

# Music as Medicine

The Science and Clinical Practice



December 14–15, 2023



# Full Summary

## DAY 1

**Opening Remarks:** Helene M. Langevin, M.D., National Center for Complementary and Integrative Health (NCCIH) Director

Dr. Langevin said that music is a primal part of human existence, so its roles in physical and mental health are not surprising. Currently, there is growing emphasis on incorporating nonpharmacologic treatments such as music-based interventions (MBIs) into health care. Some MBIs primarily target the sensory and emotional regions of the brain, while others target movement and cognition. Research in this field fits with NCCIH's goal of improving the health of the whole person through health promotion and restoration, disease prevention, and symptom management.

**Keynote: NIH's Music and Health Research—What Have We Accomplished So Far?** Francis Collins, M.D., Ph.D., NIH Distinguished Investigator, National Human Genome Research Institute, Former NIH Director

Dr. Collins explained that a previous workshop, held in 2017, brought experts together to determine what research could be done on music and the brain. Twenty-five researchers, plus representatives from the Kennedy Center and the National Endowment for the Arts (NEA) and spokespeople for music therapy professional and advocacy groups, participated in a deep dive into the existing research and opportunities. They created an agenda for future research, which was presented in a paper published in *Neuron*. In response, the National Institutes of Health (NIH) created an NIH-wide music and health working group. Members of this group organized a series of three workshops that led to the creation of a toolkit for research on MBIs for brain disorders of aging. Other activities have included a symposium at an annual meeting of the Society for Neuroscience, as well as Sound Health presentations at the Kennedy Center. NIH has identified the most compelling areas for new research 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. Potential future research directions include new technologies, further integration of music therapy and neuroscience, cultural contexts, implementation science, and integration with other arts-based interventions.

**Opening Remarks:** Maria Rosario Jackson, Ph.D., Chair, NEA

Dr. Jackson explained that music is one of the most powerful transformative experiences, impacting people intellectually, physically, emotionally, and spiritually. The NEA has worked at the intersection of the arts and health, wellness, and well-being for many years, including through joint efforts with NIH and other organizations involved in the Sound Health initiative. NEA is also dedicated to improving the health and well-being of military populations and is supporting a randomized controlled trial on music therapy for veterans with chronic pain. Dr. Jackson said that none of the goals we aspire to as a nation of opportunity are possible without understanding the role of the arts in our lives.

**Special Remarks:** Bruce Tromberg, Ph.D., National Institute of Biomedical Imaging and Bioengineering Director

Dr. Tromberg said that his remarks would be a bridge between the previous speakers and the first scientific session. Musically, a bridge is a change of pace, and it summarizes how biomedical engineers think about

music. Both musicians and engineers master instruments that generate and receive powerful invisible forms of energy, with signals over a range of wave frequencies, and modulate those signals in complex ways. Tuning these energy sources to the right frequencies can make them resonant with fundamental biological processes. However, much remains to be learned about how people’s bodies process music. This rapidly growing field of science has never been more urgent and important; it is a gateway to the understanding of key life processes and ways to transform our health.

## SESSION ONE: RESEARCH ON THE SCIENCE OF MUSIC

### **Illustrative Performance:** Shelly Berg, M.M., University of Miami School of Music

Mr. Berg played short musical excerpts on the piano to illustrate the importance of expectations in people’s reactions to music, how they differ for different musical genres, and how various musical devices and contexts can be used to elicit specific reactions from an audience. He discussed the roles of the technical and spiritual wells of musical understanding in creating music’s effects on emotion and illustrated his points by performing his composition “Julia.”

### **Medicine’s Melodies:** Music, Healing, and Wellness: Daniel Levitin, Ph.D., Minerva University/ McGill University

Dr. Levitin gave an overview on music and the brain. The populations of neurons in various regions of the brain fire in synchrony to a musical beat and play roles in the processing of music. In different brain hubs, perception and analysis, memory and associations, expectancy generation, movement, sensory feedback, visual perception, and emotional reactions all play roles in brain responses to music. Music, more than speech, engages emotional centers in the brain that mediate reward and arousal. Listening to music also facilitates entry into the default mode network—the parts of the brain that function when you’re not exerting control. Music affects body and brain chemistry, including substances involved in immune responses, alertness, and sleep/wake cycles. Serotonin and dopamine levels increase following pleasurable music listening, and cortisol levels drop following meditative music. In studies of perioperative pain, music reduced pain by 1.4 points on a 10-point rating scale. Music was as effective as a benzodiazepine in reducing stress and anxiety before surgery. The therapeutic effects of music may be linked to its inherent ambiguity; it is not a reflection of emotions but a window into them. This ambiguity challenges us to discern meaning in a subjective medium; music can do many things because it can mean many things, and it is among the most intimate art forms.

### **Investigating Auditory-Motor Interactions During Rhythm Perception in Songbirds:** Mimi Kao, Ph.D., Tufts University

Dr. Kao explained that music often features periodic auditory rhythms. The ability to synchronize movements to these rhythms—as illustrated by the beneficial impact of a strong beat on gait in a person with Parkinson’s disease (PD)—suggests strong connections between the auditory and motor regions of the brain. Perception of rhythm is predictive and tempo flexible; it involves detection of relative rather than absolute timing. Research shows that even in the absence of movement, periodic auditory rhythms strongly engage the brain’s motor system, which may play a causal role in rhythm perception, using signals from the auditory system to predict the timing of upcoming events. Dr. Kao uses songbirds as models for exploring auditory/motor interactions at the circuit level. Like humans, songbirds learn their vocalizations and use rhythmically timed vocalizations for communication. Dr. Kao’s research has shown that most male zebra finches can learn to discriminate isochronous from arrhythmic stimuli in a tempo-flexible manner across a range of rates. Female zebra finches, which do not learn to sing, can also perform this task but are slightly less adept. This is consistent with the reduced but functional auditory-motor circuitry in females.

## **Diversity in Pitch Perception:** Malinda McPherson, Ph.D., University of California, San Diego

Pitch conveys critical information in music, speech, and other natural sounds. The rate of repetition of periodic sounds is referred to as the fundamental frequency, called  $f_0$ . Sounds that are periodic in time generally have harmonics, which are integer multiples of a common  $f_0$ . Pitch discrimination is classically assumed to rely on a representation of  $f_0$ , and it has been assumed that tasks that rely on representations of  $f_0$  would be impaired with inharmonic stimuli. However, Dr. McPherson's studies have shown that  $f_0$  is not necessary for discriminating higher from lower pitch. People can do it with both harmonic and inharmonic stimuli. When tested on harmonic sounds (where listeners can use a representation of the spectrum or the  $f_0$ ), inharmonic sounds (where they must use the spectrum), and interleaved harmonic sounds (where they must use  $f_0$ ), listeners performed worse with interleaved harmonics when there was no delay, but their performance didn't deteriorate with delay. Listeners switch from one pitch code to another when remembering a sound. Investigations of neural responses to inharmonic tones using functional magnetic resonance imaging (fMRI) showed that pitch-sensitive voxels respond equally to harmonic and inharmonic tones. Harmonic structure ( $f_0$ ) is critical for remembering pitch, discriminating musical intervals, detecting out-of-key notes, hearing and discriminating tones and melodies in noise, and recognizing voices. However, it is not needed for basic pitch discrimination, providing invariance to timbral differences, speech prosody, or lexical tone discrimination.

## **Music Cognition, Memory, and Aesthetics:** Amy Belfi, Ph.D., Missouri University of Science and Technology

Dr. Belfi explained that music evokes autobiographical memories, and music-evoked memories are more detailed, vivid, and emotional than those evoked by other types of cues, such as visual images. For example, a study in her lab showed that people's descriptions of memories evoked by popular music from a particular time period were significantly more episodically detailed than their descriptions of memories evoked by pictures of celebrities from the same time period. Other studies have shown that music-evoked memories contain more motor-perceptual details than lifetime period cues, music is more likely than pictures of world events to evoke memories in people with Alzheimer's disease, music-evoked memories are associated with greater episodic re-experiencing and more intense emotions than memories evoked by television shows, and in everyday life, music is more likely than food cues to trigger memories. People can make aesthetic judgments of short snippets of music (less than a second) that predict how they will react to the whole piece of music with above-chance accuracy. The context in which people hear music also influences aesthetic judgments. For example, a comparison of reactions to a live concert and a recording of that concert showed that the standard deviation of ratings in the live setting was greater.

## **Encoding of Melody in Human Auditory Cortex:** Edward Chang, M.D., University of California, San Francisco (UCSF)

Dr. Chang explained that melody is a succession of pitches, defined by rhythms. The pitch of an individual note, the change of pitch from one note to the next, and expectations about one note following another are all critical parts of melody. To better understand expectations, Dr. Chang and his colleagues used an artificial intelligence algorithm to examine millions of examples of music to build a statistical model of the probability of one note following the next. Such models are specific to different types and genres of music. Dr. Chang and his colleagues have studied brain responses to music using electrocorticography data from patients who were undergoing surgery for epilepsy. Clear, strong responses to music were detected in both the left and right parts of the temporal lobe. The populations of neurons that were processing music overlapped with the areas that process words. Pitch, pitch change, and expectation were each encoded by a distinct neural population. Small parts of the auditory cortex are selective to music rather than speech, but they are mixed in with others rather than being located separately. Unlike pitch and pitch change, which reflect general purpose auditory coding, expectation is encoded via a neural specialization for music. The locations involved

in encoding musical expectation do not respond to speech. However, music responses in the temporal lobe emerge when speech is melodized, that is, when the speech pitch contour is turned into a musical register. The understanding of how melody is processed in the temporal lobe is rapidly evolving as research continues.

## Panel Presentations

**Victor Wooten of Bela Fleck and the Flecktones** suggested imagining that someone was doing a study on you but never talked about it. They would get many things right about you but would get some wrong. He suggested thinking about music as a spirit and asking it what it thinks at a given time. When Mr. Berg, who presented the illustrative performance for this session, said that the song he played had appeared in the time it took him to play it, he was listening to what music is saying. There may be a place for that in our studies.

**Elizabeth Margulis, Ph.D., Princeton University**, said that music has structure in terms of both its materials and its uses. People's responses to music depend on the context in which they are exposed to it. To optimize effects, we need to think as much about the patterns of people's previous exposure to music as we do about the musical stimuli we present. Research teams need to have expertise thinking deeply about the cultural uses of music as well as its material structure.

**Petr Janata, Ph.D., University of California, Davis**, presented data on coupling the dynamic structure of music to brain responses during autobiographical remembering. Activity in some brain regions is greater during exposure to music that evokes memories compared to other music. Dr. Janata and his colleagues hope to use neuroimaging to look at the formation of memories linked to music as well as their subsequent activation.

**Frank Russo, Ph.D., Toronto Metropolitan University**, explained that musical synchrony (people singing or playing instruments together) is an important aspect of some MBIs. Research consistently shows an increase in pain threshold when people sing or drum together. Improvements in mood and increases in oxytocin levels have been demonstrated for people participating in a choir but not for those who were singing individually.

**Tonya Bergeson, Ph.D., Butler University and Indiana University School of Medicine**, discussed the impact of music listening on affective domain across the lifespan. When caregivers sing to crying babies or speak to them in singsong tones, it engages their attention and helps regulate their mood. As people grow into adolescence, they associate positive emotions with music they hear in social settings. Playing individualized music from their adolescent years for older adults with dementia results in decreased short-term sundowning symptoms and longer-term benefits for mood, behavior, and cognition.

**Vern Falby, Ph.D., Emeritus, Johns Hopkins University Peabody Conservatory of Music**, said that a major challenge in using music as a therapeutic intervention is ensuring that pieces of music are investigated in rigorous and reproducible ways. There are analytical approaches that help performers and composers capitalize on the architecture of musical pieces to better communicate with their audiences. Dr. Falby is seeking scientific partners to test the effects of design features of pieces of music for their therapeutic effects.

## Discussion

- Selection of appropriate subjects for studies of music as medicine is important. It may be important to select people with little formal musical training or to compare results for accomplished musicians versus nonmusicians. Selection should depend on the research question.
- The idea that a specific part of the cortex is dedicated to music has been contentious for some time.
- Some differences in brain responses may be evident in people who have had early, intense musical training compared to those who have not.

- People with brain damage that impairs speech may be able to learn to sing because some intact neural circuits overlap with those that are damaged. You can bootstrap yourself into restoring the damaged circuits or activating latent redundant circuits. This is the basis for melodic intonation therapy for people with aphasia.
- Scientists who study music are strongly interested in expectations at a variety of levels—ranging from culture and context to spiritual and emotional levels to neural responses to individual notes. At the neural level, understanding how expectations work is important because it is linked to recognition of novelty and structure, which also relates to other brain areas and functions.
- Because many types of organisms use the neural circuitry involved in responses to music for various forms of communication, evolutionary conservation of these responses is likely. However, it has not been directly examined.
- Shared musical experiences are characteristic of most of the world’s cultures. Across evolutionary history, music has almost always been participatory and universal. However, current Western culture lacks a common melodic language and has created a class of music specialists—an unusual situation that may be detrimental.
- It is possible to identify characteristics of particularly powerful and beautiful music, but there is tension between these aesthetic ideals and the experience of the individual.
- Artists, therapists, and scientists have much to learn from one another about how music works and how its effects can be harnessed therapeutically.

**Special Remarks:** Joshua Gordon, M.D., Ph.D., National Institute of Mental Health (NIMH) Director

Dr. Gordon pointed out that we all know from personal experience that music is important to mental health. But although a natural connection exists, rigorous science is needed to establish the benefits of music and to better understand the nature of the connection. NIMH supports a variety of projects on music and health, including a study of the impact of singing to infants on synchronization of facial expressions, a study in which music is used to help people with social anxiety disorder better understand facial cues, and a study testing the potential benefits of songwriting for people with schizophrenia. Much more work needs to be done on music and mental health, Dr. Tromberg said, and he thanked the organizers of this meeting for their efforts.

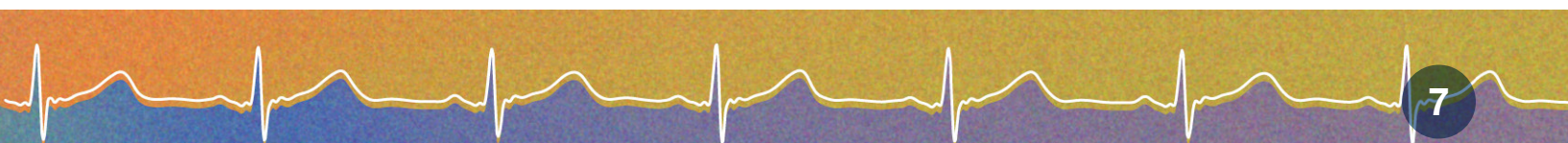
## SESSION TWO: RESEARCH ON MUSIC THERAPY AND MUSIC MEDICINE

**Illustrative Performance:** Jeralyn Glass, Crystal Cadence

Ms. Glass performed with crystal singing bowls and explained that this instrument may have unique effects on the brain because of its characteristic sound vibrations. She said that music has the power to take people beyond words and bring joy to their lives, and she explained that healing through music was helpful in her own life in a time of grief. She described positive emotional and healing experiences associated with entrainment with the frequencies of sound produced by singing bowls, and she discussed their use in therapeutic settings with groups such as cancer patients, hospice patients, and veterans.

**Music Medicine and Music Therapy at a Glance:** Marisol Norris, Ph.D., MT-BC, Drexel University

Dr. Norris explained that great strides in music-based clinical research have occurred in recent decades. While both music therapy and music medicine involve the use of music in health care, music therapy research led by music therapy practitioners centers the therapeutic engagement to support wholeness. Music medicine is often used as a complementary intervention within the broader context of clinical care. 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. Many attempts have been made to define the power, work, and scope of music therapy, with reference to its influence on human behavior and the physical world, the unconscious dimensions of music experience, the roles of music in self-actualization and spiritual development, its role as context-driven work, and its sociopolitical nature. Critical aesthetic dimensions of music-based clinical research include music-based experience; the clinical or therapeutic relationship(s); the participant's internal and external resources; the researcher or practitioner's personhood, orientation, and skill; and culturally sustaining practice.

### **eHealth Supported Mindfulness-Based Music Therapy Intervention for Allogeneic Stem Cell Transplant Patients:** Teresa Lesiuk, Ph.D., University of Miami

Dr. Lesiuk explained that stem cell transplant is a highly challenging cancer treatment that causes substantial symptoms such as pain, fatigue, and distress, which can continue for years and decrease quality of life and functioning. The development of integrative interventions may reduce debilitating symptoms, improve health-related quality of life, and ameliorate disease activity in this population. Dr. Lesiuk and her colleagues are evaluating mindfulness-based music therapy (MBMT), which combines elements of music therapy, such as music engagement and music-assisted relaxation, with well-established elements of mindfulness, such as awareness and attention regulation. This intervention has had beneficial effects in other cancer populations but is being tested for the first time as an eHealth intervention in allogeneic stem cell transplant patients. The first phase of this research involved refining and finalizing MBMT and a comparison mindfulness intervention using qualitative feedback from study participants. The next phase is a pilot randomized controlled trial (RCT) to examine the feasibility and acceptability of the MBMT and mindfulness interventions in adults with a hematologic malignancy scheduled for allogeneic stem cell transplant. If that trial succeeds, the research will move on to a larger, fully powered RCT.

### **Impact of a Culturally Based Music Intervention on Metabolites and Metabolic Pathways Associated with Chronic Stress and the Risk of Preterm Birth in Black Women:** Joanne Loewy, D.A., L.C.A.T., MT-BC, Mount Sinai Health System

More than half of Black pregnant women do not reach term in their pregnancies. Chronic stress is believed to play a role. Its biological impact can include shortened telomeres, inflammation, hypothalamic-pituitary-adrenal (HPA) axis dysregulation, and changes in metabolic pathways. Dr. Loewy's research aims to determine whether a live MBI can influence this process. The aims of her study include characterizing maternal prenatal metabolic profiles associated with chronic stress and infant gestational age among Black women, characterizing these profiles between MBI and sham control groups, and assessing the efficacy of an MBI to reduce stress and improve infant gestational age, as well as exploring how the intervention effects are mediated. The literature lacks evidence of deep listening and responses to Black lived experience. Therefore, focus groups were conducted to inform the music therapy sessions with topics related to music and stressors, as well as issues inherent to Black women.

### **Sing for Your Saunter: Enhancing Walking for People With Parkinson's Using Self-Generated Rhythmic Cues:** Gammon Earhart, Ph.D., P.T., Washington University in St. Louis

Dr. Earhart explained that disability in PD often begins with walking. Changes in walking lead to falls, increased mortality, and reduced quality of life. Walking in PD is slower, with smaller strides and greater variability. It has been known for decades that synchronizing footfalls to music can enhance gait, but this only works while music is playing, requires a device, and does not adapt to needs in the moment. Singing might be an alternative, and some people with PD use this strategy. Preliminary studies showed that singing and



mental singing influence gait velocity similarly, but mental singing leads to less gait variability. Dr. Earhart's current study is investigating the neural mechanisms of mental singing vs. music from an external source and whether personalized cues are more effective. For most people, cueing at about 120 percent of their normal walking rate is optimal. Velocity, cadence, and stride length all increased significantly when using optimized cues. With optimized cues, gait is least variable during mental singing, compared to music or no cues. The newest data, from fMRI, show multiple differences in brain activity with different types of cueing.

### **The Body Tambura as a Music-Based Treatment for Chronic Pain:** Carlene Brown, Ph.D., MT-BC, Seattle Pacific University

Research indicates that listening to monochrome-based music can reduce pain, but little is known about the underlying mechanisms. Dr. Brown described a current feasibility study that will estimate the effects of two music conditions—music therapy and music medicine—on electroencephalogram (EEG)-assessed brain activity, focusing on frontal-midline theta oscillation power. The music is played on a body tambura, a 28-stringed instrument created for use by music therapists. Its music has been found to reduce pain in palliative care settings, and its effects may be linked to its impact on EEG-assessed brain activity. In the current study, which involves people with low-back pain, the music therapy protocol involves Dr. Brown playing the body tambura live, and the music medicine protocol uses a recording of her playing. The control group listens to a reading of a narrative text. EEG measurements are made before, during, and after treatment. If the findings of this study support the feasibility of the intervention, they will inform the design of a larger, more definitive controlled trial.

## **Panel Presentations**

**Melita Belgrave, Ph.D., MT-BC, Arizona State University,** uses multiple therapeutic approaches to enhance the cognitive, physical, and psychosocial skills of older adults. During the pandemic, she worked on collaborative research with an ethnomusicologist, taking advantage of a musical instrument museum and galleries of music from around the world to develop virtual interventions for older adults. She and her collaborators had 2 years to work on that project and did not jump into the research right away. This was advantageous because it allowed time to build a foundation before developing research questions.

**Concetta Tomaino, D.A., Institute for Music and Neurologic Function,** said that part of the Institute's mission is to bring together the worlds of neuroscience and clinical music therapy. In the field of neurorehabilitation, some MBIs are well established, such as the use of a rhythmic beat to help synchronize gait in people with PD and the use of melodic intonation therapy for people with nonfluent aphasia. Clinicians and scientists need opportunities to share information through additional means besides publication; sharing stories and observations is important.

**Michael Stanley, M.D., Brigham and Women's Hospital,** said that clinicians are the natural historians who make the future of science possible. He considers himself a scientific clinician rather than a clinician scientist. His case studies are N of 1, which means that his coinvestigators are patients, and the clinical endpoints are relief of suffering and preservation of wellness. This is an awkwardly supported and little funded enterprise. Dr. Stanley hopes to incentivize and systematize the role of scientific clinicians to better generate material for further research.

**Maria Gonsalves Schimpf, M.A., MT-BC, Denver Health RESTORE,** directs a program that is focused on promoting and sustaining mental well-being of the health professional workforce. This is done through peer support, psychological first aid, emotional support, and training and education at both the individual and collective/organizational levels. As an analytical music therapist, she is interested in learning whether analytically informed music and creative arts interventions can benefit this population.

**Panagis Galiatsatos, M.D., Johns Hopkins University**, explained that multiple diseases with different causes affect the lungs, and they cannot be identified with a single biomarker. However, it may be possible to use vocal music as a tool to longitudinally follow lung disease. Dr. Galiatsatos oversees the program Medicine for the Greater Good, which promotes community health through leadership from community health workers. The program has recruited health workers who are also musicians to assist in situations where people need trauma-informed care.

**Lori Gooding, Ph.D., MT-BC, Florida State University**, representing the American Music Therapy Association (AMTA), said that research has always been a priority for AMTA. AMTA has two journals and two grants that help support music therapy research projects. The association also hosts conferences, symposia, and other events at regional and national levels where students and professionals can learn about and share research. Additionally, the association promotes research by sharing evidence-based information about music therapy through its education and advocacy work.

## Discussion

- If science is to be a public trust, it should be informed by the community. Research and practice are two sides of the same coin; each can inform the other.
- To help patients remember to use music-based techniques they have learned, therapists may include homework and involve the patient's care partner.
- In response to a question about what mechanism guides improved walking in PD patients, Dr. Earhart said that the original hypothesis was that an external stimulus like music could bypass the basal ganglia and create a detour through the cerebellum, while an internal cue could take advantage of whatever basal ganglia function is left. However, what she is seeing is greater activity in both the basal ganglia and the cerebellum when internal cues are used.
- In response to a question, Ms. Glass said that playing the crystal singing bowls involves both a high intention and learned technique.
- Addressing past traumas with music can be an important part of music therapy and disease management.
- In many cultures, singing and dancing are integral to daily life and are important ways in which people engage with one another. It may be necessary to introduce song and dance into research to gain access to psychosocial needs.
- The education of music therapists includes studies of music, behavioral science, and human anatomy, followed by music therapy courses, clinical placements, a 6-month internship, and a professional board examination.
- Practice-based research, in which data are collected as part of routine care of large numbers of people, can provide useful insights about which patients respond better to specific therapies. Research and practice can and should work together.
- Trauma and disease conditions affect systems and families as well as individuals. The most distributed neural network is that between one person's brain and another's. Diseases are social, and music and the other arts can help to address them. The community can lead this effort, and science can follow.

**Special Remarks:** **Theresa Cruz, Ph.D., Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD)/National Center for Medical Rehabilitation Research (NCMRR) Director**

Dr. Cruz said it has been a pleasure to be part of this event as a fan of both the music and the science. Like NCCIH, NICHD is not focused on a single organ or disease. The Institute has a broader mission; its vision

is healthy pregnancies, healthy children, and healthy and optimal lives. She thanked the meeting organizers for including people with disabilities when planning their agenda and urged them to take inclusion and accessibility into account when planning research and practice. She asked attendees to consider whether barriers exist that might prevent more people from being part of their work and to consider whether their work would be more impactful with greater inclusion.

## SESSION THREE: RESEARCH ON MUSIC EDUCATION AND HEALTH

### **Illustrative Performance:** Lisa Wong, M.D., Harvard Medical School

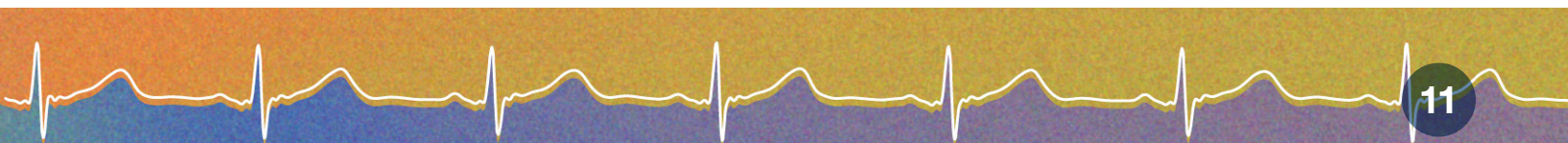
Dr. Wong and her daughter Ms. Jenn Chang performed the beautiful and mournful piece “Ashokan Farewell” (best known from its use in the television miniseries *The Civil War*). Dr. Wong explained that emotionally resonant music such as this can help children learn to listen deeply, communicate nonverbally through music, and bring their senses together to develop memories. She expressed her appreciation to music teachers who work with children every day and to researchers who are studying the impact of music education on children at the cognitive and neuroscientific levels. Music can play a crucial role in social-emotional learning, Dr. Wong said, and playing music with and for others can be a powerful antidote to loneliness and isolation.

### **Social Development in Early Childhood:** Miriam Lense, Ph.D., Vanderbilt University Medical Center

Dr. Lense explained that music is a natural and ubiquitous part of early interactions between children and their caregivers. Rhythmic behavior is prominent in infant-directed communication, as seen in the speech, movements, facial expressions, and affective touch of communicating partners. Dr. Lense has conducted studies to determine whether entrainment to predictable rhythmic structure of infant-directed singing supports the infant’s attention to the caregiver’s eyes, a very early emerging and highly conserved form of social behavior. As early as 2 months, infants increase eye looking timed to the beats of singing. At 6 months, there is a fourfold increase in eye looking in time with the beats of the singing versus chance levels. In nonautistic and autistic toddlers, the same eye tracking experiment showed that both groups exhibit increased eye looking locked to the beat, though it was reduced and more variable in the autistic toddlers. The response is reduced in jittered singing in both groups of toddlers, but in autism it is further reduced. Together, these findings suggest that predictable rhythm, including during musical interactions, may provide a mechanism for supporting social and communication skills. The findings from this research have been incorporated into the design of an integrated psychoeducational parent-child music class for children with and without neurodevelopmental differences such as autism.

### **School Readiness and Early School Success:** Steven Holochwost, Ph.D., Lehman College, City University of New York

Dr. Holochwost discussed research involving a collaboration with Play On Philly (POP), which offers intensive musical training to children from pre-K to high school. Previous work showed that children randomly assigned to participate in POP had better performance on measures of executive functions, better cognitive abilities essential to school readiness and success, and higher grades and standardized test scores. One possible explanation is that music education may tune the parasympathetic nervous system in young children. This hypothesis is being tested by studying young children participating in POP versus a control group. The children participate in a battery of executive function tasks at the beginning and end of the year, while wearing a pulsometer to monitor parasympathetic activity. Other studies, conducted in cooperation with an arts-integrated Head Start program, have shown higher levels of school readiness across multiple domains relative to peers attending Head Start programs without the arts component, and have linked these improvements to lower hypothalamic-pituitary-adrenal (HPA) axis activity. Current research is examining specific factors in music education that may lead to these effects. One study showed that children’s HPA axis activity was



significantly lower when music educators allowed them to direct their own activities and interacted with them in a more positive way.

### **Self-Regulation and Executive Functioning in Childhood:** Assal Habibi, Ph.D., University of Southern California

Dr. Habibi is studying the impact of musical training on executive function in children. In a longitudinal study (in which children were not randomly assigned to different conditions), those in a music training program showed better results on tests of working memory in the auditory domain and tests of delayed gratification after 2 years. After 3 years of training, the music group showed more engagement of the executive network of the brain in a test involving distinguishing congruent or incongruent stimuli. The differences between groups diminished as the children reached adolescence, with the control group seeming to catch up with the music group. In terms of working memory, music training was most effective at ages 6 to 10, suggesting that it would be more effective to implement music training in elementary schools than high schools. In a cross-sectional study, children with music training did better on a test of executive function involving auditory stimuli but not on one that used visual stimuli. Dr. Habibi and her colleagues are now conducting an RCT in which Hispanic children of low socioeconomic status are randomly assigned to a music program or a control theater program. The first year of the study was designed to assess feasibility and was successful. The study has now progressed to a fully powered efficacy phase that will rigorously examine effects on executive function.

### **Child and Adolescent Brain and Cognitive Development:** John Iversen, Ph.D., McMaster University

Relationships between music engagement and developmental trajectories in childhood and adolescence can be investigated by leveraging existing large-scale longitudinal studies by nesting music studies within them. Dr. Iversen has done this using two studies: PLING (the Pediatric Longitudinal Imaging, Neurocognition, and Genetics study), which includes about 200 children, and the Adolescent Brain and Cognitive Development (ABCD) Study, which has more than 11,000 participants. These studies have rich longitudinal data on brain, behavior, and genetics. Arts experience in ABCD is assessed through a questionnaire that includes detailed information about participation in a wide range of activities, including their intensity and context. Music and arts participation are positively associated with both fluid and crystallized intelligence in ABCD, and characteristic patterns of regionalized cortical expansion resembling the pattern associated with crystallized intelligence are associated with lifetime hours of music. A modest association with music was also found in the dorsolateral prefrontal cortex, a region associated with executive functions and working memory. In PLING, much more detail about musical phenotypes is available, including tests of rhythm. Positive correlations were observed between increased cortical volume and both rhythm production and rhythm perception, supporting motor theories of beat perception. Nested studies within large-scale longitudinal studies can complement and extend the knowledge gained through controlled intervention trials.

### **Music Education on Cognitive Abilities in Older Adults:** Jennifer Bugos, Ph.D., University of South Florida

Dr. Bugos studies the effects of music education training on cognitive, sensory, and physiological processes in older adults who are musical novices. Music education interventions can be used in both healthy and clinical populations. They may have beneficial effects on cognitive function by contributing to cognitive reserve, thus delaying the onset of cognitive decline. The key ingredients of a successful music education cognitive training program have not been formally established, but the literature suggests that task novelty, bimanual coordination, progressive difficulty, a practice element, and the social components and ecological validity of the intervention are all important. Limitations of research in this field include unmet needs for measures in the trained domain (music achievement), appropriate training/intensity for music interventions, manualized music curricula, active and passive control groups in studies, involvement of licensed music educators, and the use of consistent and appropriate cognitive measures. Dr. Bugos has conducted studies

of individual and group piano training in older adults, including a recent RCT with an active control (computer brain training) as well as a no-treatment control. The studies showed positive impacts of piano training on cognitive functions, particularly verbal fluency and verbal memory, that persisted for several months after the intervention ended. The greatest gains were seen in those with lower cognitive abilities at baseline. Group piano training has also been shown to have benefits for musical and general self-efficacy.

## Panel Presentations

**Indre Viskontas, Ph.D., Sound Health Network**, explained that the benefits of music are not in the final product but in the process of making it. Music education gives children skills such as grit, discipline, a growth mindset, and executive functioning. Music programs also improve school attendance and are linked to fewer risky behaviors such as alcohol use in teens. If one at-risk student graduates as a result of participating in a music program, the net societal gain would pay for 10 years of a music teacher's salary.

**Thalia Goldstein, Ph.D., George Mason University**, pointed out that music for children does not just happen in the lab. It happens in schools, informal learning environments, and homes. Brain-based changes and cognitive changes linked to music are important, but the emotion regulation, social understanding, and peer affiliation that music provides lay the groundwork for cognitive and academic gains. For children, body movement and music are linked, and a variety of activities that combine them have been shown to have beneficial effects for this age group.

**Maud Hickey, Ph.D., Northwestern University, emeritus**, described a completed study of music-making with youth in a detention center and a literature review on music for detained youth. The study examined the effects of a 10-week rap music composition program in 700 incarcerated youths. Themes that emerged from qualitative content analysis included positive feelings and competence. The literature review showed that music has multiple benefits in juvenile detention, including improved self-esteem and self-efficacy, decreased disruptions and recidivism, and improved musical skills and schoolwork.

**Tarrell Davis, M.Ed., Settlement Music School**, described the Kaleidoscope Arts Enrichment Program, an award-winning arts integrated curriculum for children age 3 to 5, most of them from Head Start eligible families, in Philadelphia. A curricular model based on this program will enable it to be successfully scaled on a national level, capturing the arts integration components that lead to school readiness, decreased stress levels, and emotional regulation, as well as closing the learning gap for children from disadvantaged backgrounds.

**Victor Minces, Ph.D., University of California, San Diego**, asked workshop participants to consider what would happen if they were deprived of music. Many people would suffer greatly. Unfortunately, this is the experiment that is being done in many schools. Making music in school can promote paying attention in the classroom. Music can also be used as a teaching tool for lessons on vibrations, waves, and frequencies; this is being done in projects that Dr. Minces leads.

**Kenneth Elpus, Ph.D., University of Maryland**, pointed out that many connections have been made between research in music education and biological research underpinning the science of music. However, the vocabularies of the disciplines differ, so connections may be missed. One key takeaway from social science work is that music education in U.S. public schools is not an equitably distributed resource. Most studies show that American society denies the benefits of music education to disadvantaged or disabled children and those from small or charter schools.

## Discussion

- 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.
- Young adolescents choosing their own music is an important part of developing autonomy, even if parents do not like the choices. However, exposing children to a rich variety of music from cultures around the world at an early age is also valuable and is a recognized part of music education.
- Experience with getting messages about vaccines out into the community during the COVID-19 pandemic illustrates that social networks that include music tend to be cohesive. There are biological mechanisms by which music can promote cohesion, including oxytocin production in response to beat synchrony, and there is an element of shared music making that induces attachments.
- Academics tend to work within narrow silos, with each discipline publishing in different journals and holding its own conferences. Efforts to promote cross-disciplinary work are valuable, but academics who are trying to get promoted and tenured face incentives that do not encourage this type of work. Funding also plays a role, and interdisciplinary funding through agencies such as NIH and the NEA, as well as private foundations, is important for interdisciplinarity. Special journal issues can also provide opportunities for intentional cultivation of cross-disciplinary relationships. There is room for networks of networks, such as NeuroArts or Sound Health, but it takes a concerted effort to bring people together across disciplines. It does not happen organically.
- In analyses of data from large studies such as the ABCD study, the focus so far has been on variables that are easily assessed. More work is needed to identify the most striking and important effects of music on child development.

### **Closing Remarks:** Julie Gerberding, M.D., M.P.H., Foundation for the NIH (FNIH) Chief Executive Officer

Dr. Gerberding expressed appreciation to all the workshop participants. She said that experiencing this day gave her insight into how blessed she was to grow up in a musically rich environment. Listening to the convergence of expertise in different disciplines in this room has been miraculous, she said. She 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.

## DAY 2

### **Opening Remarks:** Richard Hodes, M.D., National Institute on Aging (NIA) Director

Dr. Hodes explained that NIA is committed to health and quality of life as people progress through the life course. Connectivity is a key theme of NIA's work. Connectivity—within the nervous system, with music, and between and among people—is also a key theme of this meeting. Both during normal aging and in the presence of cognitive decline, music triggers memories. Even people highly compromised by dementia may still recall music. Dr. Hodes said that it is exciting to see basic research on music being translated into clinical interventions.

## **Opening Remarks:** Deborah Rutter, M.B.A., President, John F. Kennedy Center for the Performing Arts

Dr. Rutter observed that when artists come together, they do not know what will result, but art happens. Similarly, meetings like this, which bring together scientists, artists, and others, may lead to positive results that had not been anticipated. Dr. Rutter thanked Dr. Collins for bringing different groups of people together and encouraged the attendees at the meeting to be open to new ideas. 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.

## **Keynote: Looking Forward—Arts and Health in Science and Society.** Renee Fleming, M.M., Artistic Advisor, John F. Kennedy Center for the Performing Arts

In her keynote presentation, Ms. Fleming 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 looks forward to the day when MBIs are a regular part of the health care toolbox. Since the 2017 NIH music and health workshop, the field has seen exponential growth. Ms. Fleming 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 PD and dementia, those with mental health problems, and others. A key element in all this work, she said, is human connection. We live in a time of increased dependence on screens, which do not bring about the connection we need. This is all the more reason to emphasize the humanizing effects of the arts in health care. However, technology has positive applications, such as the use of telehealth to provide broader access to music therapy. Ms. Fleming observed that when she first began to make presentations about music research, it was clear that investigators did not necessarily know what other groups are doing. Organizations such as the Sound Health Network and the NeuroArts Blueprint are changing that. The next organizational focus could be to promote advocacy, development, policy, and even greater collaboration. 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, Ms. Fleming said, but much more remains to be done. She encouraged all the workshop participants to develop their own brief elevator pitches to describe the benefits of their work in terms that are meaningful to listeners. Research on music and health is making a real difference in people's lives, and all those involved in the field need to be advocates for their work.

## **Special Remarks:** Amy Adams, Ph.D., National Institute of Neurological Disorders and Stroke (NINDS) Acting Deputy Director

Dr. Adams said she is proud to be here today to share NINDS's longstanding commitment to this important work. NINDS seeks and shares fundamental knowledge about the brain and nervous system and uses that knowledge to develop technologies, treatment, and cures and improve the quality of life for people affected by neurological disorders. Dr. Adams expressed her appreciation for the work discussed here today and acknowledged two champions of this effort at NINDS, Dr. Bob Riddle and Dr. Bob Finkelstein. The fascinating research that has emerged from this initiative not only points to opportunities for music as therapy but can also help unlock persistent mysteries of how the brain works.

## **SESSION FOUR: FUTURE RESEARCH DIRECTIONS**

### **Illustrative Performance:** Grace Leslie, Ph.D., University of Colorado, Boulder

Dr. Leslie 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. The human body and spirit are its transducers and are ultimately responsible for its

healing qualities, she said, and music can be modeled as transference of interoception and bodily awareness from one person to another. Dr. Leslie demonstrated the use of technology to transform her brain waves and heart sounds into music as an illustration of the embodied nature of all musical performance.

### **Sound Induces Analgesia Through Corticothalamic Circuits:** Yuanyuan (Kevin) Liu, Ph.D., National Institute of Dental and Craniofacial Research/NCCIH

It has long been recognized that certain types of sound, including various genres of music, can induce pain relief in humans. Dr. Liu and his colleagues investigated the analgesic effects of sound in an inflammation pain model in mice, using the von Frey filament test to measure mechanical pain sensitivity. Both normal and dissonant music, as well as white sound, attenuated pain-related responses in the model. The analgesia persisted when mice were repeatedly exposed to the sounds for 3 days. The sounds were most effective if played at a level just slightly above the background ambient noise, that is, with a low signal-to-noise ratio (SNR). Chemogenetic inhibition of excitatory auditory neurons was responsible for the analgesia. The researchers identified the thalamic posterior nucleus (PO) as a downstream target of the signals. This nucleus relays somatosensory signals from the spinal cord to the somatosensory cortex, where sensation is perceived. Under inflammation pain conditions, PO neuronal activity was increased, and low SNR sound inhibited the activity of the PO neurons. In summary, these experiments showed an important effect of the auditory cortex on pain perception in this model.

### **Genomic Influences on Sensorimotor Synchronization and New Links With Health:** Reyna Gordon, Ph.D., Vanderbilt University

If musicality is deep in human evolution, as the evidence suggests, there must be a genetic signature to it, Dr. Gordon said. She described her studies of the genetic signature of rhythm. Rhythm has moderate heritability. Performance on motor timing, tapping accuracy, and rhythm discrimination tasks is heritable. In a genome-wide association study (GWAS) on a sample provided by the personal genetics company 23andMe, 606,825 research participants responded to the question “Can you clap in time with a musical beat?”. Ninety-two percent said yes; 8 percent said no. Phenotype validation tests showed that self-reported beat synchronization was a good proxy for measured rhythm phenotypes. Sixty-nine independent genomic loci were associated with beat synchronization, showing it is highly polygenic. Dr. Gordon and her group then gathered data from more than 60 GWAS studies, which showed that beat synchronization was genetically correlated with evening chronotype; lower likelihood of shortness of breath while walking on level ground; and motor, respiratory, and processing speed traits. These findings are congruent with epidemiological evidence linking lung decline, motor decline, and decreased cognitive function; shared genetics may be involved.

### **Mechanisms of Cognitive Change Following Digital Rhythm Training:** Theodore Zanto, Ph.D., UCSF

Previous research has shown that musical training can facilitate numerous cognitive abilities, improving performance on both musical and nonmusical tasks. This is thought to be facilitated by neural networks engaged during rhythm or music training. Dr. Zanto discussed an RCT his group conducted, which used an adaptive rhythm training game played on an iPad. This task specifically challenges exogenous timing and short-term memory abilities but not endogenous timing. The control was a word search game, also played on an iPad. Forty-six healthy nonmusician older adults were randomly assigned to 8 weeks of training on one of the tasks. Before and after the intervention, EEG data were measured while they were engaged in tasks that measure exogenous timing, endogenous timing, or short-term memory. Rhythm training improved exogenous timing, correlated with a decrease in neural variability localized to a sensorimotor network that includes the anterior cingulate, premotor cortex, inferior parietal lobule, and postcentral gyrus. It did not improve endogenous timing. Rhythm training improved performance on a nonmusical short-term memory task (the ability to remember faces). The effect was localized to the right superior parietal lobule, which is involved in



attentional control in the context of memory tasks. This research is a first step and an early indicator that digital rhythm training may facilitate cognitive functions in ways similar to those facilitated by traditional musical training.

#### **Applied Research: Singing for Cardiovascular Health:** Jacquelyn Kulinski, M.D., Medical College of Wisconsin

Older adults with cardiovascular disease show reduced participation in traditional physical cardiac rehabilitation due to frailty, comorbidities, and transportation issues. Singing as exercise could be a promising alternative, but there is a lack of understanding of the biological mechanisms by which singing may affect cardiovascular health. In a pilot study, Dr. Kulinski and her colleagues demonstrated acute improvement in a marker of microvascular endothelial function in cardiac patients who sang along to a recording. Recently, they conducted a feasibility crossover RCT to assess the acute effects of singing interventions, guided by either a video or in-person interactions with a music therapist, on macro- and microvascular endothelial function, heart rate variability, and other biomarkers, as compared to the effects of a rest control. Sixty-nine people with a history of coronary disease, average age 68 years, participated. Microvascular endothelial function showed significant improvement in the video intervention group but not the in-person intervention group, compared to the control group. Macrovascular endothelial function did not show significant differences. An improvement in the control arm may have diluted the effect of the singing interventions, and a carryover effect was observed. Future goals are to explore the most appropriate control group, washout time, and dose for a singing intervention; expanding to the heart failure population; and comparing traditional cardiac rehabilitation with and without singing/music therapy.

#### **Understanding the Mechanisms of Dance for Brain/Body Wellness in Aging:** Christina Hugenschmidt, Ph.D., Wake Forest University

Dance incorporates two behaviors important for brain health in aging: movement and social engagement. Dr. Hugenschmidt and her colleagues conducted a randomized single-blind 12-week, four-arm factorial trial comparing the effects of improvisational dance movement, social engagement, and these two interventions together versus usual care on quality of life in people with mild cognitive impairment (MCI) or early dementia and their caregivers. They hypothesized that the movement components of dance would strengthen connectivity in somatomotor regions and lead to improved balance, and that social engagement would reduce mood and behavior symptoms. The study was interrupted by the COVID-19 pandemic, which led to a reduced final enrollment and a mid-study switch to virtual interventions. The somatomotor network showed nonsignificant improvements in the hypothesized direction. There was a significant moderating effect of diagnosis (MCI versus dementia) on several associations with brain networks. Both caregivers and patients responded positively to the movement-alone intervention during the pandemic, suggesting opportunities for in-home mHealth interventions. Dr. Hugenschmidt's next study focuses on dosing of dance interventions (one, two, or three times a week), with outcomes of cardiorespiratory fitness and cognition. She recommended that future directions in research on dance and health should include standardization of outcomes, identification of cognitive tests sensitive to a dance intervention, and development of dance-specific mobility tests.

### **Panel Presentations**

**Maria Geffen, Ph.D., University of Pennsylvania**, studies neural mechanisms for brain computations fundamental to the understanding and perception of music, including discrimination of sound frequency and identifying the sequence of notes. The auditory cortex is the key region where information in the brain is transformed from representing the physical structure of the acoustic waveform into more abstract, more

cognitive representations; it includes both excitatory and inhibitory cell types. Two specific inhibitory neurons have been found to be key to frequency discrimination and pattern detection.

**Shihab Shamma, Ph.D., University of Maryland, College Park**, discussed imagination—arguably the most fundamental, difficult, and consequential of all the cognitive functions. Any image you generate comes from the mind, from your memory, and any action you generate begins with an image, which is then very quickly transformed into movement, voice, or another action. Studying imagination has been very challenging. When you imagine, you generate real, very precise signals in the brain. However, these signals are small and difficult to measure, and cooperation of study participants is crucial.

**Tod Machover, M.S., Massachusetts Institute of Technology Media Lab**, said that music is a fantastic laboratory for composition and creativity. New technological tools can make composition available to everyone. One software tool, called Hyperscore, allows you to make motives, melodies, and rhythms and turn those into compositions, with musical notation that musicians can play. The next generation of tools may enable musical discovery—an exploratory approach using generative AI. With new tools, musical creativity can have widely accessible forms that can positively affect well-being. Mr. Machover described citywide and international composition projects that have been completed or are currently in progress.

**Luana Colloca, M.D., Ph.D., University of Maryland, Baltimore**, described a multidisciplinary study in which she and her colleagues used two types of three-dimensional immersive virtual reality involving music—one nature based and one opera based—to explore mechanisms by which such experiences may reduce thermal pain sensitivity. They learned that pain tolerance increased when people enjoyed the music they were listening to, and a three-dimensional experience was more powerful than a two-dimensional one. The same techniques are now being studied in people with chronic pain.

**Juliet King, Ph.D.(c), ATR-BC, LPC, LMHC, The George Washington University**, said that the use of arts-based therapies was criticized in a recent preprint in *Nature Perspectives* in which the authors claimed that it is unethical to use these therapies with patients because of a lack of compelling evidence for the value of the arts in healing. However, new techniques are enabling the impact of arts therapies to be studied in rigorous quantitative ways, particularly with neuroimaging technologies that can be used outside the laboratory. Ms. King argued that there is an ethical and moral obligation and a medical imperative to understand the science of arts and therapeutics. Multidisciplinary interactions between the arts and sciences can help make this possible.

## Discussion

- A participant suggested that studies of music in animal models could benefit from collaboration with composers who have mapped the audible spectrograms of certain animal species. Dr. Liu said that how rodents perceive human music is an unanswered question. Rodents are quite social and use both sound and ultrasound to communicate. Dr. Geffen added that it is very difficult to study the responses of rodents to sounds produced by other species because the animals are extremely fearful.
- 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.
- Although there are sex differences in pain, men and women respond equally well to pain-directed MBIs. Sex stereotypes can be a social barrier to participation in some of the arts, such as dance.
- Although expectancy and placebo effects probably play a role in the impact of MBIs on pain, music has a stronger effect than mere construction of imagery. Virtual reality augments the analgesic effects of music, apparently by keeping people focused.

- 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. Measurements of rhythm impairment may help to identify children at higher risk of speech and language disorders, for example.
- In response to a question, Dr. Zanto explained that the effect demonstrated in his study on short-term memory for faces is likely to be a domain-general improvement. The superior parietal lobule expands various forms of visual information, not just memory of faces, as well as verbal information.
- In response to a question from Ms. Fleming, Mr. Machover explained that recruiting a broad range of participants for the citywide composition projects has been challenging and has required much person-to-person contact. Recruitment for the international project has been challenging because it involved learning new ways to make connections remotely.
- Dr. Robert Finkelstein of NINDS explained that NIH receives substantial funding from the Helping to End Addiction Long-term® Initiative, or NIH HEAL Initiative®, which focuses on pain. He asked the audience to help create ways to bring the music and health research community into this effort.

## SESSION FIVE: NETWORKS AND CAPACITY BUILDING OF AN INTEGRATIVE HEALTH RESEARCH COMMUNITY

### **Sound Health Network: A New Opportunity for Collaboration:** Charles Limb, M.D., UCSF

Dr. Limb explained that the Sound Health Network is an initiative of the NEA, in partnership with UCSF, in collaboration with NIH, the Kennedy Center, and Renée Fleming, to promote research and public awareness about the impact of music on health and wellness. The 2017 NIH workshop, which led to the Sound Health initiative and later creation of the Network, was pivotal because it was the first time NIH brought scientists together to talk about music. The Sound Health Network was formally launched in January 2021 in a virtual event. The Network strives to reach multiple groups of stakeholders, including the music and health research community, music therapists, scientists in related domains, broader music communities, and the general public, through music and health content, networking tools, and communications. Its resources and activities include a website ([soundhealth.uscf.edu](http://soundhealth.uscf.edu)), featured projects, a clearinghouse of publications and reports, grant opportunities, educational workshops, a webinar series, in-person convenings, virtual networking, and newsletters. The Network is a work in progress and welcomes ideas on how to provide resources more effectively.

### **Music4Pain Network:** Joke Bradt, Ph.D., MT-BC, Drexel University

Dr. Bradt explained that NIH recently funded four music research networks, three focused on pain and one on Alzheimer's disease. Dr. Bradt is the principal investigator of one network, called Music4Pain. Acute and chronic pain are among the most common and costly health problems, and traditional treatments have low efficacy and undesirable side effects. Accumulating evidence shows that MBIs can have benefits for pain, with moderate-to-large treatment effects. However, the underlying mechanisms are not understood, which makes optimization of interventions difficult and contributes to low uptake of these interventions in clinical settings. Music4Pain will bring researchers from multiple fields together, develop a conceptual framework and a taxonomy of key terms related to MBIs, address methodological challenges to mechanistic research, identify treatment response variables and predictive biomarkers, and train and mentor new and early career investigators. The network will fund 1-year pilot projects and a competitive visiting scholar training program for predoctoral and postdoctoral fellows. Dr. Bradt invited everyone to join the network to learn about its activities and take advantage of its resources.

**Effective Network to advance Scientific Evidence related to Mechanisms of Music-Based Interventions for Pain and Support CoLLaborative Efforts (ENSEMBLE):** Jeffrey Dusek, Ph.D., Case Western Reserve University

Dr. Dusek introduced the ENSEMBLE network, one of the three NIH-funded research networks focused on pain. Currently, gaps in understanding the mechanisms of MBIs for pain limit the selection of ideal clinical populations and appropriate clinical outcomes for research. The lack of meaningful and inclusive collaborations, use of inconsistent applications and definitions, and lack of funding and infrastructure have acted as barriers to advancing mechanistic research. ENSEMBLE will promote collaboration between music therapists, mechanistic scientists, and pain and integrative health researchers; develop a comprehensive framework for mechanistic studies in music therapy for pain; and initiate pilot studies. The network's initial focus will be pain associated with sickle cell disease. Activities will include scientific meetings, summer institutes, alignment of terms and taxonomy, development of best practices for patient-reported outcomes, development of electronic health record data mining approaches, and publication of a special journal issue. The new network will leverage collaborations already established by the BraveNet Practice Based Research Network (PBRN).

**Novel Technologies To Explore Mechanisms and Optimize Music-Based Intervention Pain Research:** Debra Burns, Ph.D., Indiana University–Purdue University Indianapolis

Dr. Burns observed that MBIs are very acceptable to patients, but the complexity of these interventions, the lack of evidence-based conceptual frameworks, and overreliance on subjective measures have hampered research in this field. The overarching goal of the Music Mechanisms and Technologies Network (MMTN), which Dr. Burns represented at the workshop, is to develop a framework that integrates basic, mechanistic, and translational research in music that links psychosocial, behavioral, and neurophysiological mechanisms of MBIs and chronic pain. At the same time, the network will identify novel technologies to enhance the objective measurement of pain through direct and indirect physiological pain biomarkers and encourage cross-disciplinary collaboration, including through pilot projects, to better understand the effects of specific music components and interventions. Potential objective measures to complement gold standard patient-reported outcomes for pain include electrophysiological, -omics, imaging, and behavioral techniques. The network includes experts in MBI research, neuroscience, mechanistic and intervention pain research, neural interface techniques and objective measures of pain, computational methods, integrative medicine intervention development, basic/bench science, and grantsmanship education.

**Research Network To Accelerate Mechanistic Studies of Music for Dementia (RN-MusD):** Julene Johnson, Ph.D., B.M., UCSF

Dr. Johnson introduced the NIH- and NEA-funded network that will study MBIs for dementia. It has been known for decades that people with dementia can engage with music in meaningful ways, even in the late stages of the disease. There is an urgent need for accessible approaches to reduce the burden of dementia and improve well-being for patients and their families. MBIs are a promising approach, but studies to date have had limitations in terms of size, quality, inclusion, outcomes, analytic approaches, bias, and unclear mechanisms. The overall goal of RN-MusD is to accelerate research that aims to understand the mechanisms by which MBIs affect health and well-being for older adults living with Alzheimer's disease or related dementias and their care partners. This will be accomplished by building a multi-institution, multidisciplinary research network to accelerate mechanistic studies, promoting collaborations through a pilot project program, and disseminating resources to sustain impact and evaluate progress, including resources on mobile brain-body imaging technologies relevant to MBIs and dementia. The network brings together experts in music therapy, cognitive neuroscience, dementia, biomedical engineering, and statistics. Dr. Johnson

asked the audience to save the dates (April 22–24, 2024) for the network’s Year 1 Retreat, which will include 50 to 60 stakeholders representing multiple key disciplines.

## Panel Presentations

**AZA Allsop, M.D., Ph.D., Yale University and Howard University**, said that the social domain is a powerful lens to help us consider both how to treat mental health symptoms and how to evolve our society to be more collective and sustainable. He and his colleagues study how the brain engages in social information processing and whether tools such as music, mindfulness, and psychedelics can shift those representations to facilitate social connection. In novel two-person behavior models, changes in harmonic progressions have led to effects in specific brain regions such as the angular gyrus.

**Christopher Bailey, M.L.I.S., World Health Organization (WHO)**, said that policy is important to the WHO to ensure that research is not set on the shelf but instead reaches the greatest number of people, including excluded and vulnerable populations. Some desirable policies related to arts-based therapies have been implemented in various countries, and a resolution may be considered in the World Health Assembly to unlock worldwide investment in the arts for health. New ways of presenting scientific evidence are needed to reach audiences in meaningful ways.

**Nick Skinner, B.Mus., Baltimore Symphony Orchestra**, explained that many underserved communities, including those in Baltimore City, have limited or no music programs in their schools. The lack of music education in these communities perpetuates a glaring inequality. The Baltimore Symphony Orchestra is providing Baltimore youth with equitable access to community-based high-quality music instruction through in-school, after-school, and summer programs. Music should ring through all communities, he said, and should be considered a fundamental right rather than a privilege for students.

**Lora Robinson, M.M.T., MT-BC, Howard University**, noted that Howard University is the only historically Black college or university (HBCU) that has an undergraduate degree program in music therapy. Capacity building includes reaching the next generation of researchers and clinicians. There are untapped resources in spaces such as HBCUs and other minority-serving institutions that do not yet have programs in arts-based therapies, and students at these institutions have rich cultural heritages to share.

**Kristin Sakoda, J.D., Los Angeles County Department of Arts and Culture**, explained that her department serves the largest county in the country, with a highly diverse population of 10 million. The department’s programs operate with a lens of cultural equity—the idea that everyone deserves access to the arts and that resources and recognition should reflect diverse cultures and art forms. Many of her department’s programs, including collaborations with others such as the LA Opera, Healing Arts, and the WHO, advance the arts and health.

**Ruth Katz, J.D., M.P.H., Aspen Institute**, discussed the NeuroArts Blueprint initiative, a partnership between Johns Hopkins University’s International Arts + Mind Lab and the Aspen Institute’s Health, Medicine & Society Program. The initiative defines neuroarts as the study of how the arts measurably change the body, brain, and behavior and how this knowledge is translated to specific practices that advance health and well-being. The Blueprint puts forward five core recommendations for cultivating the field of neuroarts: Strengthen the research foundation; honor and support the many arts practices that promote health and well-being; expand and enrich educational and career pathways; advocate for sustainable funding and promote effective policy; and build capacity, leadership, and communications strategies.

## Discussion

- In response to a question on inclusion of city or county governments in the music research networks, representatives of three of the NIH-funded networks said that their networks' plans include community collaborations of various types, though not necessarily with local government agencies. Ms. Susan Magsamen said that the NeuroArts Blueprint's Community NeuroArts Coalition is developing a toolkit that can be used to bring governments and other groups into a learning community. Other participants mentioned the difficulty of disseminating research findings to the public and suggested collaboration with community and religious organizations, involvement of community health workers, holding focus groups in the community, and making use of new technologies including social media.
- For some types of research, involvement of the community even before research begins is a priority. Dr. Johnson suggested the community collaborations used by the Community of Voices research study (<https://cov.ucsf.edu/>) as a model that may be helpful for others.
- A member of the audience advocated for including young adults in the conversation on the arts and health. For-credit internships in high schools; youth employment programs; meaningful jobs in laboratories, museums, and research facilities; and early involvement in research at the college level were suggested as possibilities.
- Individual forms of music may have different effects on different people. The research to be conducted by the NIH-funded networks is likely to provide insights into the precision medicine aspects of MBIs.

### **Illustrative Performance:** Fred Johnson, David A. Straz, Jr. Center for the Performing Arts

Mr. Johnson brought together themes from the workshop using the African Joli tradition of storytelling through song. His presentation emphasized the healing effects of music on both the body and the soul, the importance of bridging between art and science, the need to help people understand that music is more than just entertainment, and the importance of scientific data as well as intuition and creativity in supporting the health benefits of music and other arts.

### **Special Remarks:** Debara Tucci, M.D., M.S., M.B.A., National Institute on Deafness and Other Communication Disorders (NIDCD) Director

Dr. Tucci asked the audience to imagine what it would be like to be unable to hear and enjoy music. Over the past 10 years, through NIH-wide music and health funding opportunities and other mechanisms, NIDCD has funded nearly \$100 million of research related to music, including research on the neuroscience of how we analyze complex sounds, the use of music and rhythm to treat atypical language development, and how to improve hearing aid and cochlear implant signal processing for music perception. NIDCD also supports training in various types of music research.

### **Special Remarks:** Rick Woychik, Ph.D., National Institute of Environmental Health Sciences (NIEHS) Director

The mission of NIEHS, Dr. Woychik said, is to investigate how the environment affects people throughout their lives. NIEHS research is beginning to include environmental exposures that can positively impact human health, such as a good diet, plenty of exercise, or music. The time is ripe to integrate music into not only environmental health research but biomedical research in general. With regard to community engagement, which NIEHS strongly supports, Dr. Woychik said that listening to community members and engaging communities in collaborative partnerships are more valuable than lecturing.

## **Special Remarks:** Nora Volkow, M.D., National Institute on Drug Abuse (NIDA) Director

Dr. Volkow said that NIDA's mission is to address the problems of drug use and its consequences. Music is relevant to this mission in multiple ways. The most obvious is activating the reward systems that motivate people's actions—the ones that are hijacked by drugs. This has direct implications with respect to treatment. Providing music as an alternative reinforcer could be a valuable therapeutic intervention. But beyond that, the United States is facing an overdose crisis, motivated in part by isolation, loneliness, and loss of mission. Music could have an impactful effect as a form of healing for the community to help prevent drug abuse and other diseases of distress.

## **SESSION SIX: INTEGRATION OF MUSIC-BASED INTERVENTIONS INTO HEALTH CARE SYSTEMS**

### **Illustrative Performance:** Raul Midón

Mr. 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 relieve interpersonal tensions and create bonds between people, including those who do not share a common language or culture.

### **The NIH Toolkit for Music-Based Interventions: A Path to Strengthening Evidence-Based Research:** Emmeline Edwards, Ph.D., NCCIH

Dr. Edwards said that music has long been thought of as a healing strategy, but research on MBIs faces challenges. Many proposals for MBI projects submitted to NIH have not done well in review because their design was not sufficiently rigorous. To help investigators align their research with NIH policy on rigor and reproducibility, NIH held a series of workshops to inform the development of guidance to improve the quality of the research. The outcome from these workshops is the NIH MBI Toolkit, 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. Use of the toolkit's guiding principles is strongly recommended for NIH-funded studies of MBIs. The toolkit calls for studies of MBIs to include a conceptual model or framework; a clear research question and supporting data to test the hypothesis (from prior studies, the literature, or clinical practice); core common data elements or building blocks; and comprehensive descriptions of the intervention, the protocol for delivering it, the population to be studied, and the control groups or comparators to be used. The toolkit also includes guiding principles and implementation considerations for choosing outcome measures and biomarkers for studies of brain disorders of aging, an area that has shown great promise. A funding opportunity for feasibility trials guided by the toolkit is currently available. For the arts to become prescriptions for the future, Dr. Edwards said, adherence to the scientific method, theory-driven research, a dynamic relationship between practice and research, study of the relationship between psychopathology and treatment, and insurance-friendly concepts are needed.

### **Reporting Guidelines for Music-Based Interventions: Improving Quality and Consistency:** Sheri Robb, Ph.D., MT-BC, Indiana University

Dr. Robb explained that poor reporting of research studies is harmful because biased findings can mislead decision making in health care. Interest in the quality of published research reports emerged in the 1980s and led to the development of reporting checklists such as the Consolidated Standards of Reporting Trials (CONSORT) statement for clinical trials. However, these checklists are more useful for methodology than for describing actual interventions. A lack of clear descriptions of interventions hampers cross-study comparisons, nuanced analyses, interdisciplinary communication, identification of mechanisms of action and

factors that predict benefit, and integration of findings into practice. Problems with the reporting of MBIs have been identified in systematic reviews. Dr. Robb and her colleagues published reporting guidelines in 2011, which specified seven areas of reporting: theory of scientific rationale supporting the intervention, content of the MBI, delivery schedule, interventionist (background, training, credentials of the person delivering the intervention), treatment fidelity, setting, and unit of delivery. Reviews by Dr. Robb's group in 2018 and another team in 2021 indicated that reporting remains poor, and there is great variation in the terminology used to describe interventions. An interdisciplinary group, including authors of the reviews and NIH staff, has come together to rigorously examine, validate, and update the guidelines, using a three-stage process that includes a field scan of recent systematic reviews, a Delphi survey with expert panel analysis, and dissemination. Currently, this process is in its third stage; updated guidelines and an elaboration document are scheduled for publication in 2024.

### **Lessons Learned From Other Tools Developed by NIH: Richard Gershon, M.D., Ph.D., Northwestern University**

Dr. Gershon said the use of NIH-sponsored tools can improve grant applications and the chances of obtaining funding because the tools were designed to improve science. Even though NIH-sponsored tools are obvious choices and are free or inexpensive to use, it takes significant effort to ensure that scientists know about them. Two important health measures developed by NIH are the Patient-Reported Outcomes Measurement Information System (PROMIS) and the NIH Toolbox (a collection of more than 50 neurobehavioral measures). These tools are applicable across the age span, have no intellectual property concerns, are psychometrically sound, are brief and easy to use, and cover the full range of a trait. The sponsors of the new MBI Toolkit can leverage lessons learned from dissemination of PROMIS and the NIH Toolbox to ensure widespread adoption. Active promotion by NIH Institutes and Centers through articles, webinars, newsletters, and conferences helped to expand use of the tools. In addition, for a period of time, NINDS required grant applicants to either use the NIH Toolbox or explain their reasons for choosing an alternative. A similar approach could be adopted for the NIH MBI Toolkit.

### **Integration of a Behavioral Intervention Into the Veterans Health Administration Health Care System: Leslie Katzel, M.D., Ph.D., University of Maryland School of Medicine and Baltimore Geriatrics Research Education and Clinical Center**

Dr. Katzel discussed an intervention called Gerofit, an exercise program that has been implemented in more than 30 sites within the Veterans Health Administration (VHA). It can serve as a model for the implementation of MBIs in health care systems. Gerofit was started in a VHA facility in North Carolina in 1986; dissemination to other sites began in 2014, as part of promotion of patient-centered alternatives to institutional care. The expansion included on-site training to standardize implementation, development of a toolkit of implementation resources, and periodic assessments. Lessons learned during initial implementation included the need to leverage existing staff and resources, local leadership support, an established structure for the program, and good communication. Barriers to implementation included purchasing equipment and supplies, hiring, and space. Implications for the integration of music interventions in health care systems include the need for the system as a whole to value and encourage collaboration; implementation of standardized, well-described interventions that can be tailored and adapted to local needs; identification of local champions and leveraging of existing resources; providing seed money and dedicated protected time; ensuring sustainability; and the importance of collecting outcome data to examine the potential benefits of the intervention.



## **A Brief Introduction to Dissemination and Implementation Research for Music-Based Interventions:** David Chambers, Ph.D., National Cancer Institute

Dissemination and implementation research is about ensuring that scientific discoveries reach people who can benefit from them. Many outcomes of research never make it to implementation, and even when implementation occurs, it takes a very long time. In addition, innovations may not be created in ways that facilitate their use and are compatible with current technology and practices. An evidence-based MBI is only as good as how and whether it is adopted, providers are trained to deliver it, trained providers choose to deliver it, and eligible people receive it. Translating research into action requires establishing real-world effectiveness; adoption, implementation, and maintenance of the intervention; and reaching target populations. Much implementation research 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 to not implement is irrational. Although fidelity of interventions is desirable, adaptation will also occur over time when interventions are used in variable populations and settings and for varying purposes. Methods will also evolve over time, just as the ways of playing recorded music have changed over time. Sustainability therefore requires a dynamic approach to obtain optimal results. Dissemination and implementation are not just topics to be considered after an intervention is developed. Better results can be obtained by considering implementation issues at earlier stages in the research.

### **Panel Presentations**

**Debora Kuchka-Craig, M.H.A., F.H.F.M.A., MedStar Health**, said that 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. Nevertheless, she said she is optimistic about MBIs because of the work being done on outcomes and quality—essential elements in getting interventions moved from the experimental investigative category to the covered category. She is also optimistic because there is a major commitment on the part of governmental and commercial payers to move from volume to value.

**Kimberly Sena Moore, Ph.D., MT-BC, Florida Gulf Coast University**, said that increased access to safe, effective, evidence-supported MBIs and other arts-based interventions requires qualified providers, accessibility, funding, making processes easier for the public to navigate, and enhanced awareness of music-based options on the part of decision makers, professionals, and the public.

**Judy Simpson, MT-BC, American Music Therapy Association (AMTA)**, said that there is a strong relationship between research, state and Federal recognition, and reimbursement. Policy stakeholders often request supporting evidence of treatment benefits and cost effectiveness of music therapy. They respond positively when functional outcomes are clearly defined and cost savings are demonstrated, both for justifying reimbursement and for regulatory recognition of the music therapy profession and national board certification. Seeking inclusion of music therapy as a treatment option requires attention to factors important to policymakers and can help focus the needs for future studies.

**Sarah Lock, J.D., AARP**, said AARP's mission is to empower people to choose how they will live as they age. They cannot make this choice if their brains are not healthy. Music can be a key to sparking a lifetime of healthier brains and disrupting dementia. Evidence that a health intervention is better than a placebo and is safe is critically important to meet the standards established by Medicare, the largest payer in the country. The Centers for Disease Control and Prevention, state and local officials, insurers, and managed care systems also need to be part of the conversation. Ms. Lock asked attendees to contact her if they have NIH-funded data to share on AARP's platform.

**Wendy Weber, N.D., Ph.D., M.P.H., NCCIH**, discussed her experiences with designing pragmatic clinical trials in health care settings to be informative to payers including the Centers for Medicare & Medicaid Services (CMS). What Medicare can cover is defined by law. Interventions must be reasonable and necessary, within the scope of a Medicare benefit category. One of the challenges is that Medicare only recognizes certain categories of service providers, something that only Congress can change. For both Medicare and Medicaid, CMS looks for three key things in research evidence: the quality of the effectiveness data, the impact on outcomes that matter to patients, and research in patients similar to their beneficiaries in terms of age, diversity, co-occurring conditions, and care settings.

**Jill Sonke, Ph.D., University of Florida**, explained that social prescribing is 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. It is meant to fill a gap in wellness and prevention for those who are un- or underinsured as well as to avoid unnecessary high-risk and high-cost medical interventions. Social prescribing programs are rapidly expanding throughout the world, including in at least 28 pilot programs in the United States. Dr. Sonke's lab is studying the impact of social prescribing on key outcomes. These studies have produced evidence that arts participation is a health behavior and that access to the arts is a social determinant of health.

## Discussion

- Both research and practice can contribute to answering the question “Is this intervention ready to be implemented?” The rise of hybrid effectiveness/implementation studies is enabling implementation to be considered earlier in the research process.
- For the use of music as prevention to become more mainstream, cost savings and benefits for specific populations need to be demonstrated. Health policy involves activities at a variety of levels, including laws, funding strategies, governmental guidelines, and organizational and cultural practices. Social prescribing is just one component of this. Ms. Sonke expressed concern that too-rapid implementation of social prescribing in the United States could create systems that do not ensure equitable access for all people.
- A representative of *The Lancet* asked why her journal rarely receives submissions of implementation science papers. Dr. Chambers said that most papers are published in specialty implementation science journals, but publication in more general, high-impact journals could be pursued. There are opportunities at implementation science conferences for editors to come and speak about exactly what they are looking for. Dr. Moore added that at the other end of the implementation development spectrum, it can be difficult to interest journals in early-stage studies such as feasibility trials.
- A participant said that partnerships with musicians should be pursued when planning studies. Musical performers have practical experience in observing people's responses to music. Mr. Midón proposed a syndicated radio program that combines music with stories about MBI research and music therapy. There would be no problem with access because radio is free.
- Dr. Collins explained that the U.S. Preventive Services Task Force (USPSTF) is the organization that evaluates the literature to determine whether preventive interventions work. Its recommendations greatly influence payers' coverage determinations. Right now, the evidence on MBIs most likely would not be considered strong enough for a positive recommendation. Examining USPSTF's standards and processes could be informative.
- A participant mentioned that Canada had a grant program called Knowledge Dissemination. If NIH had a program for knowledge dissemination, with great communicators, it could be very effective.

## DAY TWO CLOSING SESSION

Dr. Collins and Ms. Fleming led the closing session. They thanked the workshop planning committee, the artists who performed, and the NIH leaders who took the time to attend. The workshop presentations underlined the need for connections between research and practice and for common terminology. Dr. Collins suggested seeking out possible connections with other NIH initiatives with overlapping interests, including the Brain Research Through Advancing Innovative Neurotechnologies® (BRAIN) Initiative, the NIH Common Fund's SPARC (Stimulate Peripheral Activity to Relieve Conditions) program, and the NIH HEAL Initiative.

In addition to integration among projects, integration among disciplines is important. NIH can help here by issuing funding opportunities that strongly encourage bringing disciplines together. Including recommendations for the use of common data elements in notices of funding opportunities would also be valuable.

Much of the discussion 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. 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. Scientific meetings and events aimed at broader audiences, such as the Sound Health events at the Kennedy Center, are both needed. The new NIH-funded research networks will have roles to play in outreach and will hold annual meetings in their focus areas.

Other points raised included the following:

- For some participants, the brief video Ms. Fleming showed of a child participating in music therapy during distressing medical treatment was the most moving and memorable part of the workshop. People need to see things like this for themselves.
- Academic leadership needs to become involved in promoting interdisciplinary work and making sure that participation in this type of work does not hamper junior scientists' careers.
- Room needs to be made for dance and other practices involving movement while maintaining the focus on music as medicine.
- Collaborations for research purposes can benefit from including musicians.
- In line with the WHO definition of health, it should be recognized that the arts have value in promoting flourishing as well as helping to manage health conditions.
- Input from the global south, where many cultures are already doing the things advocated here, would be valuable.
- The Department of Education would be a good addition to initiatives on music and health because it reaches children where they are—in schools.

At the end of the discussion, Dr. Johnson asked all participants to create profiles in the Sound Health Network's free, searchable directory <https://soundhealth.ucsf.edu/network-directory>. This directory provides an opportunity for clinicians, musicians, scientists, and others to find each other for collaboration on research in areas of mutual interest. Participants who have additional ideas can share them by sending them to [Music\\_Box@mail.nih.gov](mailto:Music_Box@mail.nih.gov). The workshop ended with a group performance of a song with lyrics adapted for this event.