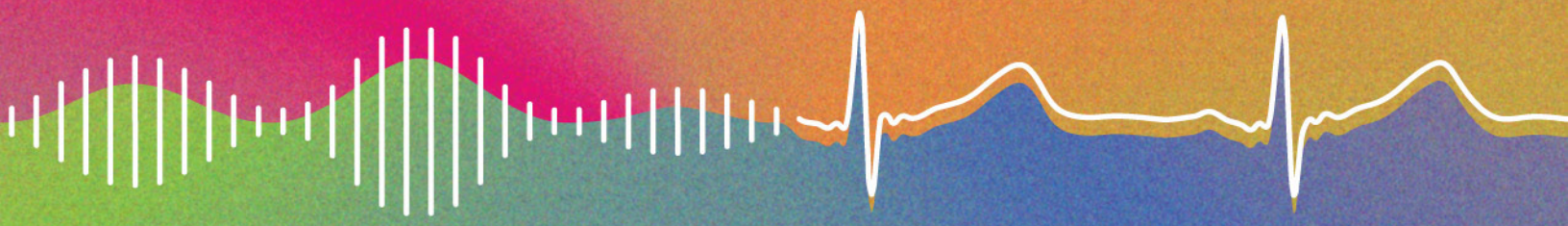
National Institutes of Health

Music as Medicine

The Science and Clinical Practice



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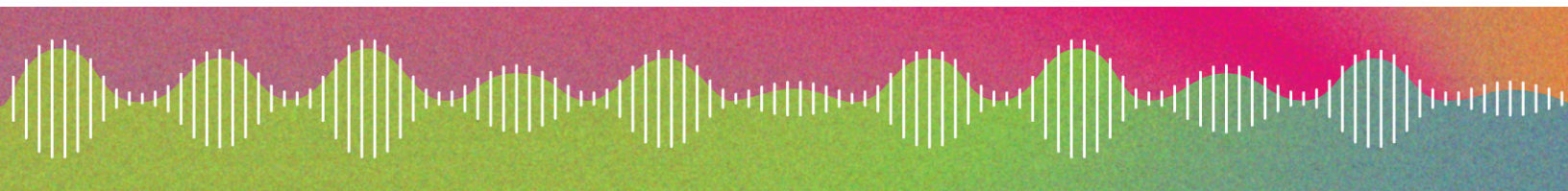
NATIONAL ENDOWMENT for the ARTS

RENÉE FLEMING

The Kennedy Center



Executive Summary

The workshop "Music as Medicine: The Science and Clinical Practice," was sponsored by the National Institutes of Health (NIH) and the National Endowment for the Arts (NEA) and jointly organized by NIH, the NEA, the Renée Fleming Foundation, and the John F. Kennedy Center for the Performing Arts. It aimed to highlight accomplishments from the last 6 years in advancing scientific research on music and health, develop a blueprint for the next phase of research, and further build the research community.

In opening remarks, **Dr. Helene M. Langevin, director of the National Center for Complementary and Integrative Health (NCCIH),** noted the growing emphasis on incorporating nonpharmacologic treatments such as music-based interventions (MBIs) into health care and explained that research in this field fits with NCCIH's goal of improving the health of the whole person.

In his Day One keynote, "NIH's Music and Health Research—What Have We Accomplished So Far?," **Dr. Francis Collins, former director of NIH** and co-chair of the workshop, discussed the landmark 2017 NIH workshop on research on music and the brain and the activities that resulted from it, including the development of the NIH toolkit for research on MBIs for brain disorders of aging, a symposium at an annual meeting of the Society for Neuroscience, and Sound Health presentations at the Kennedy Center. In addition, NIH has identified the most compelling scientific areas and issued funding opportunities, which led to a $35 million investment in new research, including studies of the impact of music experiences on infants, children, and adolescents as well as research on the use of imaging technologies to better understand the neural impact of music.

In opening remarks, **Dr. Maria Rosario Jackson, chair of the NEA,** explained that music is one of the most powerful transformative experiences, impacting people intellectually, physically, emotionally, and spiritually. She discussed the NEA's long-standing commitment to working at the intersection of the arts and health and its involvement in the Sound Health initiative. In special remarks, **Dr. Bruce Tromberg, director of the National Institute of Biomedical Imaging and Bioengineering,** pointed to the shared interests between musicians and biomedical engineers, both of whom are interested in generating, receiving, and modulating signals over a range of wave frequencies. Studies of MBIs are a gateway to understanding key life processes and ways to transform our health, he said.

The performer for **Session One: Research on the Science of Music,** Mr. Shelly Berg of the University of Miami, discussed the roles of the technical and spiritual wells of musical understanding in creating music's effects on emotion. He illustrated his points by performing his piano composition "Julia." Speakers and panelists in this session discussed the roles of different regions of the brain in responding to music. In various brain hubs, perception and analysis, memory and associations, expectancy generation, movement, sensory feedback, visual perception, and emotional reactions all play roles in responses to music. Clear, strong responses have been detected in both the left and right parts of the temporal lobe, and the populations of neurons that process music overlap with those that process words. Music, more than speech, engages emotional centers in the brain that mediate reward and arousal. Research in songbirds, a valuable animal model, supports the importance of connections between the auditory and motor regions of the brain in rhythm perception. In humans, differences in pitch perception have been demonstrated for harmonic versus inharmonic stimuli. Music-evoked memories have been found to be more detailed, vivid, and emotional than memories evoked by other types of cues. Music listening has impacts on the affective domain across

the lifespan, and group participation in music may have stronger effects on mood and pain than music experienced individually.

Challenges in research on music as a therapeutic intervention include rigorously investigating the characteristics of the music itself, selection of appropriate subjects for research studies, and understanding how expectations work at the neural level. Workshop participants agreed that artists, therapists, and scientists have much to learn from one another about how music works and how its effects can be harnessed therapeutically.

In special remarks, **Dr. Joshua Gordon, director of the National Institute of Mental Health,** explained that although we know from personal experience that music is important to mental health, rigorous science is needed to establish the benefits of music and to better understand the nature of the connection.

To begin **Session Two: Research on Music Therapy and Music Medicine,** Ms. Jeralyn Glass of Crystal Cadence performed with crystal singing bowls and explained that these instruments may have unique effects on the brain and on people's emotions because of their characteristic sound vibrations. Speakers in this session explained that NIH-supported studies have progressed from concentrating on the physiological effects of music to investigating its cognitive and psychological effects and exploring the applications of music therapy in health care settings. They have also delved into the neuroscientific aspects of music, examining impacts on brain structure, connectivity, and function. Individual studies discussed in this session are investigating a mindfulness-based music therapy intervention for cancer patients undergoing allogeneic stem cell transplant, an MBI to reduce stress and improve infant gestational age in Black women, mental singing to enhance walking for people with Parkinson's disease, and the use of the body tambura (a musical instrument designed for use in music therapy) as a treatment for chronic pain.

In panel presentations and discussion, participants noted the importance of clinicians as natural historians who generate material for future research, advocated for sharing of ideas through stories and observations as well as scientific publications, discussed the potential use of vocal music to longitudinally follow lung disease, suggested that addressing past traumas with music can be a part of music therapy and disease management, and advocated for practice-based research as a source of insights about which patients respond better to specific therapies.

In special remarks, **Dr. Theresa Cruz, director of the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development's National Center for Medical Rehabilitation Research,** thanked the meeting organizers for including people with disabilities when planning their agenda. She asked attendees to consider whether their work would be even more impactful with greater inclusion.

At the beginning of **Session Three: Research on Music Education and Health,** pediatrician Dr. Lisa Wong and her daughter Ms. Jenn Chang performed the beautiful but mournful piece "Ashokan Farewell" (best known from its use in the television miniseries *The Civil War*). Dr. Wong explained how emotionally resonant music such as this can help children learn to listen deeply, communicate nonverbally through music, and bring their senses together to develop memories. The scientific presentations in this session focused on the important roles played by music educators and music education programs at life stages from infancy to old age. Research findings suggest that predictable rhythm, including during musical interactions, may support the development of social and communication skills in infants and young children, including those with and without neurodevelopmental differences. Musical training for children can support school readiness and success and enhance performance on tests of working memory and executive function. The emotion regulation, social understanding, and peer affiliation that music provides may help to lay the groundwork for cognitive and academic gains. Observational studies have linked music and arts participation with higher levels of both fluid and crystallized intelligence and with characteristic patterns of brain activity. In older adults, music education interventions such as group piano training can have beneficial effects on cognitive

function by contributing to cognitive reserve, thus delaying the onset of cognitive decline.

Participants emphasized that music education for children is not an equitably distributed resource in the United States; disadvantaged or disabled children and those from small or charter schools are less likely to have access to it. Much relationship building is needed to strengthen links between music education and biomedical and behavioral research. Musicians and music educators are very knowledgeable and may be the source of important research questions as well as insights on what really matters in the school setting. Focusing on mutual respect between the communities and learning to speak each other's languages is important.

In closing remarks at the end of the first day of the workshop, **Dr. Julie Gerberding, chief executive officer of the Foundation for the NIH,** shared three takeaway points from the day: First, truly understanding the science of music and medicine is not just a nice thing to do; it is a medical imperative. Second, access to music and music education should be looked at as a social determinant of health and well-being. And finally, music is an incredibly powerful connector that can bring people from different backgrounds and cultures together. It transcends the differences between people, and all can sing from the same sheet of music.

In Day 2 opening remarks, **Dr. Richard Hodes, director of the National Institute on Aging (NIA),** explained that connectivity is a key theme of NIA's work and of this workshop. He said that it is exciting to see basic research on music being translated into clinical interventions for people with dementia and other conditions. **Ms. Deborah Rutter, president of the Kennedy Center,** said that meetings like this, which bring together scientists, artists, and others, may lead to positive results that had not been anticipated. She said that she will do whatever she can, with the soapbox of the Kennedy Center, to facilitate collaborations and tell the story of music and health.

In her keynote presentation, "Looking Forward—Arts and Health in Science and Society," **Ms. Renée Fleming, Artistic Advisor at the Kennedy Center,** told the workshop participants that they are a remarkable community of thinkers who are daring to make a connection between disciplines that have too often stood apart. She described a wide range of examples of research projects and community- and health care-based programs that benefit children, older adults, those with chronic diseases such as Parkinson's disease and dementia, those with mental health problems, and others. A key element in all this work, she said, is human connection. The creative, expressive elements of our humanity are essential at a time of rapid societal change. Performing artists can be encouraged to see that the stage and concert hall are not the only outlets for their gifts; careers in the arts and health can also be fulfilling. Much has been accomplished in research on music and health, Ms. Fleming said, but much more remains to be done.

In special remarks, **Dr. Amy Adams, acting deputy director of the National Institute of Neurological Disorders and Stroke (NINDS),** explained NINDS's longstanding commitment to research on music, the brain, and health. Research findings in this field have pointed to opportunities for music as therapy and may help unlock persistent mysteries of how the brain works.

The musical performer in **Session Four: Future Research Directions,** Dr. Grace Leslie of the University of Colorado Boulder, explained that even though technological advances have made it possible to treat music as a disembodied sensory stimulus, music is still a form of communication between one person and another that acts on multiple levels. She demonstrated the use of technology to transform her brain waves and heart sounds into music as an illustration of the embodied nature of all music performance. Research discussed in this session included studies showing that sound induces analgesia through corticothalamic circuits in an animal model; that beat synchronization is highly polygenic in humans and is genetically correlated with motor, respiratory, and processing speed traits; that digital rhythm training may facilitate cognitive functions in ways similar to those facilitated by traditional musical training; that singing interventions may improve some markers of cardiovascular function in older adults; and that dance interventions may have benefits for

older adults with cognitive impairment or early dementia and their caregivers. Additional research is looking at neural mechanisms for brain computations fundamental to the understanding and perception of music, the neural basis of imagination, technological tools that may make participation in musical discovery and composition available to broader groups of people, and the use of music and virtual reality to reduce pain sensitivity, among other topics.

Developing interdisciplinary teams and collaborative funding for work that involves both artists and scientists is an ongoing challenge. Other key issues include the replicability of arts-based interventions, intellectual property concerns, and translation into public health practice. Research on dance and health could benefit from standardization of outcomes, identification of cognitive tests sensitive to a dance intervention, and development of dance-specific mobility tests. Understanding the biological basis of music and musicality may help to identify risk and resilience for a variety of health traits and disorders and could facilitate the use of music in precision medicine, both for diagnosis and for treatment.

Session Five: Networks and Capacity Building of an Integrative Health Research Community included presentations on the Sound Health Network, which promotes research and public awareness about the impact of music on health and wellness through a broad range of activities, and on four music research networks recently funded by NIH—three focusing on pain and one focusing on dementia. These networks, each with a different emphasis, will bring researchers from multiple fields together, develop essential tools such as conceptual frameworks and taxonomies of key terms, investigate mechanisms of action, support pilot projects, and conduct dissemination and education activities such as visiting scholar training programs, summer institutes, and publication of special journal issues.

Panel presentations focused on the roles of the World Health Organization, the Baltimore Symphony Orchestra, Howard University and other minority-serving educational institutions, local and county government, and the NeuroArts Blueprint Initiative in supporting music education, access to the arts, and research. Participants in the Session Five discussion emphasized the need for community collaborations in research and explained that the NIH-funded networks will include various types of community collaborations. They also drew attention to difficulty of disseminating research findings to the public and suggested working together with community and religious organizations, involving community health workers, creating opportunities to involve young adults in the conversation, holding focus groups in the community, and making use of new technologies including social media. In his performance at the end of this session, Mr. Fred Johnson of the David A. Straz Center for the Performing Arts brought together themes from the workshop using the African Joli tradition of storytelling through song, emphasizing the healing effects of music on both the body and the soul and the importance of both scientific data and creativity in supporting the health benefits of music and other arts.

In special remarks, **Dr. Debara Tucci, director of the National Institute on Deafness and Other Communication Disorders (NIDCD),** said that through NIH-wide music and health funding opportunities and other mechanisms, NIDCD has funded nearly $100 million of research related to music. NIDCD also supports training in this field. **Dr. Rick Woychik, director of the National Institute of Environmental Health Sciences (NIEHS),** said that NIEHS research is beginning to include environmental exposures that can positively impact health, such as music. The time is ripe, he said, to integrate music into not only environmental health research but biomedical research in general. **Dr. Nora Volkow, director of the National Institute on Drug Abuse (NIDA),** said that music is relevant to NIDA's mission as a potential therapeutic intervention in the treatment of substance use disorders and as a form of healing for the community to help prevent drug abuse and other diseases of distress.

At the beginning of **Session Six: Integration of Music-Based Interventions Into Health Care Systems,** Mr. Raul Midón, a songwriter, guitarist, and disability rights ambassador, performed two of his songs—

"Suddenly" and "Keep On Keeping On"—and commented on the multiple impacts of music, such as its ability to create bonds between people, including those who do not share a common language or culture. The scientific portion of the session began with a presentation by Dr. Emmeline Edwards of NCCIH on the new NIH Toolkit for MBIs, a web resource designed to ensure that researchers use unbiased and well-controlled experimental designs and appropriate methodology, analysis, interpretation, and reporting of results in their studies. A funding opportunity for feasibility trials guided by the toolkit is currently available. Other speakers discussed the development of reporting guidelines for MBIs—vital tools for ensuring that studies are comparable and reproducible and that their findings can be integrated into practice—and the value of tools developed by NIH to enhance the quality of clinical trials, such as the Patient-Reported Outcomes Measurement Information System (PROMIS) and the NIH Toolbox (a collection of more than 50 neurobehavioral measures).

The development of an evidence-based intervention does not ensure that it will be used in practice. New interventions need to be designed in ways that will facilitate their use, and dissemination and implementation research is needed to ensure that scientific discoveries reach the people who can benefit from them. Lessons learned from the implementation of other types of interventions can inform the implementation of MBIs and help break down barriers to their use. Implementation research often involves challenging traditional assumptions, such as the ideas that evidence-based practices and systems are static, that implementation proceeds one practice at a time, that consumers/patients are homogeneous, and that choosing not to implement is always irrational. Although fidelity of interventions is desirable, adaptation will also occur over time, just as the ways of playing recorded music have evolved over time.

Understanding the perspectives of providers, payers, and policymakers can be helpful to those who hope to implement MBIs in health care practice. Providers cannot be all things to all patients, and payers cannot pay for everything that might be beneficial. Often, reimbursement only occurs in response to state mandates. Policy stakeholders need high-quality evidence to support the treatment benefits and cost effectiveness of interventions.

This session also included a panelist presentation on social prescribing—a means for connecting people to nonclinical and community-based resources, such as arts, culture, nature, and social activities, to support health and well-being. Social prescribing programs are rapidly expanding throughout the world, including in at least 28 pilot programs in the United States.

In the **Day Two Closing Session,** Dr. Collins and Ms. Fleming led a discussion that focused on ways to continue conversations on music as medicine. Suggestions included annual meetings, a publication from this workshop, starting a society, starting a journal, giving a prize, and connecting with established publications and established conferences. Dr. Collins suggested seeking out possible connections with other NIH initiatives with overlapping interests. The Society for Neuroscience meetings were suggested as a good way to reach a very large audience, and the Gordon Conferences were suggested as an opportunity for a deeper dive. The new NIH-funded research networks will have roles to play in outreach and will hold annual meetings in their focus areas.

Participants also mentioned that academic leadership needs to become involved in promoting interdisciplinary work, that room needs to be made for dance and other practices involving movement while maintaining the focus on music as medicine, and that the arts have value in promoting flourishing as well as helping to manage health conditions. All workshop participants were invited to create profiles in the Sound Health Network's free, searchable directory (https://soundhealth.ucsf.edu/network-directory), which provides an opportunity for clinicians, scientists, and musicians to find each other for collaborations in areas of mutual interest. The workshop ended with a group performance, led by Dr. Collins, of a song with lyrics adapted for this event.