. To ensure that all children have access to a full and balanced education that includes

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music, we believe that policymakers, legislators, educators, and parents need to hear directly from scientists about the new and truly significant findings concerning music education and child development so that they can make informed decisions about the place of music in the school curriculum.

The Brain and Creativity Institute at the University of Southern California (USC) has been involved in music, neuroscience, and education research for the past decade; in this chapter, we summarize some of the most important findings on music training and child development drawn from our work and from the work of other groups. Advocating for access to quality music education should not have to be on the grounds of research proven benefits, such as improved language skills cognitive abilities or brain health. The plain consequences of music experience on the enjoyment of life and on humans are justification enough. We firmly believe that music and other arts are essential components of childhood development that will promote skill learning and will give children access to creative imagination in a fundamentally enjoyable and interactive context.

The Measurable Benefits of a Music Education

Playing a musical instrument typically requires a child to learn to continuously switch between reading musical notes and translating them into meaningful sounds by monitoring and adjusting fine finger movements to an instrument. When playing in a group, children also have to learn to attend to new and competing streams of sound as produced by their own playing and by other performers. Playing a musical instrument, as is the case with the acquisition of other complex skills, requires focused attention, self-discipline and prioritizing practice over more instantly gratifying activities. It is likely that mastering such skills can benefit a variety of processes including executive functions, cognitive abilities and prosocial behaviors. Furthermore, playing music entails not only the recruitment of the auditory, somatosensory, and visual systems but also the interaction of these sensory systems with the motor, executive, and affective systems. The combination of such demands is likely to influence the differential development, maintenance, and function of certain brain structures and systems.

A Longitudinal Study of the Effects of Music Education on Child Development

In the hope of uncovering the effects of musical education on the developing brain, we undertook a longitudinal study of school children (2012–2020). We opted for a population from deprived socioeconomic backgrounds convinced that such backgrounds could eliminate cultural factors which might otherwise contaminate the data. Here, we review the impact of this classical music training program comparing the target group with control groups not involved in music training but with comparable socioeconomic and cultural background.

We recruited eighty-eight participants, with an average age of 6.8 years from community music and sports programs and from public elementary schools in the Greater Los Angeles area. The participants came from three groups: the first group constituted children who had enrolled and were about to begin participation in the Youth Orchestra of Los Angeles at the Heart of Los Angeles program, known as YOLA at HOLA. The Youth Orchestra of Los Angeles is a signature education program of the Los Angeles Philharmonic. It is inspired by the Venezuelan approach to music studies known as "El Sistema". It offers free group-based classical music instruction 4–5 days a week to children from underserved communities of Los Angeles. The program emphasizes systematic, high intensity group music training. It focuses on rhythm, melody, harmony, and ensemble practice with the goal of promoting social inclusion. The curriculum includes group string instrument practice, group singing, the Orff Approach, and musicianship (ear training and theory skills), totaling 6–7 hours of music instruction per week.

The second group of children had enrolled and were about to begin participation in community-based soccer or swimming programs. The soccer and swimming programs offered free or low-cost training in a community setting to all children whose parents choose to enroll. The sports training group was selected as a comparison group to control for aspects of musical training that would likely be shared by those in a regular, extra-curricular activity. These include social engagement, discipline, and sustained effort. Sports training was also chosen because of its attendant sensory motor learning, a component that is widely shared with music training. These aspects alone may have beneficial

effects on development of both cognitive and social skills, and it was thus essential to include an active comparison group.

The third group of children was recruited from public elementary schools in the same Los Angeles areas. At the time of recruitment, the children in the third group were not engaged in any organized and systematic after-school programs (Habibi et al., 2014).

All participants came from equally underprivileged backgrounds. Their family incomes were predominately below the federal poverty guidelines. All resided in geographical regions of Los Angeles affected by well-known common problems: large urban areas, high levels of poverty, drug trafficking, and violence. Most child participants were of Latino background and were being raised in bilingual households. They attended English-speaking schools that did not offer comprehensive music or sports education programs.

The children visited our laboratories at USC's Brain and Creativity Institute once a year, for six cumulative years, and participated in series of psychological and behavioral probes assessing cognitive, social, and emotional development. Furthermore, they completed neuroimaging assessments including Magnetic Resonance Imaging (MRI) and electroencephalography (EEG) designed to assess maturation of brain structures and connectivity of brain structures (Habibi, Sarkissian, Gomez, & Ilari, 2015).

At the beginning of the study, when children did not yet have any music or sports training, we found that the children in the music training group were not different from the children in the other two groups. Specifically, there were no differences between groups in brain measures and in intellectual, motor, musical, and social measures.

Music Education and Children's Cognitive, Social, and Brain Development

The findings concerning the influence of music training on the children's development are first reported in terms of the impact of music training on musical and auditory skills followed by the impact on nonmusical skills, cognitive abilities, and socioemotional maturation.

We found that children who received music training perform better than children in both comparison groups on tasks measuring pitch and rhythm discrimination (Ilari et al., 2016). The children were also

better at perceiving temporal regularity in musical rhythm—what is commonly known as beat perception—which is a fundamental skill for music perception and production. The children in the music group, but not the children in the two comparison groups, showed enhanced ability to detect changes in tonal environment and displayed an increased functional development of the auditory pathways as measured by cortical auditory evoked potentials to musical notes (Habibi et al., 2016). The development of these skills in childhood is critical for music training and also contributes significantly to the development of language and communication skills.

In relation to cognitive abilities, we found that children who received music training show improvements in executive function skills when compared to their peers who did not receive music education. Executive functions are top-down processes related to goal acquisition and decision making that primarily recruit the brain's prefrontal areas (Miller & Cohen, 2001). These skills have been shown to be predictive of academic success (Alloway et al., 2005), career success (Bailey, 2007), positive socioemotional wellbeing (Eisenberg et al., 2005), reduced substance abuse risk and incarceration (Moffitt et al., 2011), and physical health (Miller, Barnes, & Beaver, 2011).

We also observed that children who received music training are better at decision making and at controlling their impulses. For example, compared to their control counterparts, they are capable of rejecting a small reward in favor of larger and better rewards at a later time (Hennessy et al., 2019). They reach this level of maturity earlier than the children who did not receive music training. They also perform better in assessments requiring task switching skills and they display stronger engagement of the brain's prefrontal network while performing these tasks inside the MRI scanner at an earlier age (Sachs et al., 2017). These findings suggest that music training during childhood is associated with beneficial changes in the brain's cognitive control and decision-making networks.

In the context of this study, we also conducted annual interviews with the parents of the participating children. Our goal was to examine parental views on the potential effects of music education program on children's socio-emotional skills and personality. What we observed is that parents held the impression that children who participated in the music as well as in sports programs in their communities were less aggressive and hyperactive, and showed more emotional stability

over time than children who did not attend such programs. This is noteworthy considering that there were no differences in such measures at the beginning of the study and prior to the children's entry into these programs (Ilari et al., 2019). These findings suggest that access and participation in community-based programs can affect children, families, and their communities in positive ways. In relation to other social skills, we also observed that children musicians who show higher synchronization with others in a joint-drumming task were more willing to share their resources (e.g., stickers, toys) with others, suggesting that formal music training not only enhances rhythm synchronization skills in children but also generates positive affect and pro-social behavior towards others (Ilari, Fesjian, & Habibi, 2018).

Finally, in relation to brain development and in line with reports from others, we observed that children who received music training show more robust connectivity (larger fractional anisotropy) in the white matter pathways connecting the left and the right hemisphere, via the corpus callosum (see Fig. 1) (Habibi et al., 2018). Given that playing a musical instrument requires processing of sound, coordination of both hands, and integration of actions of auditory and motor systems, it is possible that these demands lead to a higher interhemispheric interaction and communication, which, in turn, might promote an accelerated maturation of the connections that join them.

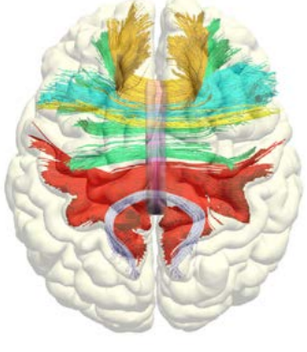

Fig. 1 Aerial view of the brain from the top depicting white matter pathways connecting the left and the right hemisphere. Children who received music training showed more robust connectivity in the frontal, sensory and motor segments of these interhemispheric connections. Image from data collected as part of ongoing study at the Brain and Creativity Institute (2012–2020); post-processed by Dr. Hanna Damasio (2020), CC-BY-NC-ND.

Concluding Remarks

The findings from this multi-method interdisciplinary research program indicate that music education induces a degree of brain and behavioral changes in developing children that cannot be attributable to pre-existing biological traits and developmental abilities. Considering these findings, the idea of reducing or removing music lessons from education curriculum is unjustifiable. However despite the unequivocal evidence indicating that participation in music education programs can positively benefit children, schools will continue to adopt a take-it-or-leave-it approach as long as legislators and policymakers view music participation as relatively inconsequential, and do not allocate the necessary budgets to support implementation and maintenance of music programs. Neuroscience and psychology research now show that music and arts in general can play an important role in developing the intellectual and emotional well-being of our children. We believe that it is the responsibility of every education policymaker to consider these findings seriously and to ensure that we keep in place the financial and educational structures that provide all students—irrespective of their socio-economic status, ethnic, or geographic background—access to a complete and balanced education with high standards for every subject including music and arts.

References

Alloway, Tracy Packiam, Susan Elizabeth Gathercole, Anne-Marie Adams, Catherine Willis, Rachel Eaglen, and Emily Lamont. 2005. "Working Memory and Phonological Awareness as Predictors of Progress towards Early Learning Goals at School Entry", *British Journal of Developmental Psychology*, 23(3): 417–426, https://doi.org/10.1348/026151005x26804

Bailey, Charles E. 2007. "Cognitive Accuracy and Intelligent Executive Function in the Brain and in Business", *Annals of the New York Academy of Sciences*, 1118(1): 122–141, https://doi.org/10.1196/annals.1412.011

Eisenberg, Nancy, Adrienne Sadovsky, Tracy L. Spinrad, Richard A. Fabes, Sandra H. Losoya, Carlos Valiente, Mark Reier, Amanda Cumberland, and Stephanie A. Shepherd. 2005. "The Relations of Problem Behavior Status to Children's Negative Emotionality, Effortful Control, and Impulsivity: Concurrent Relations and Prediction of Change", *Developmental Psychology*, 41(1): 193–211, https://doi.org/10.1037/0012-1649.41.1.193

Habibi, Assal, B. Rael Cahn, Antonio Damasio, and Hanna Damasio. 2016. "Neural Correlates of Accelerated Auditory Processing in Children Engaged in Music Training", *Developmental Cognitive Neuroscience*, 21: 1–14, https://doi.org/10.1016/j.dcn.2016.04.003

Habibi, Assal, Antonio Damasio, Beatriz Ilari, Ryan Veiga, Anand Joshi, Richard Leahy, Justin Haldar, Divya Varadarajan, Chitresh Bhushan, and Hanna Damasio. 2018. "Childhood Music Training Induces Change in Micro and Macroscopic Brain Structure; Results from a Longitudinal Study", *Cerebral Cortex*, 28(12): 4336–4347, https://doi.org/10.1093/cercor/bhx286

Habibi, Assal, Beatriz Ilari, Kevin Crimi, Michael Metke, Jonas T. Kaplan, Anand A. Joshi, Richard M. Leahy, David W. Shattuck, So Y. Choi, Justin P. Haldar, Bronte Ficek, Antonio Damasio, and Hanna Damasio. 2014. "An Equal Start: Absence of Group Differences in Cognitive, Social, and Neural Measures prior to Music or Sports Training in Children", *Frontiers in Human Neuroscience*, 8(SEP), https://doi.org/10.3389/fnhum.2014.00690

Habibi, Assal, Alissa Der Sarkissian, Martha Gomez, and Beatriz Ilari. 2015. "Underprivileged Communities: Strategies for Recruitment, Participation, and Retention", *Mind, Brain, and Education*, 9(3): 179–186, https://doi.org/10.1111/mbe.12087

Hennessy, Sarah L., Matthew E. Sachs, Beatriz Ilari, and Assal Habibi. 2019. "Effects of Music Training on Inhibitory Control and Associated Neural Networks in School-Aged Children?: A Longitudinal Study", *Frontiers in Neuroscience*, 13: 1–16, https://doi.org/10.3389/fnins.2019.01080

Herholz, Sibylle C., and Robert J. Zatorre. 2012. "Musical Training as a Framework for Brain Plasticity: Behavior, Function, and Structure", *Neuron*, 76(3): 486–502, https://doi.org/10.1016/j.neuron.2012.10.011

Ilari, Beatriz, Cara Fesjian, and Assal Habibi. 2018. "Entrainment, Theory of Mind, and Prosociality in Child Musicians", *Music & Science*, 1: 2059204317753153, https://doi.org/10.1177/2059204317753153

Ilari, Beatriz, Priscilla Perez, Alision Wood, and Assal Habibi. 2019. "The Role of Community-Based Music and Sports Programmes in Parental Views of Children's Social Skills and Personality", *International Journal of Community Music*, 12(1): 35–56, https://doi.org/10.1386/ijcm.12.1.35_1

Ilari, Beatiz S., Patrick Keller, Hanna Damasio, and Assal Habibi. 2016. "The Development of Musical Skills of Underprivileged Children Over the Course of 1 Year: A Study in the Context of an El Sistema-Inspired Program", *Frontiers in Psychology*, 7, https://doi.org/10.3389/fpsyg.2016.00062

Miller, Earl K., and Jonathan D. Cohen. 2001. "An Integrative Theory of Prefrontal Cortex Function", *Annual Review of Neuroscience*, 24(1): 167–202, https://doi.org/10.1146/annurev.neuro.24.1.167

Miller, Holly Ventura, J. C. Barnes, and Kevin M. Beaver. 2011. "Self-Control and Health Outcomes in a Nationally Representative Sample", *American Journal of Health Behavior*, 35(1): 15–27.

Moffitt, Terrie E., Louise Arseneault, Daniel Belsky, Nigel Dickson, Robert J. Hancox, HonaLee Harrington, Renate Houts, Richie Poulton, Brent W. Roberts, Stephen Ross, Malcolm M. Sears, W. Murray Thomson, and Avshalom Caspi. 2011. "A Gradient of Childhood Self-Control Predicts Health, Wealth, and Public Safety", *Proceedings of the National Academy of Sciences*, 108(7): 2693–2698, https://doi.org/10.1073/pnas.1010076108

Music for All Foundation. 2004. *The Sound of Silence: The Unprecedented Decline of Music Education in California Public Schools: A Statistical Review* (Warren, NJ: Music for All Foundation), https://www.americansforthearts.org/by-program/reports-and-data/legislation-policy/naappd/the-sound-of-silence-the-unprecedented-decline-of-music-education-in-california-public-schools-a

Rabkin, Nabkin, and E. C. Hedberg. 2011. *Arts Education in America: What the Declines Mean for Arts Participation. Based on the 2008 Survey of Public Participation in the Arts. Research Report 52* (Washington, D.C.: National Endowment for the Arts), https://www.arts.gov/sites/default/files/2008-SPPA-ArtsLearning.pdf

Sachs, Matthew, Jonas Kaplan, Alissa Der Sarkissian, and Assal Habibi. 2017. "Increased Engagement of the Cognitive Control Network Associated with Music Training in Children during an FMRI Stroop Task", *PLoS ONE*, 12(10): e0187254, https://doi.org/10.1371/journal.pone.0187254

Swaminathan, Swathi, and E. Glenn Schellenberg. 2016. "Music Training", in *Cognitive Training*, ed. by Tilo Strobach and Julia Karbach (Cham: Springer International Publishing), pp. 137–144, https://doi.org/10.1007/978-3-319-42662-4